



**Understanding the Role of Self-Management in Musicians
with Playing-Related Musculoskeletal Disorders**

Noudy Eleryan

**A thesis submitted for the award of
Doctor of Philosophy**

Cardiff University

March 2025

Abstract

Background: Musicians are vulnerable to developing playing-related musculoskeletal disorders (PRMSDs). Self-management interventions can help to reduce the risk and severity of musculoskeletal disorders (MSDs). However, there is a lack of evidence-based self-management interventions for PRMSDs in musicians. Digital health interventions (DHIs) have the potential to provide personalised self-management support. This thesis aims to explore DHIs for self-management of playing-related musculoskeletal disorders (PRMSDs) in musicians.

Methods: Mixed methods design.

Phase 1: A scoping review of the currently available evidence on DHIs for PRMSDs in musicians was conducted to understand how DHIs are currently being designed and implemented for PRMSDs, including their theoretical underpinnings and mechanisms of action.

Phase 2: An online survey and four online focus groups were conducted with UK-based musicians with current or previous PRMSDs to explore musicians' barriers and facilitators to self-management of PRMSDs, health needs, and opinions on the use of DHIs.

Phase 3: Online interviews were conducted with healthcare professionals experienced in managing PRMSDs in musicians to gather diverse perspectives on developing DHIs for their self-management.

Results: Phase 1 identified nine studies examining DHIs for musicians, revealing significant methodological limitations across the literature, including inadequate theoretical foundations, insufficient sample sizes, use of non-validated outcome measures, and limited consideration of self-employed musicians' needs.

In Phase 2, a total of 100 musicians with current or previous PRMSDs participated in the survey study. The majority were self-employed (49%), while 36% were students, 8% were full-time employed musicians, and 5% were both employed and self-employed professional musicians. Thirty-eight percent of the participants experienced PRMSDs 0 to 2 times, 24% experienced them 3 to 4 times, and the remaining 38% reported having PRMSDs more than 5 times in the past five years. The participants indicated that the main contributing factors for their PRMSDs were excessive playing and poor posture.

Furthermore, the participants revealed several barriers to PRMSD self-management, including limited early health education, financial and time constraints, and insufficient accessible resources. Key facilitators and health needs identified were an understanding of musicians' professional demands, personalised health support, peer support, and accessible resources, incorporating features such as well-being support, automated reminders for taking breaks/exercising during long rehearsals, and feedback and monitoring.

In Phase 3, healthcare professionals recommended that DHIs for PRMSDs experienced by musicians should incorporate high-quality pain education, advice and resources to support load management, and potentially health tracking tools such as pain diaries, activity logs, and self-monitoring features, while addressing potential barriers such as safeguarding risks that may require professional oversight. Both

musicians and healthcare professionals emphasised that successful DHI implementation would depend on cost, ease of use, and the consolidation of resources into a single platform.

Conclusion and future implications: This research establishes a foundation for developing DHIs that empower musicians to manage their health effectively while supporting their careers and overall wellbeing. Future work should: (1) develop user-focused DHIs through collaboration with musicians, clinicians, and industry partners to co-design interventions to address musicians' unmet health needs through pain education and appropriate load management advice and prevention, and maximise the potential for scaling up such interventions; (2) integrate key features such as personalised feedback, health tracking, consolidated resources, and peer support; (3) engage with public partners through facilitating workshops with musicians, educators, and industry representatives to ensure that interventions align with the realities of diverse musician populations and are scalable; and (4) conduct feasibility studies and eventually a full randomised controlled trial (RCT) to evaluate the effect of DHI in on PRMSDs and musicians' ability to participate in playing their musical instruments pain-free.

Table of Contents

Abstract.....	i
Table of Contents	iv
Dedication.....	xv
Acknowledgements.....	xvi
Publications and Conference Presentations	xvii
Abbreviations	xviii
List of Tables	xix
List of Figures	xxi
Chapter 1: Introduction.....	23
1.1 Motivation for the Thesis.....	24
1.2 Background	25
1.3 Aim of the Thesis	27
1.4 Research Approach	27
1.5 Overview of the Thesis	29
Chapter 2: Literature Review.....	31
2.1 Introduction	32
2.2 Literature Search Strategy	32

2.3 Definition and Prevalence of Musculoskeletal Disorders.....	36
2.4 Definition and Prevalence of Playing-Related Musculoskeletal Disorders	38
2.5 Risk Factors and Underlying Mechanisms for Musculoskeletal Disorders and Playing-related Musculoskeletal Disorders.....	40
2.5.1 Personal Risk Factors	43
2.5.2 Physical Risk Factors	45
2.5.3 Psychological Risk Factors.....	46
2.5.4 Cultural Risk Factors	47
2.5.5 Lifestyle Factors.....	50
2.5.6 Summary.....	51
2.6 Management of Playing-Related Musculoskeletal Disorders in Musicians	51
2.6.1 Workplace Physiotherapy Services.....	52
2.6.2 Ergonomic Equipment.....	54
2.6.3 Health Education.....	55
2.6.4 Exercises	58
2.6.5 Summary.....	62

2.7 Self-Management Interventions for Playing-Related Musculoskeletal Disorders	63
2.8 Digital Health Interventions for Playing-Related Musculoskeletal Disorders	66
2.9 Gap in the Literature and Rationale for the Thesis	70
2.9.1 Aim	71
Chapter 3: Methodology	72
3.1 Introduction	73
3.2 Philosophical Assumptions	73
3.3 Design Thinking	77
3.3.1 The Medical Research Council Framework	78
3.3.2 Development – Phase 1: Identifying the Evidence Base	78
3.3.3 Development – Phase 2: Identifying or Developing Theory	80
3.4 Multiphase Mixed Methods Design.....	88
Chapter 4: Phase 1: Scoping Review	90
4.1 Introduction	91
4.2 Study Design and Methods	91
4.2.1 Stage 1: Review Question, Aim and Objectives	92

4.2.2	Stage 2: Identifying Relevant Literature.....	92
4.2.3	Stage 3: Study Screening and Selection.....	96
4.2.4	Stage 4: Charting the Data	96
4.2.5	Stage 5: Collating, Summarising and Reporting Results	97
4.3	Search Results	98
4.3.1	Risk of Bias.....	100
4.4	Discussion	122
4.4.1	Exercise-Based Interventions	122
4.4.2	Health Education.....	125
4.4.3	Method of Delivery	127
4.4.4	Settings and Related Factors.....	129
4.5	Strengths and Limitations	131
4.6	Summary and Future Recommendations	131
Chapter 5: Phase 2 / Part 1 – Survey Study		134
5.1	Introduction	135
5.2	Research Question, Aim and Objectives	136
5.2.1	Research Question	136

5.2.2	Aim	136
5.2.3	Objectives	136
5.3	Study Design and Methods	137
5.3.1	Eligibility Criteria.....	138
5.3.2	Sampling Method	138
5.3.3	Sample Size	139
5.3.4	Recruitment Strategy	139
5.3.5	Survey Questions.....	140
5.3.6	Survey Tool.....	146
5.3.7	Pilot Survey	146
5.3.8	Data Analysis.....	147
5.4	Ethical considerations	149
5.4.1	Ethical Approval.....	149
5.4.2	Data Collection.....	149
5.4.3	Risk Assessment.....	150
5.4.4	Data Storage and Handling	151
5.5	Results	151

5.5.1	Participants' Characteristics	151
5.5.2	The Frequency of Playing-Related Musculoskeletal Disorders in the last Five Years	154
5.5.3	Impact of Playing-Related Musculoskeletal Disorders on Musicians' Career, Stress and Social Connections	160
5.5.4	Management Methods of Playing-Related Musculoskeletal Disorders	161
5.5.5	Participants' Needs and Preferences for Improved Management of Playing-Related Musculoskeletal Disorders	163
5.6	Discussion	166
5.7	Strengths and Limitations of the Study	174
5.8	Summary and Future Recommendations	175
Chapter 6: Phase 2 / Part 2 – Focus Group Study		176
6.1	Introduction	177
6.2	Research Question, Aim and Objectives	178
6.2.1	Research Question	178
6.2.2	Aim	178
6.2.3	Objectives	178

6.3 Study Design and Methods	179
6.3.1 Sampling and Recruitment.....	180
6.3.2 Sample Size	183
6.3.3 Number and Size of Focus Groups	184
6.3.4 Topic Guide and Development of Questions	186
6.3.5 Pilot Study	187
6.4 Ethical Considerations	188
6.4.1 Ethical Approval.....	188
6.4.2 Data Collection.....	188
6.4.3 Risk Assessment.....	189
6.4.4 Data Storage and Handling	189
6.5 Data Collection and Processing	190
6.6 Data Analysis.....	192
6.6.1 Phase 1 – Familiarisation	194
6.6.2 Phase 2 – Data Coding	194
6.6.3 Phase 3 – Generating Initial Themes.....	195
6.6.4 Phase 4 – Developing and Reviewing Themes.....	196

6.6.5 Phase 5 – Refining, Defining and Naming Themes	196
6.6.6 Phase 6 – Writing Up.....	197
6.7 Rigour and Quality	197
6.7.1 Credibility.....	197
6.7.2 Transferability.....	200
6.7.3 Dependability.....	200
6.7.4 Confirmability	201
6.8 Results and Discussion.....	201
6.8.1 Participants.....	201
6.8.2 Themes	202
6.9 Thematic Cross-overs	242
6.10 Strengths and Limitations.....	243
6.11 Summary and Future Recommendations	244
Chapter 7: Phase 3 – Interview Study.....	246
7.1 Introduction	247
7.2 Research Question, Aim and Objectives	248
7.2.1 Research Question	248

7.2.2	Aim	248
7.2.3	Objectives	248
7.3	Study Design and Methods	249
7.3.1	Size and Number of Interviews	251
7.3.2	Sampling Method	251
7.3.3	Eligibility Criteria.....	252
7.3.4	Recruitment	253
7.3.5	Topic Guide.....	254
7.3.6	Pilot Study	256
7.3.7	Data Collection and Processing	256
7.4	Ethical Considerations	258
7.4.1	Data Collection	258
7.4.2	Risk Assessment.....	258
7.5	Data Analysis.....	259
7.5.1	Phase 1 – Familiarisation	259
7.5.2	Phase 2 – Data Coding	260
7.5.3	Phase 3 – Generating Initial Themes	260

7.5.4 Phase 4 – Developing and Reviewing Themes.....	261
7.5.5 Phase 5 – Refining, Defining and Naming Themes	262
7.5.6 Phase 6 – Writing Up.....	262
7.6 Rigour and Quality	262
7.7 Results and Discussion.....	263
7.7.1 Participants.....	263
7.7.2 Themes	265
7.8 Thematic Cross-overs	298
7.9 Strengths and Limitations	298
7.10 Summary and Future Recommendations	300
Chapter 8: Summary Discussion	302
8.1 Introduction	303
8.2 Overview of the Results	304
8.2.1 Scoping Review (Chapter 4).....	304
8.2.2 Consultations with Musicians (Chapters 5 and 6).....	304
8.2.3 Consultations with Healthcare Professionals (Chapter 7).....	305
8.3 Applying the Behaviour Change Wheel to Intervention Design.....	306

8.4 Knowledge Contribution.....	318
8.5 Strengths and Limitations of the Thesis	320
8.6 Recommendations for Future Research	321
Chapter 9: Conclusion	324
References	327
Appendices	424

Dedication

I would like to dedicate this thesis to my late grandparents. I would not be the person I am today, nor would I have achieved what I have, if it was not for their support while growing up.

Acknowledgements

I would like to express my sincere gratitude to my supervisors, Dr Liba Sheeran, Professor Valerie Sparkes and Dr Rebecca Hemming for their support and encouragement. There is no doubt that my achievements as an academic, both current and future, are due to their guidance and support. Thank you for believing in me.

I owe enormous thanks to my parents and my brother who supported and motivated me throughout my studies.

I would like to thank all the study participants. Without their participation, this project would not have been possible.

Finally, I would like to thank the organisations that helped me in recruiting participants including the British Association of Performing Arts Medicine (BAPAM), the Musicians' Union, the Music Agency and Cardiff University School of Music. Also, I would like to thank organisations that provided financial support to cover tuition fees and to attend conferences including the Chartered Society of Physiotherapy and The Musculoskeletal Association of Chartered Physiotherapists.

Publications and Conference Presentations

Eleryan, N., Hemming, R., Sparkes, V. and Sheeran, L. 2025. Digital Health Self-management Interventions for Musicians with Playing-Related Musculoskeletal Disorders: A Scoping Review. *Musculoskeletal Science and Practice* 8, 103408. doi: [10.1016/j.msksp.2025.103408](https://doi.org/10.1016/j.msksp.2025.103408)

Eleryan, N., Sparkes, V., Hemming, R., and Sheeran, L. 2024. Exploring musicians' perspectives on the management of musculoskeletal disorders and the potential role of digital health interventions: A survey study. *Physiotherapy*, 123, pp.e156-e157. (Presented at the Chartered Society of Physiotherapy, Cardiff, Wales)

Eleryan, N., Sparkes, V., Hemming, R. and Sheeran, L. 2024. The effect of self-management interventions on musculoskeletal disorders in musicians: a scoping review. *Physiotherapy*, 123, p.e74. (Presented at the Chartered Society of Physiotherapy, Cardiff, Wales)

Eleryan, N., Sparkes, V., Hemming, R. and Sheeran, L. 2024. The effect of self-management interventions on musculoskeletal disorders in musicians: a scoping review. (Presented at the Chartered Society of Physiotherapy at the Interdisciplinary World Low Back and Pelvic Girdle Pain Congress, Melbourne, Australia) (Oral Presentation).

Eleryan, N., Sparkes, V., Hemming, R. and Sheeran, L. 2023. The effect of self-management interventions on musculoskeletal disorders in musicians: a scoping review. (Presented at the World Physiotherapy Congress, Dubai, United Arab Emirates) (Oral Presentation).

Abbreviations

Abbreviation	Terms
BAPAM	British Association of Performance Arts Medicine
BCTs	Behaviour Change Techniques
BCW	Behaviour Change Wheel
COM-B	Capability, Opportunity, Motivation, Behaviour
DHIs	Digital Health Interventions
e-Health	Electronic Health
HSE	Health and Safety Executive
JB I	Johanna Briggs Institute
JISC	Joint Information Systems Committee
KTA	Knowledge-to-Action
m-Health	Mobile Health Applications
MRC	Medical Research Council
MSDs	Musculoskeletal Disorders
NHS	National Health Service
NICE	National Institute for Health and Care Excellence
PRMSDs	Playing-Related Musculoskeletal Disorders
RCT	Randomised Controlled Trial
SD	Standard Deviation
WHO	World Health Organisation
WRMSDs	Work-Related Musculoskeletal Disorders

List of Tables

Table 2.1: Search Strategies for the Literature Review	34
Table 3.1: Summary of Research Paradigms (adapted from Creswell 2014)	74
Table 4.1: Eligibility Criteria.....	94
Table 4.2: Results of Initial Search in Medline	96
Table 4.3: Risk of Bias Summary – Evaluated Using the Johanna Briggs Institute Quality Appraisal Checklists for Randomised Controlled Trials (Barker et al. 2023) and Quasi-Experimental Studies (Barker et al. 2024).	103
Table 4.4: General Characteristics of the Included Studies.....	109
Table 4.5: Summary of Interventions, Intended Outcomes, Completion and Adherence Rates in the Reviewed Studies (n=9)	120
Table 5.1: Survey Questions, Type, Response and Rationale for Inclusion....	144
Table 5.2: Pilot Survey Results	147
Table 5.3: Survey Response Rate	152
Table 5.4: Summary of Participants' Characteristics	153
Table 5.5: Playing-Related Musculoskeletal Disorders in Different Age Groups over the Previous Five Years	156

Table 5.6: Playing-Related Musculoskeletal Disorders across Different Employment Groups	157
Table 5.7: Playing-Related Musculoskeletal Disorders and Weekly Practice Hours.....	157
Table 5.8: Playing-Related Musculoskeletal Disorders and Weekly Working Hours in Musicians	159
Table 5.9: Statistical analyses examining the association between weekly working hours and frequency of playing-related musculoskeletal disorders	160
Table 5.10: Participants’ Needs and Preferences to Better Manage Playing-Related Musculoskeletal Disorders	165
Table 6.1: Topic Guide for the Focus Group Study	187
Table 6.2: Participants’ Characteristics	202
Table 7.1: Interview Participants	264
Table 8.1: Behavioural Analysis of the Project, guided by the Capability, Opportunity, Motivation-Behaviour model (adapted from Michie et al. 2011)..	309
Table 8.2: Integrating the Capability, Opportunity, Motivation – Behaviour Model and Intervention Functions (adapted from Michie et al. 2015)	311

List of Figures

Figure 1.1: Thesis Structure	30
Figure 2.1: Octave and Chord Span (reproduced from Yoshimura and Chesky 2009)	44
Figure 2.2: Different Hand Sizes Playing a Chord (reproduced from Yoshimura and Chesky 2009)	44
Figure 3.1: The Behaviour Change Wheel (reproduced from Michie et al. 2011)	84
Figure 3.2: The Capability, Opportunity, Motivation, Behaviour (COM-B) model (reproduced from Michie et al. 2011)	84
Figure 4.1: PRISMA Flow Chart (adapted from Page et al. 2021)	99
Figure 4.2: Summary of the Key Findings of the Scoping Review.....	106
Figure 5.1: Survey Flowchart	142
Figure 5.2: Contributing Factors to Playing-Related Musculoskeletal Disorders in Musicians.....	155
Figure 5.3: Assessment of Normality for Participant Age Distribution	156
Figure 5.4: Assessment of Normality for Weekly Practice Hours	158
Figure 5.5: Assessment of Normality for Weekly Working Hours	159

Figure 5.6: Impact of Playing-related Musculoskeletal Disorders on Musicians' Career.....	161
Figure 5.7: Self-Perceived Effectiveness of Management Methods Utilised by Musicians.....	163
Figure 5.8: Participants' Preferences for Digital Health Technology	166
Figure 6.1: Flow Chart of the Recruitment Process of Participants in the Focus Group (following completion of the online survey).....	182
Figure 6.2: Thematic Map of Focus Group Results.....	204
Figure 7.1: Interview Topic Guide for Interviews with Healthcare Professionals	255
Figure 7.2: Thematic Map of Interview Results	266

Chapter 1: Introduction

1.1 Motivation for the Thesis

I am a physiotherapist with an interest in occupational health, developed through my clinical role supporting individuals from a range of occupations, including nurses, desk workers, construction workers, drivers, and manual labourers. At the beginning of my PhD, I reviewed the literature on the prevalence and management of MSDs in these roles. Although these occupations are widely recognised as being at high risk for MSDs, they often have structured occupational health pathways to support prevention, early intervention, and return-to-work strategies. One occupational group that appeared to fall outside these frameworks was performing artists, particularly musicians, despite their consistently high prevalence of PRMSDs.

While observing rehearsals and performances at the BBC National Orchestra of Wales, and through discussions with academic staff at the Royal Welsh College of Music and Drama, I noted that musicians often played for extended periods in physically demanding static positions, frequently without breaks. Informal conversations with musicians, managers and academic staff at these institutions revealed that many accepted pain or discomfort as part of the job, often without seeking help or knowing where to turn for support. Misconceptions about posture and a lack of information about exercise were also apparent. These experiences motivated the current research. Addressing this gap is important not only for the health and wellbeing of musicians, but also for sustaining their careers, supporting the creative industries, and informing occupational health approaches for other artistic professions.

1.2 Background

It is estimated that 86–89% of musicians experience a range of PRMSDs that affect the joints, bones, muscles, ligaments, nerves, and supporting blood vessels, and interfere with their ability to play at their normal level, at least once in their careers (Zaza et al. 1998; Kok et al. 2016; Baadjou et al. 2016). This high prevalence may be influenced by the competitive nature of the music industry, as well as by unstable employment due to short-term performance contracts and limited job security (Throsby and Petetskaya 2017; Stanhope et al. 2022b). As a result, musicians often continue playing when in pain, which can lead to chronic PRMSDs that may affect their livelihood and overall wellbeing (Baadjou et al. 2016; Stanhope and Weinstein 2021).

However, ceasing to play altogether may not be an appropriate solution either, as those who have taken time off from performing report a diminished sense of identity and self-worth, alongside feelings of letting down colleagues, isolation, and depression (Rickert et al. 2014; Stanhope and Weinstein 2021). This may be because musicians typically start their training in childhood (Creech et al. 2008; De bezenac and Swindells 2010), with their musical identity becoming a core aspect of their persona (Bragge et al. 2006; MacDonald and Saarikallio 2022). Moreover, playing music serves not only as a career but also as a recreational pursuit, as it involves communication and social interaction with other musicians (Guptill 2011; Stanhope and Weinstein 2021).

The current recommendations for PRMSDs management include workplace physiotherapy services, ergonomic equipment, health education, and exercise programmes (Chan and Ackermann 2014); however, these recommendations have not been successful in alleviating the severity or incidence of PRMSDs to date (Stanhope et al. 2022a). The empirical evidence suggests that the optimal

management approach for musculoskeletal disorders (MSDs) is through early self-management interventions with the aim of increasing people's skills and knowledge to effectively address and manage their health issues through education, resources and training (National Institute for Health and Care Excellence [NICE] 2016). This carries benefits for both individual musicians and the wider industry. For musicians, the earlier a musculoskeletal problem is managed, the less likely it is that it will develop into a painful, chronic condition, thus preserving their ability to play and potentially their livelihood (Oakman et al. 2016). For the industry, early intervention allows the retention of experienced musicians who may be expensive to replace and difficult to find (Crawford et al. 2020).

Digital Health Interventions supporting PRMSD self-management may offer a flexible, accessible, and potentially cost-effective solution for musicians. Recent systematic reviews suggest that DHIs supporting self-management can improve pain and reduce functional disability in people with MSDs (Hewitt et al. 2020). DHIs have also been shown to reduce catastrophising and enhance coping strategies by strengthening emotional resilience, alleviating distress, and supporting overall wellbeing (Hewitt et al. 2020).

To date, to the best of the author's knowledge, no study has explored musicians' barriers and facilitators to PRMSD self-management, health needs, and opinions on the use of DHIs or their preferences regarding the design and implementation of DHIs for self-management of PRMSDs. This lack of engagement with end-users may have contributed to the limited success of previous DHIs for musicians (Stanhope et al. 2022a), as interventions may not be tailored to the specific needs, preferences, and contexts of musicians.

More importantly, there have been significant developments in DHIs supporting musculoskeletal health and early self-management in recent years, especially following the COVID-19 pandemic, including the integration of personalised features such as real-time feedback and interactive platforms (NICE 2021), which could improve the engagement and effectiveness of PRMSD self-management in musicians (Baadjou et al. 2021). Altogether, this warrants further exploration of DHIs for PRMSD self-management in musicians.

1.3 Aim of the Thesis

The thesis aims to explore DHIs for PRMSD self-management in musicians. The objectives of this thesis are to:

- Map the available evidence on DHIs for PRMSD self-management in musicians.
- Explore musicians' experiences, needs and preferences regarding PRMSD self-management and what barriers and facilitators influence their engagement with such self-management.
- Explore the perspectives of musicians and healthcare professionals on the intervention components, potential facilitators, barriers, and potential solutions involved in developing a DHI to support PRMSD self-management in musicians.

1.4 Research Approach

This thesis adopted the Medical Research Council (MRC) framework for developing and evaluating complex interventions: this is a widely accepted and utilised framework for designing, testing, and implementing interventions in healthcare (Skivington et al.

2021). The thesis focused on the development stage, which involves identifying the theoretical foundations of the intervention, defining its key characteristics (e.g., content and dose), understanding the delivery context, and exploring facilitators and barriers to implementation. These aspects are informed by existing evidence and engagement with public partners, including end-users, healthcare professionals, and researchers (O'Cathain et al. 2019; Skivington et al. 2021). A mixed methods design with three phases of research was used to address these components and achieve the study aim and objectives.

Phase 1 consisted of a scoping review to synthesise current evidence on DHIs for PRMSD self-management in musicians. This included mapping the development of existing DHIs; examining key characteristics such as content, delivery mode, duration, theoretical underpinning, review of measured outcomes, and any estimates of impact on musicians' ability to continue playing; and reported adverse effects. This phase was undertaken to identify gaps and inform future interventions, as recommended for the development of complex interventions (Skivington et al. 2021).

Phase 2 adopted a sequential mixed methods approach, combining an online survey and four subsequent focus groups with musicians who had current or previous PRMSDs. This phase explored musicians' experiences, needs, and preferences regarding PRMSD self-management, and what barriers and facilitators influenced their engagement with PRMSD self-management, as well as their views on using DHIs to support self-management. The survey findings informed the topics and discussions in the focus groups, allowing for a deeper understanding of the musicians' perspectives.

Phase 3 involved twelve qualitative interviews with healthcare professionals experienced in managing PRMSDs in musicians. The focus was to explore their views

on the key components of DHIs, potential benefits, concerns, barriers, and facilitators to their implementation. Engaging healthcare professionals provided valuable insights into the development and delivery of interventions, aligning with recommendations to involve both end-users and public partners in the design of complex interventions (Craig et al. 2008; O'Cathain et al. 2019; Skivington et al. 2021). The following section presents the structure of these research phases throughout the thesis.

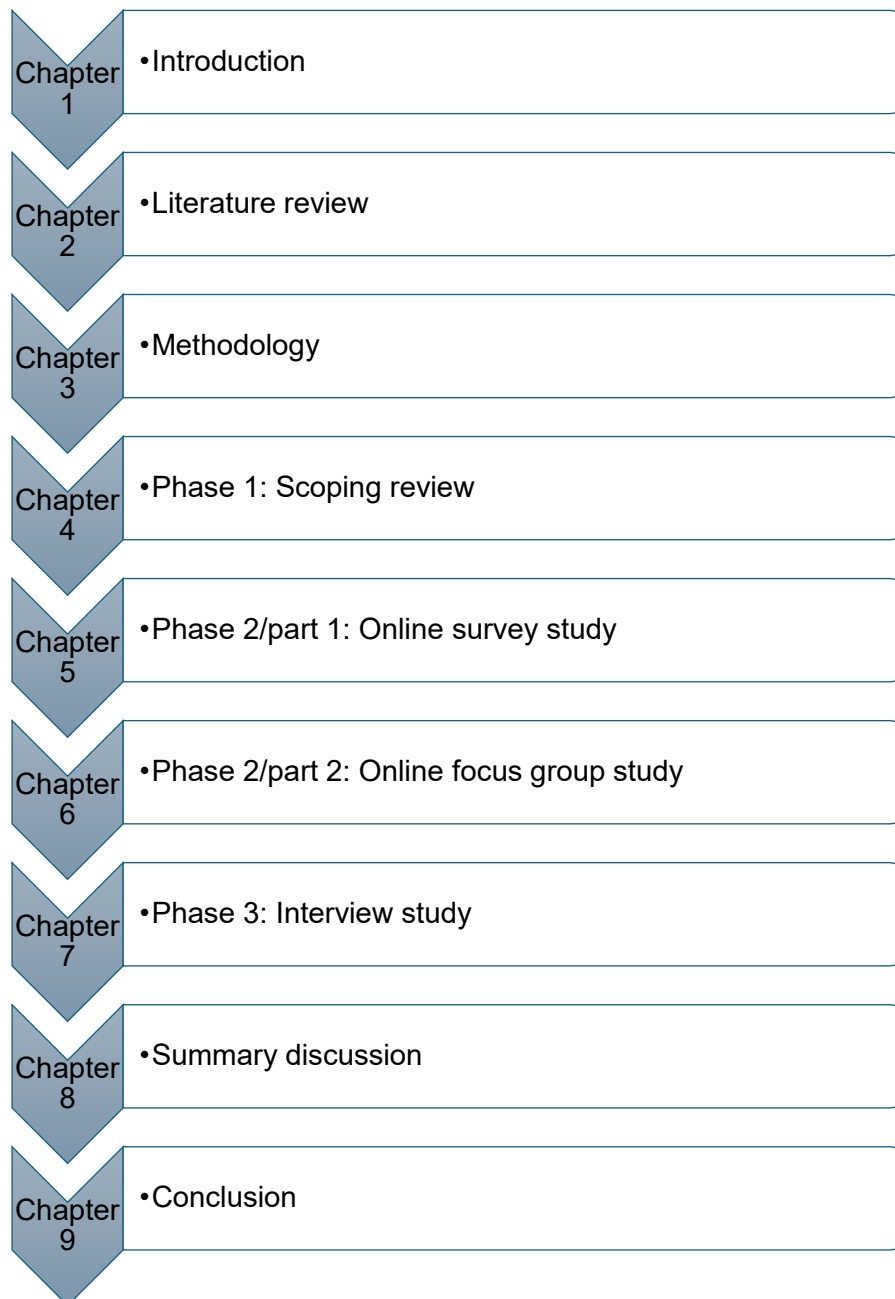
1.5 Overview of the Thesis

This thesis consists of nine chapters. Chapter 1 provides a brief introduction to the context of the study, outlines the research aims and objectives, the different study phases, and the thesis structure. Following this current chapter, Chapter 2 provides a background overview of the epidemiology and aetiology of musculoskeletal disorders (MSDs), including playing-related musculoskeletal disorders (PRMSDs) and current management methods for PRMSDs, including self-management, followed by a review of digital health interventions (DHIs) supporting the self-management of MSDs as a justification of this thesis's aims and objectives.

Chapter 3 presents the underpinning methodology, with a discussion of the different research paradigms and the theories and methodological frameworks used in this study. Chapter 4 includes a scoping review conducted to explore the current evidence on DHIs for PRMSDs in musicians (Phase 1). Chapters 5 and 6 include a sequential mixed methods study, consisting of an online survey and online focus groups with musicians (Phase 2). The findings from the sequential mixed methods study informed the online interviews with healthcare professionals (Phase 3), as presented in Chapter 7. Chapter 8 provides an overall summary and discussion of all three phases, including their strengths and limitations, knowledge contribution, and recommendations for

future research. The final chapter (Chapter 9) provides an overall conclusion. Figure 1.1 sets out the structure of the thesis.

Figure 1.1: Thesis Structure



Chapter 2: Literature Review

2.1 Introduction

This chapter discusses the literature related to the aetiology and management of PRMSDs in musicians, including the use of DHIs. There is limited research specifically focused on PRMSDs; therefore, some citations related to PRMSDs may appear outdated compared to other domains. However, these older sources remain relevant as the knowledge base on musician-specific conditions has developed slowly, and these older studies still represent the most comprehensive work available on PRMSDs. The literature review also draws upon the broader evidence base concerning MSDs and work-related MSDs to supplement the musician-specific research. The insights gained from this review provide the context and rationale for the study.

2.2 Literature Search Strategy

The literature review is divided into three sections critically exploring literature related to:

1. Epidemiology, causes, and risk factors for MSDs, with a specific focus on PRMSDs in musicians.
2. General management of PRMSDs in musicians.
3. Self-management interventions of PRMSDs in musicians.

A comprehensive search strategy was developed using the following electronic databases: CINAHL, EMBASE, Medline, AMED, and PubMed, focusing on English-language texts from peer-reviewed journals. The decision to review English-language studies was based on the practicality of ensuring accurate interpretation and analysis, as the reviewer is proficient only in English and no translation services were available.

No date restrictions were applied to the search, as DHIs and PRMSDs are emerging topics, and the aim was to capture all the relevant studies. Table 2.1 details the search strategy, including key term combinations, Boolean operators (AND/OR) and inclusion criteria for all four searches.

Table 2.1: Search Strategies for the Literature Review

Search category 1	Boolean search operators	Search category 2	Boolean search operators	Search category 3
Keywords for the aetiology and risk factors of work-related/playing-related musculoskeletal disorders				
Work-related musculoskeletal disorders OR Performance-related musculoskeletal disorder OR performance related musculoskeletal disorder OR PRMD OR PRMSD playing-related pain OR playing-related musculoskeletal disorders OR playing-related condition or music-related musculoskeletal disorder OR music-related musculoskeletal symptom OR pain OR musculoskeletal problem OR musculoskeletal complaint OR musculoskeletal disease OR non-specific musculoskeletal disorder	AND	Definition OR diagnosis OR aetiology or risk factors OR contributing factors OR causes OR pain response OR indicators OR determinants OR predictors OR causal factors OR predisposing factors	AND	Music OR music playing OR musical performance OR performing art OR instrumental music OR musician OR conservatoire OR orchestra OR orchestral musician OR music academy student OR music student OR instrumentalist OR classical musician
Keywords for management of playing-related musculoskeletal disorders in musicians				
Management OR therapy OR treatment OR guidelines OR ergonomics OR posture OR postural education OR exercise OR physical activity OR therapeutic exercise OR education OR health promotion OR advice OR physical therapy OR physiotherapy OR rehabilitation	AND	Performance-related musculoskeletal disorder OR performance related musculoskeletal disorder OR PRMD OR PRMSD playing-related pain OR playing-related musculoskeletal disorders OR playing-related condition or music-related musculoskeletal disorder OR music-related musculoskeletal symptom	AND	Music Or music playing OR musical performance OR performing art OR instrumental music OR musician OR conservatoire OR orchestra OR orchestral musician OR music academy student OR music student OR instrumentalist OR classical musician
Key words for self-management and behaviour change interventions for musculoskeletal disorders				

Search category 1	Boolean search operators	Search category 2	Boolean search operators	Search category 3
Management OR self-management OR self-management OR self-management support OR supported self-management OR self-care strategies OR self-treatment OR self-education OR self-care OR self-help OR active intervention OR active involvement OR active coping OR health promotion OR reduction OR protection OR education	AND	Behaviour modification OR health behaviour change OR intervention strategies OR behaviour change techniques	AND	Performance-related musculoskeletal disorder OR performance related musculoskeletal disorder OR PRMD OR PRMSD playing-related pain OR playing-related musculoskeletal disorders OR playing-related condition or music-related musculoskeletal disorder OR music-related musculoskeletal symptom
Key words for digital health interventions for self-management of musculoskeletal disorders				
Work-related musculoskeletal disorders OR musculoskeletal disorders OR pain OR musculoskeletal problem OR musculoskeletal complaint OR musculoskeletal disease OR non-specific musculoskeletal disorder OR musculoskeletal condition OR musculoskeletal pain OR muscle tension OR low back pain OR non-specific low back pain OR LBP OR CLBP OR NSLBP OR neck pain OR non-specific neck pain OR NSNP OR osteoarthritis OR arthritis	AND	E-health interventions OR Electronic health OR Mobile health interventions OR M-Health OR digital health interventions OR digital health OR digital interventions	AND	Management OR self-management OR self-manage OR self-management support OR supported self-management OR self-care strategies OR self-treatment OR self-education OR self-care OR self-help OR active intervention OR active involvement OR active coping OR health promotion OR reduction OR protection OR education

2.3 Definition and Prevalence of Musculoskeletal Disorders

According to the World Health Organisation (WHO 2021), MSDs are conditions that affect the body's muscles, bones, joints, tendons, and ligaments, include more than 150 different conditions, and are a common cause of pain, reduced function and stiffness. MSDs can be broadly divided into three categories: inflammatory conditions, conditions of widespread or regional pain, and degenerative conditions (WHO 2021). MSDs can have sudden onset and be short-lived, such as muscle strains and ligament sprains, whereas other conditions may develop gradually over time and may persist for long periods, such as arthritic conditions and complex regional pain syndrome (WHO 2021).

The global burden of MSDs represents one of the most significant challenges facing healthcare systems worldwide (WHO 2021; 2023a). Over 1.63 billion people are affected with MSDs globally, with projections indicating continued increases, particularly in economically developed countries (Gill et al. 2023). MSDs rank first in years lost due to disability (Cooper 2018), fifth in disability-adjusted life-years (Cooper 2018), second in overall cause of non-fatal disability (Gill et al. 2023) and represent one of the primary reasons for the use of rehabilitation services (Cieza et al. 2020). MSDs affect individuals across their lifespan, from adolescents to the elderly (Woolf et al. 2012; Wu et al. 2021). Recent data from the UK shows that in 2023, 18.4% of people aged 16 and over self-reported a long-term MSD (Gov.UK 2023). This figure represents an increase from the reported prevalence of 17.6% in 2022 and 17% in 2021 (GOV.UK 2023). This increase could be attributed to several factors, including population growth, aging and lifestyle factors, including work (Gill et al. 2023; Liu et al.

2022). MSDs that result from or are exacerbated by work activities are referred to as work-related musculoskeletal disorders (WRMSDs) (Crawford et al. 2020).

The Health and Safety Executive (HSE) report on WRMSDs in the UK highlights that over 473,000 workers are affected, resulting in the loss of 6.6 million working days during 2022/23 (HSE 2023). The consequences of WRMSDs are personal, economic and organisational, with individuals experiencing negative health impacts and businesses facing lost productivity and increased healthcare costs (HSE 2021). Reduced productivity can manifest as sickness absence or ill-health presenteeism (Crawford et al. 2020). Long-term sickness absence can lead to distress, lower self-esteem, and even depression (Bevan 2015).

However, simply reducing absence rates may not be beneficial (Crawford et al. 2020). In fact, ill-health presenteeism, where employees work while unwell, often exacerbates symptoms and delays recovery (Demerouti et al. 2009; Bryan et al. 2020). Limited recovery can increase the risk of cumulative negative effects, such as elevated stress levels and decreased job satisfaction, which negatively affect health and work productivity (Demerouti et al. 2009). While WRMSDs and their impacts affect workers across all sectors (HSE 2023), certain professions face heightened risks due to their specific physical demands and working conditions (Zaza et al. 1998). Among these professions, professional musicians represent a unique workforce within the spectrum of WRMSDs that is often overlooked (Zaza et al. 1998).

2.4 Definition and Prevalence of Playing-Related Musculoskeletal Disorders

Musicians – including performing artists, music educators, and individuals working in therapeutic contexts (e.g., music therapists) – face chronic exposure to substantial continuous and repeated physical movements (Zaza et al. 1998; Williamon 2004). Until the late 1990s, there were only sporadic reports in the literature that musicians suffer from cramps and fatigue, with no clear definition or incidence rates of musicians' medical issues (Williamon 2004). In 1998, Zaza and colleagues proposed that all musicians' WRMSDs should be collectively considered as PRMSDs, defined as any musculoskeletal symptoms, such as pain, numbness, tingling or weakness, that interfere with the ability to play an instrument to a normal level (Zaza et al. 1998). The first systematic review investigating the point prevalence of PRMSDs found that 39-87% of adult professional orchestral musicians experience PRMSDs, with 20-30% forced into early retirement due to these musculoskeletal injuries (Zaza 1998).

Other cross-sectional studies suggest that 80–97% (n=210) of British orchestral musicians suffered from PRMSDs in at least one region of the body over the previous 12 months (Leaver et al. 2011), with the neck being the most affected anatomical region in Danish orchestral musicians (Paarup et al. 2012). In 2016, a systematic review suggested that the 12-month period prevalence of PRMSDs in Dutch orchestral musicians ranged between 86% and 89% (n=357) (Kok et al. 2016). The lifetime prevalence of PRMSDs in these orchestral musicians was estimated to be between 62% and 93% (Kok et al. 2016). These consistently high prevalence rates across multiple studies highlight the significance of PRMSDs in the musical profession, although there are several methodological concerns regarding how this evidence has been gathered.

The review by Kok et al. (2016) included only cross-sectional studies, which take a snapshot of disease and exposure at a single point in time (Setia 2016). Therefore, whilst these studies can identify associations between playing an instrument and the presence of musculoskeletal symptoms, they cannot determine whether the playing led to the development of these disorders or if pre-existing conditions influenced the ability to play (Setia 2016). Furthermore, the review included any relevant study, regardless of quality, which may explain the wide range of prevalence reported (Kok et al. 2016). Issues such as misreporting of prevalence as incidence, lack of statistical testing, and omission of key details (e.g., response rates and prevalence figures) were common in the included studies (Kok et al. 2016). It is standard practice to only include evidence of adequate methodological quality in systematic reviews (Higgins et al. 2022).

Moreover, many of the reviewed studies had response rates below 50%, which raises concerns about the representativeness of the findings and increases the risk of response bias (Caldron et al. 1986; Hartsell and Tata 1991). Non-response bias occurs when individuals who opt to participate differ systematically from those who do not (Davern 2013). As a result, participants who experience significant symptoms or have a personal interest in the topic may be more inclined to respond, leading to an overestimation (or underestimation) of the true prevalence (Davern 2013). Other important limitations include a reliance on self-reported outcome measures developed by the authors themselves, which were not validated against established tools (Bragge et al. 2006; Kok et al. 2016).

Addressing many of these methodological limitations, Cruder et al. (2021) conducted a multicentre longitudinal study that explored the point prevalence and risk factors of

PRMSDs in orchestral musicians across Europe, including Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Italy, Latvia, Portugal, Spain, Scotland, Switzerland and the Netherlands. The study included 560 musicians from 56 institutions across different European countries and utilised validated questionnaires to assess perceived exertion and fatigue (Cruder et al. 2021). Its findings indicated that the point prevalence of self-reported PRMSDs was 48% and that female musicians were more likely to report PRMSDs compared to their male counterparts. Furthermore, musicians who played instruments requiring both upper limbs to be elevated in a frontal position (e.g., harp, trombone, trumpet, violin) had a higher likelihood of developing PRMSDs (54.4%). This risk was further increased in musicians who played for longer hours, had more years of experience, reported higher levels of perceived exertion after 45 minutes of practice, and experienced fatigue. An important finding of this study is that it shifts the focus from simply reporting prevalence rates to exploring risk factors for PRMSDs. The next section examines the risk factors and underlying mechanisms that contribute to MSDs generally, before moving to focus on PRMSDs.

2.5 Risk Factors and Underlying Mechanisms for Musculoskeletal Disorders and Playing-related Musculoskeletal Disorders

The underlying mechanisms contributing to MSDs are complex and highly multifactorial, influenced by the diversity of the conditions and varied working environments (WHO 1985). Multiple models and frameworks have been proposed to address this complexity (Karsh 2006). One prominent framework is the dose–response model, which suggests a direct correlation between exposure to physical stressors in the work environment and the incidence of MSDs (Armstrong et al. 1993; Lötters and Burdorf 2002). The process begins when healthy tissues are subjected to

continuous loading, causing microtears (Armstrong et al. 1993; Gallagher and Heberger 2013). With prolonged exposure, the extent of the microtears may increase, depending on load magnitude and/or cycle repetition, eventually resulting in tissue injury (Gallagher and Heberger 2013).

When tissues are injured, the inflammatory response is activated, releasing biochemical mediators such as prostaglandins and cytokines that sensitise nociceptors and contribute to pain (Barbe and Barr 2006; Yam et al. 2018). In response, the central nervous system may trigger a muscle spasm to limit movement to protect the injured area (Gallagher and Heberger 2013). As the muscles tighten, the range of motion in the affected area decreases to prevent aggravation of the injury (Barbe and Barr 2006; Yam et al. 2018). If muscle guarding persists, it can lead to muscle fatigue, ischemia, and the buildup of metabolic waste products, which may prolong recovery (Barbe and Barr 2006; Yam et al. 2018).

Mechanical loading plays an important role in collagen synthesis by stimulating fibroblasts – the cells responsible for producing collagen – to properly align collagen fibres during the healing process (Gallagher and Heberger 2013). However, when pain and discomfort increase and consequently reduce activity and movement, mechanical loading may become insufficient (Varani et al. 2006). Reduced mechanical loading can disrupt collagen production, leading to the formation of disorganised collagen fibres (Varani et al. 2006). Over time, this disorganisation may reduce the efficiency of tissues, as greater energy and force are needed to accomplish ordinary movements (Varani et al. 2006). This additional effort leads to faster fatigue, and as muscles tire, tension may increase, creating a cycle where tension and fatigue are co-dependent,

ultimately increasing pain and discomfort (Thornton and Hart 2011; Gallagher and Heberger 2013).

The plausibility of the dose–response model was demonstrated by in-vitro studies on tendons (Schechtman and Bader 1997), ligaments (Thornton et al. 2007; Lipps et al. 2013; Lipps et al. 2014), cartilage (Bellucci and Seedhom 2001), and spinal motion segments (Gallagher et al. 2005). Irrespective of the tissue studied, all studies demonstrated a direct relationship between the load magnitude, cycle repetitions and material failure (Gallagher et al. 2007). Questions persist, however, influenced by the lack of specificity in the dose–response model regarding precise dose or response, as well as the magnitude, duration, and latency period of exposures related to specific conditions contributing to the development of MSDs (Karsh 2006). Moreover, individual variability in responses to loading is not adequately accounted for within the model (Huang et al. 2002; Punnett and Wegman 2004). Biological responses to mechanical loading can vary between individuals and without understanding and addressing this, it is difficult to develop targeted interventions for MSDs (Karsh 2006).

The National Institute for Occupational Safety and Health (NIOSH) has described an alternative multi-dimensional model of job stresses and health (Bernard et al. 1997; Bernard et al. 2011; Lee et al. 2016). The NIOSH model considers physical, personal/lifestyle, organisational and social risk factors, and categorises MSDs into modifiable and non-modifiable subtypes to guide management (Bernard and Putz-Anderson 1997). Modifiable risk factors are those that can be changed, such as biomechanical demand, while non-modifiable risk factors are inherent characteristics that cannot be changed, such as age, gender, and genetic conditions (Bernard and Putz-Anderson 1997; Bernard et al. 2011). The current consensus is that the effect of

these risk factors is cumulative and interactive, with their combined impact exceeding that of any individual factor (Marras et al. 2009). The next section offers a critical review of literature on the key modifiable and nonmodifiable risk factors specifically for PRMSDs in musicians.

2.5.1 Personal Risk Factors

Some non-modifiable personal risk factors for PRMSDs include age and gender (Baadjou et al. 2016; Kok et al. 2016). Several studies report a positive correlation between female gender and higher PRMSD incidence (Paarup et al. 2012; Kenny and Ackermann 2015; Steinmetz et al. 2015; Kok et al. 2016), similar to trends observed in the general population (Strazdins and Bammer 2004; Bartley and Fillingim 2013; Liu et al. 2022). Although the evidence is limited by an imbalanced gender distribution in music research (Yoshimura et al. 2006; Yoshimura and Chesky 2009; Steinmetz et al. 2015), biomechanical studies reveal that smaller hand spans in women (17–19 cm) compared to men (20–22 cm) increase strain during octave stretches (Yoshimura et al. 2006; Yoshimura and Chesky 2009). This anatomical difference, combined with the rapid fingering movements required during playing, increases injury risk in female pianists (Sakai 2002; Sakai et al. 2006). Figures 2.1 and 2.2 illustrate the mismatch between standard piano keyboard design and female pianists' hand anthropometry.

Figure 2.1: Octave and Chord Span (reproduced from Yoshimura and Chesky 2009)

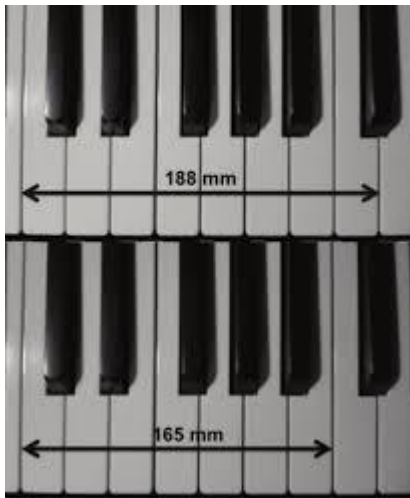
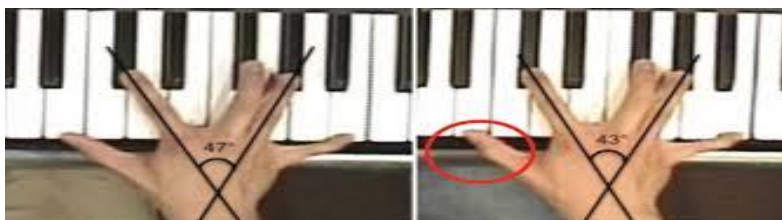


Figure 2.2: Different Hand Sizes Playing a Chord (reproduced from Yoshimura and Chesky 2009)



Age is another proposed risk factor for PRMSDs, although systematic reviews indicate that evidence for this relationship remains inconclusive (Baadjou et al. 2016; Kok et al. 2016). Several studies found no significant relationship between age and PRMSDs in various musician populations, including orchestral classical musicians in Slovenia ($n=70$) (Crnivec 2004), Australia ($n=377$) (Kenny et al. 2018), and oboists in Canada ($n=233$) (MacDonald et al. 2022). Contrasting evidence comes from Berque et al. (2016), who found the highest prevalence of PRMSDs in Scottish orchestral musicians aged 46 years and older ($n=101$), although their study's average age of 47.7 years (± 10.4 years) may have influenced these findings. Abr  u-Ramos and Micheo (2007),

in a cross-sectional study of 75 orchestral musicians from the Puerto Rico Symphony Orchestra, observed a U-shaped risk distribution, with the youngest (22–29 years) and the oldest (50–61 years) musicians showing higher injury rates. However, both age groups consisted primarily of violinists who maintained intensive practice schedules (28.7 and 32 hours per week, respectively) (Abréu-Ramos and Micheo 2007). This may suggest that the risk of PRMSDs may be attributed to the biomechanical demands of music performance, rather than age alone.

2.5.2 Physical Risk Factors

Biomechanical demands, including sustained awkward postures and repetitive movements, are considered key modifiable physical risk factors for PRMSDs (Chan and Ackermann 2014). String instrumentalists, such as violinists and violists, are considered a high-risk group (Adam et al. 2018), as they must maintain an elevated and abducted shoulder position while supporting the instrument with the clavicle and head (Smithson et al. 2017). Smithson et al. (2017) used ultrasound imaging and found that elevated and abducted postures caused superior migration of the humeral head, narrowing the subacromial space and increasing the risk of shoulder impingement.

Similarly, Adam et al. (2018) conducted an observational study using ultrasound to examine thoracic outlet syndrome in string instrumentalists (n=64) in the USA, comprising violinists (41%), violists (33%), and cellists (27%). The study revealed that a significant majority of musicians (69%) (n=44) exhibited abnormal ultrasound findings, including subclavian artery and vein compression and absent arterial traces, compared to only 15% of controls (p=0.001). This pattern of dysfunction was further supported by Upper Limb Tension Test results (a clinical test used to evaluate nerve

tension in the arm), where 44% of musicians tested positive compared to just 3% of controls (healthy non-musician participants) ($p=0.03$). Musicians who tested positive reported longer practice hours (5.3 ± 2.4 hours daily), which was significantly higher than that of controls (0.65 ± 0.4 hours daily, $p<0.001$).

Several studies support this dose–response relationship, showing associations between practice time and PRMSDs in Spanish student musicians (Rodríguez-Romero et al. 2016; Gómez-Rodríguez et al. 2020; MacDonald et al. 2022). For instance, Rodríguez-Romero et al. (2016) found that playing for more than 33 hours per week increased the likelihood of shoulder pain fivefold in Spanish music students ($n=206$), while MacDonald et al. (2022) indicated that Australian oboists ($n=233$) playing for 6–18 hours per week reported higher rates of injuries compared to those playing for only 1–3 hours per week. Although, these differences did not reach statistical significance (MacDonald et al. 2022), physical demands do not occur in isolation, as psychological and cultural factors also influence how musicians manage their practice routines and respond to physical stress (Chan and Ackermann 2014; King et al. 2024).

2.5.3 Psychological Risk Factors

Musicians face a range of psychological risk factors, including performance anxiety and work-related stress, which can impact their physical and psychological health (Baadjou et al. 2016; Matei and Ginsborg 2017; Pecun et al. 2017; Fernholz et al. 2019; Bruyneel et al. 2024). Systematic reviews report that point prevalence rates of performance anxiety and stress range from 16.5% to 60%, with university-level musicians exhibiting higher levels of stress and anxiety and more PRMSDs than their older counterparts (Baadjou et al. 2016; Fernholz et al. 2019). However, the findings

are limited by the cross-sectional design, lack of clear inclusion criteria and self-reported data (Fernholz et al. 2019). Pecen et al. (2017), in a qualitative study of British Orchestral musicians (n=15), identified that systemic challenges such as abusive teacher–student dynamics, unsupportive institutional cultures, and intense social comparison in British conservatoires amplify these risks.

Bruyneel et al. (2024) found in a cross-sectional study that 37% (n=86) of the Geneva University student musicians had experienced PRMSDs in the past year, with psychological distress and perfectionism emerging as key risk factors. Students with PRMSDs scored significantly higher on perfectionism metrics ($p=0.007$) compared to their peers. Network analyses revealed that perfectionism, performance anxiety, and psychological distress form a vicious cycle: anxiety about mistakes compels students to practice excessively, while neglecting self-care (e.g., 40% skipped warm-ups/recovery exercises) (Bruyneel et al. 2024). Although Pecen et al. (2017) highlighted that pressures such as perfectionism and competition persist throughout a musician's career, older musicians often benefit from having developed more effective coping strategies and resilience over time (Matei and Ginsborg 2017).

2.5.4 Cultural Risk Factors

In addition to the psychological challenges highlighted above, cultural norms within the music industry compound these pressures by normalising pain and discouraging help-seeking (Guptill 2011; De Kock et al. 2023; Bruyneel et al. 2024). Bruyneel et al. (2024) found that only 23% of music students with PRMSDs sought medical help, as most viewed discomfort as a necessary part of professional musical training. Furthermore, two phenomenological inquiries into the lived experience of violinists and cellists in Canada (n=10) (Guptill 2011) and violinists in South Africa (n=3) (De Kock et al. 2023)

with PRMSDs revealed that musicians continued performing despite pain due to pervasive stigma around injury. This stigma, rooted in fears of being perceived as weak, replaceable, or unprofessional, discourages open discussion about pain and prevents many from seeking timely help (Guptill 2011; De Kock et al. 2023). Compounding this issue, institutions and healthcare professionals often fail to provide adequate support, with musicians reporting frustration over the lack of understanding of their unique needs within both medical and music communities (De Kock et al. 2023).

While these results provide important insights, they do not provide information on how musicians actually manage their condition, what their needs are, or how these cultural challenges can be addressed. In addition, the findings are limited by several methodological concerns, as neither study provided a clear definition of PRMSDs (Guptill 2011; De Kock et al. 2023). Guptill (2011) introduced selection bias by excluding a participant with positive healthcare experiences. Similarly, in De Kock et al.'s (2023) study, the first author's dual role as a violinist and researcher might have influenced the interpretations of participants' lived experiences. Moreover, both studies focused exclusively on classically trained violinists and cellists, whose experiences may differ from those of other instrumentalists, non-classical musicians, or musicians operating outside formal institutional settings, such as self-employed musicians.

The employment structure of the UK music industry presents unique challenges for musicians' health and wellbeing (Musicians' Union 2021). Musicians in the UK earn an average annual income of £23,059, significantly below the national average of £29,832 (Complete Music Update 2020). Nearly 94% work in a self-employed or freelance capacity for all or part of their income, with almost half lacking regular employment

(Help Musicians and Musicians' Union 2023). This employment pattern has important implications for health management, as many musicians lack access to sick leave and workers' compensation benefits (Stanhope et al. 2022b). These factors may compel musicians to work longer hours or perform without adequate rest, potentially increasing their risk of musculoskeletal symptoms, functional disability, anxiety, and depression (Stanhope et al. 2022b).

A cross-sectional survey in Australia found that self-employed musicians (n=24) tended to report a higher prevalence and severity of musculoskeletal symptoms, greater emotional impact, and were more likely to consult healthcare professionals—such as physiotherapists or general practitioners—compared to their employed counterparts (n=90); however, these observed differences were not statistically significant (Stanhope et al. 2022b). It is possible that the small sample sizes contributed to limited statistical power, increasing the risk of Type II error—failing to detect true differences between groups (Field, 2013). Additionally, not all participants had PRMSDs, with the study reporting an overall musculoskeletal symptom prevalence of 87.9% (98 out of 225) over 12 months and 71.5% (161 out of 225) over seven days among all professional musicians. Nonetheless, the study did not present subgroup-specific data for employed versus self-employed musicians, which limits the ability to draw definitive conclusions or establish associations between employment status and PRMSDs (Stanhope et al. 2022b).

Furthermore, Stanhope et al. (2022b) focused solely on employment within the music industry, whereas it is common for musicians to have careers that involve a mix of music-related and non-music-related work (Teague and Smith 2015). The Musicians' Census report in the UK suggests from the 1,461 respondents, 53% (n=774) of

musicians sustain their career by sourcing other forms of income outside of music, with two thirds (62%, n=906) of these generate additional funds from alternative employment (Help Musicians and Musicians' Union 2023). This diversity in employment can impact various aspects of their well-being, including sleep patterns, energy levels, stress management, and recovery time, due to the demands of different types of work and longer working hours (Teague and Smith 2015).

2.5.5 Lifestyle Factors

Research on touring freelance musicians indicates that lifestyle factors such as nutrition and sleep significantly impact their well-being (Kaneko et al. 2005; Cizek et al. 2016). For example, irregular touring schedules often disrupt healthy eating patterns; one survey of UK freelance musicians reported that over 60% (n=35) relied on convenience foods, fast foods, and airport meals (Cizek et al. 2016). Although direct evidence linking poor nutrition to musculoskeletal health in musicians is limited, studies in athletes suggest that inadequate nutrition may lead to muscle atrophy, reduced strength, and impaired tissue repair (Campbell et al. 2007). Similarly, sleep deprivation is associated with increased musculoskeletal pain. Surveys of touring and orchestral musicians in Finland (n=1005) indicated that 63% (n=633) experienced sleep disorders, and those affected were 4.5 times more likely to suffer pain, respectively (Ahlberg et al. 2019). However, these findings relied on univariate analyses that oversimplify the multifactorial nature of PRMSDs (Field 2013). Longitudinal studies in adult populations have linked sleep problems to chronic pain conditions such as fibromyalgia (Smith et al. 2004; Davies et al. 2008; Edwards et al. 2008), suggesting that poor sleep is likely to exacerbate musicians' vulnerability to PRMSDs, though methodological limitations prevent definitive conclusions.

2.5.6 Summary

Musicians are highly skilled professionals; however, they often have little choice but to accept difficult physical, psychological and organisational working conditions. The literature reviewed above highlights significant prevalence rates of PRMSDs and multiple risk factors, including physical factors such as repetitive loading and poor biomechanics, alongside psychological and social factors related to the culture within the sector, employment and health support challenges. It is important to acknowledge that the evidence base is relatively small and of low quality. Many studies use cross-sectional designs, limiting their ability to establish causality.

Furthermore, most of the available evidence has focused on university-level student musicians and classical orchestral musicians, with little attention given to other genres or self-employed musicians, who make up the majority of musicians and face significant challenges such as financial instability and organisational support (Section 2.3). This leaves a considerable gap in understanding PRMSDs experienced by the majority of musicians. Therefore, further research is needed to expand the current evidence base on the prevalence, risk factors, and health impacts of PRMSDs across different employment statuses and professional contexts. The next section introduces literature and evidence for the management of PRMSDs in musicians.

2.6 Management of Playing-Related Musculoskeletal Disorders in Musicians

From the review of the multifactorial nature of PRMSDs in musicians, it is clear that management of PRMSDs should adopt a biopsychosocial approach—one that considers the interaction of biological factors (e.g. physical symptoms and injury), psychological factors (e.g. stress, anxiety, coping strategies), and social factors (e.g. performance demands, financial pressures, and support systems) in both the

development and treatment of these conditions (Engel 1977). However, a recent systematic review of management interventions for PRMSDs revealed that research has predominantly focused on physical risk factors, neglecting psychological and cultural dimensions (Stanhope et al. 2022a).

Of the 14 studies included in the review, 11 investigated exercise programs, one focused on an education programme and two tested ergonomic equipment. None of the studies exclusively focused on management (i.e., treating diagnosed PRMSDs), instead, the interventions targeted prevention and symptom reduction in musicians with and without PRMSDs. In addition, there were only five RCTs, with the remaining studies being comparative studies with concurrent controls (n=7) and case series (n=2).

The conclusion from the review is that current evidence is low-quality and insufficient to support definitive recommendations for PRMSD prevention and management due to the limited number of RCTs and the generally low quality of available evidence (Stanhope et al. 2022a). This includes methodological limitations such as high risk of bias, heterogeneous outcomes, lack of safety reporting and the absence of clinically significant findings. However, a systematic search identified additional studies on workplace physiotherapy services, ergonomic equipment, exercises, and health education that the review did not include. The following section provides a critical evaluation of some of the studies overlooked in the systematic review by Stanhope et al. (2022a).

2.6.1 Workplace Physiotherapy Services

Physiotherapy services have become an integral part of workplace MSD management, offering early intervention to prevent long-term disability and support employees in

maintaining workability (Prall and Ross 2019). A similar trend has emerged in the music industry, with the World Confederation for Physical Therapy (2011) recognising physiotherapists as best positioned to manage PRMSDs in musicians (Chan et al. 2013a).

In Australia, Chan et al. (2013a) conducted a mixed methods study over three months to evaluate the impact of an on-site physiotherapy-led triage service across seven Australian symphony orchestras. However, the study did not specify who developed the service or provide details about the physiotherapists' expertise in performing arts medicine. Despite that, the study found that the service was well received; however, only 83 of 483 musicians (17%) utilised it during the study period (three months). Among those who attended, 75% (n=62) reported symptom improvements, and 94% (n=78) felt that they had better health management. The study relied on subjective, self-reported feedback rather than objective clinical outcomes such as return-to-work times, injury recurrence rates, or measurable changes in pain. Additionally, non-validated measures assessed symptom improvement, satisfaction, and the likelihood of continued service use. Given that successful rehabilitation for musicians requires restoring professional performance ability, the lack of objective measures limits the ability to determine the service's true effectiveness (Norton 2020).

Furthermore, the qualitative evaluation in this study revealed that the uptake was influenced by musicians' reluctance to use the service and doubts about healthcare professionals' understanding of musicians' specific needs (Chan et al. 2013a). These findings echo previous research by Park et al. (2007) and Guptill (2011) which found that musicians were reluctant to seek care due to fears about receiving advice to stop playing and perceptions that healthcare providers lacked understanding of musicians'

specific needs. Such hesitations can be understood through the lens of the Health Belief Model (Rosenstock 1974), which suggests that individuals' engagement with health services is influenced by their perceptions of benefits and barriers. In this context, musicians' fears may outweigh perceived treatment benefits, suggesting that successful interventions must be both clinically effective and demonstrate understanding of musicians' specific needs (Norton 2020). However, the lack of research into barriers to PRMSDs management and musicians' health beliefs limits the ability to develop interventions that effectively address these challenges (Holden et al. 2012).

2.6.2 Ergonomic Equipment

Ergonomic equipment, such as instrument supports and ergonomic chairs, represents another approach for PRMSDs management (Chi et al. 2020). Ergonomic equipment is used by musicians to assist with holding instruments and maintaining optimal posture (Chan and Ackermann 2014; Chi et al. 2020). Several studies have assessed the impact of chin and shoulder rests assisting violin holding on muscle activity (Kok et al. 2019; Mann et al. 2023). However, the cross-sectional design, small sample size, and little to no attention on the impact of those aids and subsequent changes in muscle activity and tension limits the quality of the evidence from these studies, as also indicated by a systematic review on ergonomic intervention for pianists and violinists (Chi et al. 2020). The review emphasised the need for rigorous research that explores not only the long-term efficacy of ergonomic equipment but also its usability, aesthetic considerations, and practical impact on performance (Chi et al. 2020).

The evidence for ergonomic chairs shows similar limitations. Ohlendorf et al. (2018) compared six different ergonomic chairs (upholstered stool, stool with a wooden seat,

seat with a backrest, saddle chair with a small seating surface, saddle chair with a large seating surface, cylindrical seat roll) in 47 Austrian professional musicians without PRMSDs. Their findings showed that chairs with soft cushioning reduced seated pressure on the ischial tuberosity by 30%, though they did not investigate whether this pressure reduction affected musicians' comfort or pain levels. The analysis revealed no significant differences in postural variables between the different ergonomic designs, and the absence of participants with PRMSDs limits the direct application of their findings to musicians experiencing playing-related pain.

In Italy, Russo et al. (2019) found similar biomechanical effects without clear clinical implications when investigating differences between standard orchestra chairs and ergonomic chairs with back support in nine violinists. While they observed significantly lower erector spinae muscle activation with ergonomic chairs, they found no differences in muscle fatigue or lower back pain between chair types. This finding again highlights the gap between measured biomechanical changes and their relationship to PRMSDs. Furthermore, while some musicians spend considerable time seated, other potential PRMSDs triggers such as moving equipment and travel remain unexamined in this population (Willis et al. 2019). Therefore, there is a need for a broader approach that is practical and relevant to all musicians.

2.6.3 Health Education

Health education, involving learning experiences designed to help individuals and communities to improve their health by increasing their knowledge or influencing their attitudes (WHO 2014), is another approach utilised for PRMSDs management in musicians (Matei 2018). Three RCTs exploring the effect of health education on music

students conducted in Spain (López and Farías Martínez 2013), the UK (Matei et al. 2018) and the Netherlands (Baadjou et al. 2018) were identified.

López and Farías Martínez (2013) investigated the effects of a health education programme to prevent PRMSDs in student musicians. The covered various topics, including risk evaluation associated with instrument practice, common medical problems, warm-up routines, postural hygiene, prevention strategies, and treatment options for injuries. The students were randomly divided into an intervention group (n=90) and a control group (n=59). The control group did not take the course and were evaluated with a questionnaire at the beginning of the academic year and one year later, while the experimental group took the course and were evaluated at the beginning of the course, six months later and one year later. The study reported improvements in body awareness and reduction in PRMSDs frequency; however, the results were not statistically compared, and participants were included in the study regardless of whether they had PRMSDs or not.

In the Netherlands, Baadjou et al. (2018) compared a conservatoire-led health education course focusing on posture, ergonomics, health behaviour, and stress management against a physical activity programme requiring students to track daily activity. Despite initially recruiting 170 students, the study faced substantial attrition, with participation declining to 62% (n=105) and 58% (n=99) respectively by the intervention's end, further decreasing to just 30% (n=51) and 36% (n=61) at 16-month follow-up. In a subsequent qualitative study exploring participants' perception of the programme, participants indicated that the content lacked focus on psychosocial risk factors, was too generic, and was not sufficiently related to their instrument playing, leading to a lack of perceived value and motivation (Baadjou et al. 2021). The

participants further indicated that lack of institutional support and difficulties in managing their time effectively made it challenging to attend in-person sessions, calling for more accessible resources (Baadjou et al. 2021). In response to these challenges, the authors suggested that online resources and social media could help address these barriers by creating accessible content and fostering a sense of community to encourage and motivate students (Baadjou et al. 2021; Kapp et al. 2009).

In the UK, Matei et al. (2018) implemented a 10-week health education programme to improve music students' physical and psychological health and health-related behaviours. The health education programme was delivered over five months to 104 first-year undergraduate music students, and evaluated using a questionnaire at baseline and at the end of the health education programme. A total of 81 (90%) students completed both questionnaires. However, there were no significant differences in PRMSD frequency or severity, self-efficacy, knowledge of potential risk factors, general health, or health-promoting behaviours between baseline and post-intervention. Although in a subsequent qualitative study, Matei and Ginsborg (2022) reported that participants found the programme interesting and engaging, some participants indicated that the programme was not tailored to their specific circumstances, lacked practical application, was not solution focused, and contained redundant material.

A critical limitation across all three studies (López and Farías Martínez 2013; Matei et al. 2018; Baadjou et al. 2021) was the lack of transparency regarding programme development and delivery. None provided information about how the education programmes were developed or the qualifications of those involved in their delivery.

This lack of documented expert input may explain both the high attrition rates and consistent feedback about content being too generic. Similarly, Stanhope et al. (2022a) emphasised that education programmes should incorporate musicians' needs and expert healthcare professionals' input to increase intervention effectiveness and acceptance.

2.6.4 Exercises

Exercise is often recommended for managing PRMSDs, given the high physical demands of playing instruments, such as prolonged periods of practice, repetitive movements and awkward postures (Section 2.5.2) (Bragge et al. 2006; Moraes and Antunes 2012), as well as previous cross-sectional studies suggesting that oboists prefer therapeutic exercises over health education or passive treatment methods (MacDonald et al. 2022). However, to date, only one RCT has investigated different warm-up exercises in musicians, though this study was conducted with uninjured participants (McCrary et al. 2015).

In this study, McCrary et al. (2015) examined the effects of different warm-up exercises (aerobic, stretching, and standard violin warm-up) on muscle activity, musical performance and perceived exertion in 55 healthy Australian and New Zealand violinists. While perceived exertion, measured using the Borg Scale, decreased significantly ($p=0.005$) in all warm-up groups compared to controls, there were no significant changes in muscle activity or musical performance (McCrary et al. 2015). However, these findings should be interpreted cautiously for several reasons. First, measurements were taken only 15 minutes before and after the intervention, which is insufficient to examine the true effects of an exercise intervention. Second, 92.7% ($n=51$) of participants regularly performed warm-ups and 83.6% ($n=46$) anticipated

performance improvements, suggesting that results could reflect pre-existing beliefs rather than physiological changes (McCrary et al. 2015).

The reliance on self-reported outcomes also introduces potential response bias, where participants may report what aligns with their expectations rather than actual physical changes (Rosenman et al. 2011). Therefore, the evidence linking warm-up to PRMSD prevention or management remains tenuous due to the lack of research on injured musicians, methodological limitations of existing studies and inadequate intervention duration. Further research is needed to establish whether warm-up exercises have any meaningful impact on PRMSD outcomes.

Moreover, two studies examined the effect of strengthening exercises on PRMSDs. In Australia, Ackermann et al. (2002) studied 18 participants, and in Canada, Kava et al. (2010) studied 14 participants, investigating the effects of upper extremity and trunk exercises in music students. Both studies compared a strength training group with an endurance training group. Both studies compared a strength training group with an endurance training group. One study found significant improvements in perceived exertion during music playing in the endurance group (Kava et al. 2010). Neither study showed changes in PRMSD severity or frequency or muscle strength. This could be because the exercise programme was conducted for 6 weeks with exercise sessions running twice weekly for 45 minutes (Ackermann et al. 2002) to one hour (Kava et al. 2010). Muscle gain involves increasing motor unit recruitment of a particular task which could take up to 10 weeks (Kerksick et al. 2006). Therefore, exercising over a longer period could have a greater effect on muscle strength and, in turn, influence the ability to cope with the physical demands of playing a musical instrument.

In contrast to warm-up and strengthening exercises, motor control exercises offer a different approach by targeting the activation of deep stabilising muscles to improve the activation and timing of muscles that stabilise joints and support posture (Van Vliet and Heneghan 2006). This may be relevant for activities requiring precise and repetitive movements, such as playing a musical instrument, where poor motor control can lead to injuries, as observed in string players (Baader et al. 2005; Konczak et al. 2009). Four studies investigating the same motor control exercises for musicians' PRMSDs (Chan et al. 2013b; Chan et al. 2014; Roos and Roy 2018; Roos et al. 2024) were found. The exercise protocol, developed by Chan et al. (2012), focused on improving motor control and proprioception in the shoulder and scapular region, strengthening deep neck flexors, and activating core stabilisers through progressive exercises. This protocol was tested in a single-group, pre-post study with 85 Australian professional orchestral musicians, examining the effects of the exercises on PRMSDs' frequency, severity, perceived exertion, and performance factors (Chan et al. 2014).

Chan et al. (2014) reported significant reductions in PRMDs frequency and severity, as well as perceived exertion, following the 10-week exercise program ($p < 0.05$). However, the exact p-values were not provided. While these findings indicate short-term efficacy, the clinical significance remains uncertain, particularly given the relatively low adherence rate. The completion rate was 62% (53 out of 85 participants), despite supervised exercise sessions being scheduled during musicians' working hours and encouragement to complete at least 12 of the 16 face-to-face sessions over the intervention period.

Several factors may have contributed to the low adherence: some musicians (22%) ($n=7$) were concerned that exercise would worsen their health condition or negatively

affect their performance (Chan et al. 2014), while 4% (n=1) reported no need for exercises because they did not have pain, and 22% (n=7) reported high workload and commitments, including touring schedules, which prevented them from attending the exercises classes. Recognising these challenges, subsequent research has adapted the exercise protocol using DHIs, with mixed results, as will be discussed in this chapter (Section 2.6.2) and Chapter 4 (Chan et al. 2013b; Roos and Roy 2018; Roos et al. 2024).

Overall, the evidence suggests that exercise alone, supervised or not, may have a short-term benefit but does not appear to be sustainable for musicians to continue, which may impact its potential for long-term benefit. While a recent systematic review by Iglesias-Carrasc et al. (2024) concluded that exercises significantly reduce pain intensity compared to control groups that received other interventions or no interventions, methodological limitations weaken this conclusion. The review included only five RCTs, with quality assessment provided for only three studies. Standard practice is that all studies should be critically evaluated, and the overall conclusion should reflect the quality of the included studies (Higgins et al. 2022).

Furthermore, there was substantial heterogeneity in the interventions (e.g., mixed protocols for strength training, postural exercises, and cycling), musician populations (students vs. professionals), instrument types (strings vs. wind), and outcome measurement tools (visual analogue scales vs. self-reported non-validated questionnaire). Such clinical and methodological variability undermines the validity of pooling results, despite the reported statistical homogeneity ($I^2 = 0\%$). Therefore, the conclusion from this review should be approached with caution.

2.6.5 Summary

The aim of this section was to assess the evidence for management of PRMSDs in musicians. Whilst there is growing interest in implementing workplace physiotherapy services and ergonomic interventions, the evidence supporting their effectiveness remains limited. Health education programmes, while promising, often fail to translate knowledge into sustained behaviour change. Exercise interventions include warm-up exercises, although there is no research on the effect of warm-up exercises for musicians with PRMSDs. Motor control exercises may have short-term benefits; however, the studies investigating these exercises were weakened by high drop-out and low adherence rates.

Furthermore, several common limitations exist in the current evidence. First, most management approaches have focused on addressing single factors (such as physical exercise or posture), despite PRMSDs being complex conditions influenced by multiple factors including physical, psychological, lifestyle, and organisational aspects (as discussed in Section 2.4). Second, most studies did not attempt to filter out individuals with pre-existing symptoms at the time of recruitment; therefore, the results do not relate to the management of PRMSDs (Stanhope et al. 2022a). Third, the evidence base is limited to classical orchestral musicians and music students and thus may not represent the experiences and needs of musicians from other genres or employment contexts. Notably absent from the literature are studies exploring the lived experiences of musicians managing PRMSDs or their specific health needs to better navigate these conditions. This gap limits the development of interventions that align with musicians' real-world challenges.

Altogether, this suggests the need for a more comprehensive, evidence-based approach that addresses multiple risk factors, incorporates musicians' and other partners' input, and considers the diverse needs of musicians with PRMSDs across different genres and employment contexts when developing interventions for PRMSDs management, and most importantly, is responsive to changing needs and empowers musicians to support their musculoskeletal health throughout their careers. Self-management is a relatively new concept now widely endorsed by clinical guidelines for its potential to empower individuals to adopt high quality self-care behaviours, particularly in the area of musculoskeletal health (Bodenheimer et al. 2002). The next section will discuss the current evidence for self-management options and how these might inform future approaches for management of PRMSDs in musicians.

2.7 Self-Management Interventions for Playing-Related Musculoskeletal Disorders

Self-management interventions focus on enhancing individuals' knowledge and skills to manage their own conditions rather than relying on treatments provided by healthcare professionals (Nicholl et al. 2017). Bandura (1989) suggested that self-management is largely dependent on promoting self-efficacy: an individual's confidence in their ability to plan and carry out the actions necessary to achieve specific goals. According to Corbin and Strauss (1988), this involves engaging in three steps simultaneously. The first step focuses on the individuals' capacity to engage in medical management, such as medication adherence and maintaining a healthy diet (Lorig and Holman 2003). The second step involves adopting new behaviours and making lifestyle changes, such as engaging in exercise (Lorig and Holman 2003). The third step involves managing psychosocial factors, such as fear and depression, as

these are common factors in people with MSDs and may affect recovery (Lorig and Holman 2003). A key component in managing these psychosocial factors is social support, which provides emotional encouragement, practical assistance and opportunities to share experiences with others (Lorig and Holman 2003). This social support can be provided by healthcare providers, family members, peers with similar conditions or support groups (Lorig and Holman 2003).

Several behavioural elements have been identified to promote self-management including goal setting, problem-solving, action planning decision making and self-monitoring (Lorig and Holman 2003). These elements distinguish self-management interventions from traditional educational interventions. For example, where health education may inform individuals about the importance of exercise and the practical guidance on exercise technique (Section 2.5.3, 2.5.4), self-management interventions can help individuals identify personal barriers to exercise (e.g., poor motivation, lack of time, work commitments) (problem solving), develop strategies to overcome these barriers (decision making) and create sustainable plans that address their individual circumstances (action planning/goal setting) (Bodenheimer et al. 2002). This shift from passive receipt of information to active engagement in healthcare decisions represents a fundamental difference between traditional health education and exercise programmes and self-management interventions (Bodenheimer et al. 2002).

The most recent clinical guidelines developed by NICE promote self-management interventions as the first line of treatment for MSDs (NICE 2021). However, to date, no previous study has investigated self-management interventions for PRMSDs in musicians, despite promising evidence for various MSDs, including low back pain and osteoarthritis (NICE 2021) as well as other chronic conditions such as diabetes and

respiratory and mental health conditions (Panagioti et al. 2014). Several systematic reviews have demonstrated that self-management interventions can reduce disability and pain, particularly in the short term, for chronic low back pain (Oliveira et al. 2012; Rathnayake et al. 2021) and osteoarthritis (Kroon et al. 2018; Wu et al. 2022).

In a meta-analysis of 13 studies, Oliveira et al. (2012) found moderate effectiveness in reducing pain and disability in chronic low back pain populations, while Rathnayake et al. (2021) conducted a systematic review and meta-analysis of nine RCTs and found that self-management interventions for people with chronic non-specific low back pain had a moderate effect in the short term (Rathnayake et al. 2021). Similarly, Kroon et al. (2018) reported clinically meaningful improvements in pain and function for osteoarthritis patients through self-management interventions. More recently, Wu et al. (2022) reviewed 13 RCTs and found that self-management interventions improved pain, function, stiffness, mental health, and quality of life in patients with knee osteoarthritis compared to control groups.

However, most of the systematic reviews on self-management interventions acknowledge that the quality of evidence available could be considered low to moderate (Rathnayake et al. 2021; Wu et al. 2022). For example, Rathnayake et al. (2021) found that many trials did not adequately address the support mechanisms necessary for effective self-management, particularly the role of healthcare providers in guiding and supporting patients, which is important for sustained engagement (Waddell et al. 2008; Babatunde et al. 2023). Moreover, delivery methods for these interventions were mostly through in-person visits, with few incorporating digital approaches, which is a factor worth considering given that support seems crucial for effective long-term self-management, as intervention effects decrease over time

(Rathnayake al. 2021). Similarly, Wu et al. (2022) reported that self-management interventions for osteoarthritis are mainly based on patients' self-reported feedback and that there is a lack of standardised monitoring of patients outside the clinical environment.

A recent systematic review conducted by Spink et al. (2022) further corroborates that lack of accessible resources, poor communication and lack of support and monitoring from healthcare providers negatively affect patient engagement in treatment and the ability of adults to self-manage chronic MSDs effectively. Therefore, factors facilitating engagement with self-management interventions must be carefully considered while remaining mindful of the need for high-quality research. Recently, DHIs have emerged as a potential solution by providing accessible support and continuous engagement opportunities (Spink et al. 2022; Wu et al. 2022).

2.8 Digital Health Interventions for Playing-Related Musculoskeletal Disorders

According to the WHO (2016), DHIs utilise digital, mobile and wireless technologies to support the achievement of health objectives. This term encompasses both electronic health (eHealth), which was initially delivered exclusively via computers, and mobile health (mHealth) applications that make use of mobile and wireless devices (Bert et al. 2014; WHO, 2016; Agarwal et al. 2019; WHO 2023b). With the rapid increase in global internet usage and the impact of the COVID-19 pandemic, DHIs have gained widespread attention as accessible and scalable tools for delivering health interventions and promoting positive health behaviours across various conditions, including diabetes, asthma, mental health disorders and MSDs (Ritterband and Tate 2009; Bert et al. 2014; Agarwal et al. 2019; Kelly et al. 2022).

Empirical research highlights the potential of DHIs to enhance self-management through personalised, accessible support (Hewitt et al. 2020). Although DHIs cannot fully replace patient-to-therapist interactions, they offer several advantages for physiotherapy management, such as the cost-effective delivery of tailored information and feedback (de Vries and Brug 1999; Bennett and Glasgow 2009), continuous monitoring of outcomes outside clinical settings, and real-time feedback on treatment adherence, posture and biomechanics (Dicianno et al. 2015). These features can significantly enhance patient engagement through interactive platforms and personalised care plans, which is especially beneficial for managing chronic conditions such as MSDs (Hewitt et al. 2020). Moreover, the private and anonymous nature of DHIs creates a safe space for users to explore health information and seek support without fear of stigmatisation or professional repercussions (Borghouts et al. 2021).

Several systematic reviews highlight DHIs' efficacy in improving pain, functional disability, and psychosocial outcomes for general MSDs (Hewitt et al. 2020), low back pain (Du et al. 2017; Nicholl et al. 2017; Scholz et al. 2024), as well as early cost-effectiveness in healthcare settings (Suman et al. 2019; Fatoye et al. 2023; Geraghty et al. 2024). However, the evidence for DHIs in workplace settings remains limited. A recent systematic review included eight studies, six of which focused solely on exercise management, while only two studies incorporated aspects of pain self-management (Blake et al. 2024). The review indicated that the studies had low to moderate quality, with key gaps such as neglecting psychosocial risk factors that are known to affect pain self-management and the perceived burden of chronic pain, including self-efficacy, anxiety, and depression (Long and Holman 2003; Kowal et al. 2014). Moreover, the interventions mainly focused on assessing pain and did not assess outcomes related to the workplace and employment, such as work capacity,

job-related factors and return to work (Blake et al. 2024). Additional gaps highlighted include poorly described interventions and insufficient public partner involvement including employers, healthcare providers, and employees which is essential to enhance the effectiveness and relevance of workplace DHIs (Blake et al. 2024). This concurs with findings from previous systematic review on workplace DHIs for MSDs (Axon et al. 2019; Chen et al. 2021).

There is currently no systematic synthesis of DHIs for musicians; therefore, it is not possible to draw definitive conclusions. However, a systematic search revealed varied research across multiple designs and settings, including feasibility studies, pilot interventions, quasi-experimental designs, and RCTs (Su et al. 2012; Chan et al. 2013b; Ingle 2013; Roos and Roy 2018; Kuo et al. 2020; Porter 2021; Austen et al. 2024; Roos et al. 2024). These studies span different musical contexts, from music schools to professional orchestras, and employ diverse intervention approaches ranging from pre-recorded videos, websites and hybrid interventions (i.e., digital delivery and in-person support) to deliver exercises and health education. Out of these studies, only two RCTs were found (Porter 2021; Roos et al. 2024).

The RCT by Roos et al. (2024) evaluated a web-based workplace intervention for 65 Canadian orchestral musicians, combining educational content with Chan et al.'s (2014) exercise programme (Section 2.5.4). Whilst initial pain improvements were significant, these effects were not sustained at follow-up, and the results were confounded by participants' concurrent use of other treatments. The study's limitations extended to the lack of transparency regarding expertise in performing arts medicine: only one physiotherapist had some musical background and experience treating musicians (amount unspecified), while the second had received just four hours of

program-specific training. Moreover, the study did not detail who developed the educational content or how it was validated, reflecting a common limitation in PRMSDs research.

The second RCT, conducted by Porter (2021) in the USA, investigated an isometric and stretching programme, delivered via Zoom, in 19 student musicians. Although participants reported reduced pain in specific areas (head/neck during self-practice, $p=0.045$; back pain during ensemble practice, $p=0.017$), the study's generalisability was limited by its small sample size ($n=19$). In addition, the study did not specify which exercise was investigated; nor did it detail how the exercises were developed or by whom. This lack of information undermines the ability to assess the intervention's reproducibility, understand the underlying mechanisms of pain reduction and apply the findings to other musicians.

Web-based health education for student musicians has also been investigated using quasi-experimental studies in Taiwan and Australia (Su et al. 2012; Ingle 2013). The evidence has consistently shown limited improvements in health awareness, knowledge of injury prevention, physical fitness, nutrition and emotional well-being, behavioural changes and physical and psychological health outcomes (Su et al. 2012; Ingle 2013). Possible reasons could be the high dropout rate (84%) (only four out of 25 participants remained) and the lack of statistical analysis (Ingle 2013). In addition, the development processes lacked transparency, with minimal input from musicians, clinicians, or other relevant partners during design and implementation (Su et al. 2012; Ingle 2013) – a known prerequisite for successful interventions (Waddell et al. 2008).

To address these methodological limitations and enhance future DHI development for PRMSDs, several frameworks have emerged. NICE published the evidence standards

framework for DHIs, which, along with the updated MRC framework (Skivington et al. 2021; Unsworth et al. 2021), emphasises the importance of rigorous development processes to address many of the methodological limitations identified in current DHI research. This includes reviewing existing literature to identify the current evidence and conducting co-production research by engaging public partners (target population, individuals involved in intervention delivery, and those whose personal or professional interests are affected) in identifying problems, setting goals, and implementing and evaluating the intervention (Greenhalgh et al. 2019; Price et al. 2021). Therefore, the overall aim of the thesis was to enhance understanding of DHIs for PRMSD self-management in musicians by engaging public partners and following evidence-based frameworks for intervention development.

2.9 Gap in the Literature and Rationale for the Thesis

Musicians face a uniquely high risk of PRMSDs due to chronic physical strain, psychological stressors, and precarious working conditions (Sections 2.4–2.5). Despite this vulnerability, a recent systematic review highlighted the absence of conclusive evidence supporting existing PRMSDs interventions, with all studies failing to demonstrate clinically significant outcomes (Stanhope et al. 2022a). Existing interventions primarily focus on physical risk factors, lack transparent development processes, and are not sufficiently tailored to musicians' needs (Section 2.6.3). DHIs may offer self-management support that is both personalised and widely accessible to musicians (Section 2.8.1). However, current DHIs replicate the limitations of traditional approaches (Section 2.8.1). Without clearly understanding musicians' health needs, barriers to care, and preferences for intervention delivery (which prior studies have not done), interventions may continue to provide limited improvements. Furthermore,

involving healthcare professionals with expertise in performing arts medicine is essential, given musicians' documented mistrust of healthcare professionals and the consistent lack of transparency regarding the qualifications and expertise of those developing and delivering interventions. This thesis aims to fill this critical gap by developing DHIs in a systematic, evidence-based manner that emphasises public engagement following the MRC framework for complex interventions (Skivington et al. 2021).

2.9.1 Aim

The overall aim of this thesis was to explore DHIs for PRMSD self-management in musicians. The objectives of this thesis are to:

- Map the available evidence on DHIs for self-management of PRMSD in musicians (Phase 1).
- Explore experiences, needs, and preferences of musicians regarding PRMSD self-management, and what barriers and facilitators influence their engagement with PRMSD self-management (Phase 2).
- Explore the perspectives of musicians and healthcare professionals on the intervention components, potential facilitators, barriers, and potential solutions of developing a DHI to support PRMSD self-management in musicians (Phases 2 and 3).

The following chapter outlines the philosophical underpinnings of the research and describes the multiphase mixed methods design employed to address the research objectives.

Chapter 3: Methodology

3.1 Introduction

An appropriate research methodology is essential for selecting philosophical assumptions and a research design that effectively addresses a research problem (Creswell 2004). This chapter outlines the methodological approach used to achieve the study's aim and objectives, including the key philosophical considerations and the research design. It explores the underlying theoretical foundations and frameworks that inform the study and guide intervention development. Additionally, the chapter discusses how these methodological choices shape the research process, ensuring coherence and alignment with the study's objectives.

3.2 Philosophical Assumptions

Several research paradigms are outlined in the literature; however, positivism, constructivism, and pragmatism are the most commonly discussed paradigms, as outlined in Table 3.1 (Creswell 2014).

Table 3.1: Summary of Research Paradigms (adapted from Creswell 2014)

Paradigm	Positivism	Constructivism	Pragmatism
Ontology	Assumes a single objective reality exists	Recognises multiple subjective realities	There is no one way of viewing reality
Epistemology	Truth or reality is uncovered through measurement and hypothesis testing	Truth or knowledge is uncovered through researcher-participant interactions and interpretations	Truth or knowledge is acquired through methods best suited to the research question
Researcher position	Must employ rigorous methods to minimise bias	Actively engages with participants and interprets findings	Selects research approaches based on intended outcomes
Research type	Quantitative	Qualitative	Mixed methods (quantitative and qualitative)
Research strategy	Experimental and survey research	Qualitative approaches including phenomenology, ethnography, narratives, case studies, and grounded theory	Combines explanatory and exploratory
Data collection method	Quantitative data collection methods	Interviews, focus groups and observations	Both qualitative and quantitative methods
Data analysis	Statistical analysis	Text analysis	Integrates statistical and text analysis
Advantages/ disadvantages	Offers reproducibility and generalisability while being time-efficient / provides limited depth of understanding	Provides deep understanding of health behaviours and experiences / requires significant time investment	Offers flexibility and problem-focused approaches / may involve complex designs with potential methodological inconsistencies

As shown in Table 3.1, positivists believe in a single reality or truth in the world (Creswell 2014). These paradigms view reality as objective and aim to explore knowledge by testing theories or hypotheses to understand the world (Tashakkori and Teddlie 2003; Creswell 2014). Positivists' views are associated with quantitative methods where researchers collect and analyse quantifiable data against a set of pre-defined variables and hypotheses (Tashakkori and Teddlie 2003; Creswell 2014). In quantitative research, data collection can be time-consuming and costly due to the large number of participants required; however, data analysis can be conducted efficiently using computer-based software packages (Connolly 2007). Replicability of

research design is another benefit, since quantitative research relies on hypothesis testing and clear guidelines for its conduct (Pannucci and Wilkins 2010) and minimising bias (Denscombe 2017).

Conversely, from the perspective of constructivism, researcher detachment may be viewed as a weakness because it is difficult to get an in-depth understanding of the phenomenon being investigated (Watson 2015). Constructivists assume that multiple realities exist, that reality is subjective, and that knowledge can be interpreted differently based on the meanings individuals construct from their experiences (Creswell 2014). Their views align with qualitative methods, which involve gathering data from participants to generate subjective interpretations of the situation being studied (Creswell 2014). Although constructivism is valuable for exploring patterns of health behaviours and lived experiences, qualitative research can be limited in scale and scope compared to more quantitative approaches (Khankeh et al. 2015). This is because qualitative methods typically focus on depth rather than breadth by exploring individual experiences and complex phenomena in detail but within smaller sample sizes (Creswell 2014). This approach may not always allow for generalisations to larger populations, which is a strength of quantitative research (Creswell 2014).

Pragmatism views reality between subjective experiences and objective facts, suggesting that reality is not fixed, but is continually shaped by our interactions and interpretations (Morgan 2014). It emphasises practical applications of ideas, focusing on how knowledge is created and used rather than strictly adhering to the nature of reality (ontology) or the theory of knowledge (epistemology) (Saunders et al. 2009; Morgan 2014). Pragmatists are concerned with what works in practice and how different approaches can be integrated to address complex problems (Morgan 2014).

This approach allows the researcher to choose the most appropriate method, either quantitative or qualitative, and to combine them when needed (Creswell et al. 2004; Creswell and Clark 2011). In a similar way, in mixed methods research, researchers can choose the methods, techniques, and procedures of research that best meet their needs and purposes (Creswell et al. 2004). Accordingly, several scholars suggest that pragmatism is the most appropriate paradigm for mixed methods research (Morgan 2014).

The aim of this thesis was to explore DHIs for PRMSD self-management in musicians. It also aimed to consider the theory and evidence related to PRMSDs and DHIs, along with the beliefs, knowledge, and practices of relevant partners. The thesis was underpinned by pragmatism, where the nature of reality (ontology) is between the objective and subjective stances. This objective reality is evidenced by the literature supporting the existence and effectiveness of DHIs for people with MSDs and WRMSDs (Oliviera et al. 2012; Du et al. 2017; Hewitt et al. 2020; Rathnayake et al. 2021; Wu et al. 2022) (Chapter 2, Section 2.6). While the subjective reality is related to musicians' perception of DHIs, this can vary based on personal preferences and psychological and contextual factors, which suggests that multiple realities may exist.

In terms of epistemology, the researcher's views were influenced by the existence of several frameworks that are potentially suitable for addressing the aims of this thesis related to health intervention development and evaluation. Among these, Design Thinking (Roberts et al. 2016) and the MRC framework for developing and evaluating complex interventions (Skivington et al. 2021) offer structured approaches. The next section will provide an overview of these frameworks.

3.3 Design Thinking

Design Thinking focuses on creating solutions by exploring and understanding the experiences of those who will use them (Roberts et al. 2016). The process begins with Empathy, where developers observe and engage with users to comprehend their thoughts, feelings and behaviours in a specific context (Sonney et al. 2019). This understanding informs the next stage (Define), where the core problem is clearly defined from the user's viewpoint (Ku and Lupton, 2020). The process then moves to Ideation where multiple ideas are generated to address the problem(s) identified (Ku and Lupton, 2020). The ideas that are most promising advance to the Prototype phase (Ku and Lupton, 2020). During the Prototype phase, ideas transform into simple, low-cost physical or digital solutions that users can interact with (Ku and Lupton, 2020). The final phase is the Testing phase where the prototype is tested with the target end-users, preferably in the environment where the problem occurs, and the solution will be implemented (Ku and Lupton, 2020). In this phase, end-users provide feedback on what works well, what does not, what is missing, and what should be changed to refine the prototype (Ku and Lupton, 2020).

A systematic review indicated that Design Thinking is an acceptable and effective method to use in healthcare although more research is needed (Altman et al. 2018). However, Design Thinking does not provide detailed guidance on how to handle the complex aspects of healthcare systems, how to evaluate the clinical effectiveness of an intervention, or how to ensure that the intervention can be implemented in a sustainable way over the long term (Altman et al. 2018; Krolikowski et al. 2022). These aspects are crucial for successful healthcare interventions, which is why frameworks like the MRC framework might be prioritised in early development stages (i.e., theory

development) while Design Thinking may then complement further testing stages to refine usability and user experience (Roberts et al. 2016).

3.3.1 The Medical Research Council Framework

The MRC framework emphasises theoretical underpinnings, contextual considerations, and the use of multiple research methods to generate robust evidence (Skivington et al. 2021). It ensures that interventions are not only user-centred but also rigorously developed, tested, and adapted for real-world implementation. While Design Thinking provides a valuable framework for ensuring usability and engagement, particularly in digital interventions (Roberts et al. 2016), the MRC framework offers a more structured and evidence-based approach to developing and evaluating complex health interventions (Skivington et al. 2021). Given the aims of this thesis, which focus on enhancing DHIs for PRMSD self-management in musicians, the MRC framework was considered the most appropriate. Specifically, the MRC framework was used to (i) systematically map the existing evidence base; (ii) inform the theoretical underpinning of the intervention; (iii) determine the key components, such as the content, the equipment and the context of the intervention; and (iv) identify facilitators and barriers to future implementation of the intervention. The next section explores how the MRC framework was utilised for that purpose.

3.3.2 Development – Phase 1: Identifying the Evidence Base

According to the MRC framework, the first step in intervention development involves conducting a thorough review of the existing evidence and synthesising the findings to understand the current state of knowledge on the topic and to identify gaps or limitations in the existing evidence base (Skivington et al. 2021). Evidence synthesis can take many forms, including narrative reviews, systematic reviews, and scoping

reviews (Greenhalgh et al. 2018). While narrative reviews provide broad perspectives on a topic, their unsystematic approach to literature selection risks incomplete coverage and subjective conclusions, rendering them unsuitable for robust evidence synthesis (Green et al. 2006). Systematic reviews, conversely, employ prespecified methods to synthesise high-quality evidence to answer specific questions about effectiveness or outcomes (Greenhalgh et al. 2018). DHIs and PRMSDs are both emerging topics with sparse evidence that is methodologically inconsistent and marked by limited high-quality RCTs, heterogeneous interventions (e.g., web-based, video-based vs. hybrid programmes), and significant risks of bias (e.g., exclusion of dropouts, confounding treatments), as discussed in Chapter 2, Sections 2.6 and 2.8 and 2.6.1 (Stanhope et al. 2022a). Systematic reviews typically include high-quality studies that are sufficiently homogenous and rigorous (Higgins et al. 2022).

Scoping reviews are an exploratory and descriptive approach to knowledge synthesis that can be used to assess and understand the extent of knowledge in emerging fields (Peters et al. 2020). Scoping reviews retain the methodological rigor and transparency of systematic reviews, including systematic search strategies and reproducible frameworks (Peters et al. 2020; Pollock et al. 2021), but are designed to iteratively explore the breadth of literature to determine the value in undertaking a full systematic review, summarising and disseminating research findings, and identifying gaps in the literature to inform further research (Levac et al. 2010; Peters et al. 2020). A key strength of scoping reviews is that they allow for inclusion of different types of studies including grey literature, such as policy documents, reports, dissertations and other non-peer-reviewed sources (Peters et al. 2020). This is particularly valuable for emerging fields such as PRMSDs and DHIs for PRMSDs, where formal academic research may be limited, but useful insights and data can be found in non-peer-

reviewed sources (Peters et al. 2020). Given that the aim is to explore an issue that has been relatively underexplored, employing a scoping review to identify and critically develop key areas for further research was considered appropriate (Levac et al. 2010).

The scoping review methodology was guided by the Johanna Briggs Institute (JBI) framework, which is currently considered to be the most rigorous and defined approach (Peters et al. 2015). The framework is divided into the following steps: (1) identifying the research question, aim and objectives; (2) identifying relevant literature; (3) study screening and selection; (4) charting the data; (5) collating, summarising, and reporting the results; (6) consultation (if applicable) (Peters et al. 2020).

3.3.3 Development – Phase 2: Identifying or Developing Theory

Theoretical frameworks serve multiple purposes in intervention design and evaluation (Davis et al. 2015). They provide a structured approach to understanding causal mechanisms, documenting effective components, and tailoring strategies to specific contexts (Michie et al. 2011). When conducted and evaluated rigorously, theory-based interventions allow researchers to identify which components are most impactful and which might be redundant, potentially enhancing user engagement over time (Craig et al. 2008; Skivington et al. 2021).

While there is broad agreement on the value of theory-based interventions (Moore and Evans 2017), it would be misleading to assume that these interventions are superior to those developed through other approaches (Moore and Evans 2017). Rather, theoretical frameworks allow researchers to design interventions in a well-organised manner that accounts for the complex interplay between individual and environmental factors influencing behaviour, therefore facilitating more targeted health interventions (Davis et al. 2015). The MRC framework, however, offers limited guidance on selecting

and applying theories to specific contexts (Skivington et al. 2021). Therefore, it was necessary to explore relevant theories that could effectively promote self-management behaviours among musicians with PRMSDs.

3.3.3.1 Behaviour Change Theories

Behaviour change theories are frameworks that provide systematic explanations of why people behave the way they do and how behaviour change can be achieved (Davis et al. 2015). These theories draw on psychological, sociological, and behavioural science principles to understand the factors influencing behaviour and to guide the development of complex interventions (Michie et al. 2011). In a scoping review, Davies et al. (2015) identified eighty-two different theories used in health-related behavioural interventions, with four theories accounting for 60% of the articles within the review: the Transtheoretical Model of Change, the Theory of Planned Behaviour, the Social Cognitive Theory, and the Behaviour Change Wheel (BCW).

The Transtheoretical Model is a stage-based approach to behaviour change (Prochaska and Prochaska 2019). The model acknowledges that individuals progress through different stages, including precontemplation (no intention to change), contemplation (intending to change), and action (actively making changes) (Prochaska and Prochaska 2019). However, the stages can vary based on different behaviours or conditions and are not clearly defined or supported with evidence (West 2005). This subjectivity makes it challenging to assign individuals to stages, leading to potential misclassification, which in turn undermines the validity of the model (West 2005). Furthermore, a key construct of the Transtheoretical Model is decisional balance, which involves weighing the advantages and disadvantages of changing

behaviour as individuals progress through the stages (Prochaska and Prochaska 2019).

However, musicians often have strong emotional ties to their profession, including concerns about career implications and personal identity tied to their musical practice, which can influence their behaviour (Pradhita 2022). Similarly, studies indicate that intentions to change can fluctuate based on individual circumstances, motivation levels and self-efficacy, which the model does not account for (Littell and Girvin 2002; West 2005). This limitation may explain why studies using the Transtheoretical Model for interventions related to MSDs, alcohol consumption, and smoking have not demonstrated significant benefits compared to non-theoretical control interventions (Alciauskaite et al. 2015; Davis et al. 2015).

In contrast, both the Theory of Planned Behaviour and the Social Cognitive Theory consider motivation levels, self-efficacy, and psychological factors in behaviour change (Bandura 1998; Knauder and Koschmieder 2019). The Theory of Planned Behaviour suggests that behaviours are influenced by three main factors: individuals' attitudes, subjective norms, and perceived behaviour control (Ajzen 1985). Meanwhile, the Social Cognitive Theory suggests that individuals consider outcomes, observe others' behaviour, and evaluate self-efficacy when making decisions about their behaviour (Bandura 1998). Interventions combining both theories have shown significant effects on pain and disability in people with MSDs (Irvine et al. 2015).

However, both theories offer an incomplete understanding of behaviour change (Davis et al. 2015), as neither considers contextual factors that shape behaviour, such as access to resources, environmental barriers, and organisational policies (Michie et al. 2011). As outlined in Chapter 2, musicians' health behaviours may be influenced by

external factors such as the physical environments in which they perform, financial stability, social support from peers, and organisational policies that affect their working conditions (Guptill 2011; Stanhope et al. 2022b). Further, the MRC framework advocates for a system thinking approach that considers behaviour as part of a larger interconnected system involving individual, interpersonal, organisational and environmental factors (Skivington et al. 2021). In addition, the NICE (2014) behaviour change guidance suggests that interventions are more effective if they simultaneously target variables at different levels (individual, social, and physical environment). Therefore, despite the widespread use of the Transtheoretical Model of Change, the Theory of Planned Behaviour, and the Social Cognitive Theory, none were considered appropriate in the context of this study.

On the other hand, the BCW has emerged as a prominent framework for designing, implementing, and evaluating behaviour change interventions across diverse fields (Michie et al. 2011). The BCW provides a systematic and structured approach for understanding and designing behaviour change interventions by integrating various behaviour change theories and frameworks (Michie et al. 2011). The BCW was developed through a systematic review and synthesis of 19 existing behaviour change theories (Michie et al. 2011). As outlined in Figure 3.1, the BCW consists of three layers.

Figure 3.1: The Behaviour Change Wheel (reproduced from Michie et al. 2011)

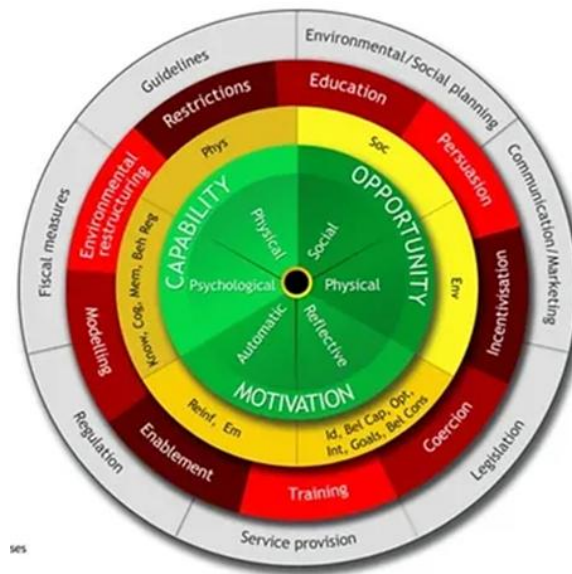
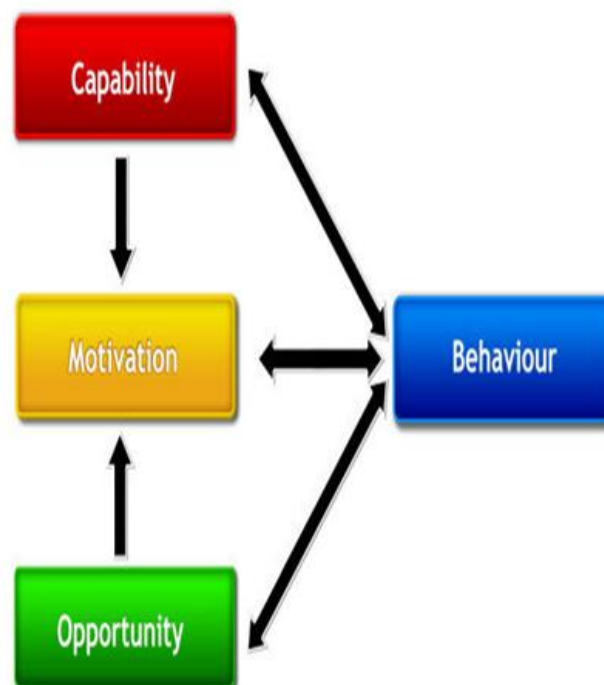


Figure 3.2: The Capability, Opportunity, Motivation, Behaviour (COM-B) model (reproduced from Michie et al. 2011)



The centre of the wheel is the Capability, Opportunity, Motivation, Behaviour (COM-B) model, which serves as a theoretical framework for identifying barriers and enablers of target behaviours (Figure 3.2) (Michie et al. 2011). Capability refers to an individual's psychological and physical capacity to perform the behaviour (Michie et al. 2011). Motivation encompasses both reflective (conscious) and automatic (habitual) drives that direct the behaviour (Michie et al. 2011). Opportunity represents the external factors that make the behaviour possible or prompt it, which can include social and physical opportunity (Michie et al. 2011). The single-headed and double-headed arrows in Figure 3.2 indicate that behaviour is considered an interaction between all three components (Michie et al. 2011). The second layer of the BCW includes nine intervention functions that can be used to modify the behaviour (Michie et al. 2011). These intervention functions can be implemented through 93 specific Behaviour Change Techniques (BCTs) (e.g., goal setting, self-monitoring) (Chapter 2, Section 2.7) (Michie et al. 2013). Finally, the outer layer of the BCW comprises seven policy categories that support the implementation of interventions (Michie et al. 2011).

The BCW was chosen over other models due to its comprehensive nature and flexibility (Michie et al. 2011). It allows for a more holistic understanding of behaviour by considering a wide range of influences, from individual psychological factors to broader social and environmental determinants (Michie et al. 2011). This aligns with the MRC framework's recommendation for a system thinking approach (Skivington et al. 2021) and an emphasis on multi-level interventions (NICE 2014). In addition, the BCW has been used successfully in previous studies to develop similar DHIs to manage MSDs (Berry et al. 2021), and osteoarthritis (Nelligan et al. 2019). For example, Berry et al. (2021) and Nelligan et al. (2019) systematically developed a DHI for MSDs and osteoarthritis self-management by employing the BCW to map

appropriate intervention functions and multiple BCTs: 25 and 30 respectively. Therefore, the BCW model was considered appropriate for the context of this study.

Aspects of the BCW, particularly the COM-B model were previously applied in a health education course for promoting music students' health (Matei et al. 2018; Matei and Ginsborg 2022). However, the application in Matei and Ginsborg (2022) suggests a limited understanding of the model. Their account demonstrates standard health guidance simply arranged within COM-B domains—delivering facts about healthy lifestyles (capability), highlighting environmental prompts such as staircase use (opportunity), and encouraging enjoyable activities (motivation) (Matei and Ginsborg 2022). This approach exemplifies what Norton (2020) identified as a common shortcoming in Performing Arts Health research. Interventions typically do not assess specific behavioural barriers before designing educational programmes or select appropriate intervention functions based on identified barriers to achieve target behaviours (Norton 2020), despite these being fundamental steps in the BCW model (Michie et al. 2011). Norton (2020) indicated that further research is needed to apply the BCW model comprehensively in Performing Arts Health research.

3.3.3.2 Behaviour Change Wheel

The first step in the BCW model involves conducting a thorough diagnosis of the target behaviour(s) and influential factors to determine which components of the COM-B model require modification to achieve that target behaviour (Michie et al. 2011; Atkins et al. 2017). As discussed in Chapter 2, self-management is recommended in the management and treatment of MSDs (Section 2.7). However, self-management interventions and DHIs have not been fully realised in PRMSDs research (Section 2.6).

Therefore, the target behaviour of the intervention is to support musicians to self-manage PRMSDs.

To determine which components of the COM-B model require modification to achieve the target behaviour, and the specific content and components of intervention functions, two approaches are recommended: 1) reviewing existing literature to establish effective interventions in similar contexts, and 2) engaging with public partners (Michie et al. 2011; O'Cathain et al. 2019). Public partners encompass a wide range of individuals, including those involved in creating and delivering interventions, as well as end users such as practitioners, policymakers, patients, and members of the public (O'Cathain et al. 2019). Given the broad definition of public partners, it is important to carefully consider which individuals are most relevant at different phases of the research (Skivington et al. 2021).

The MRC framework emphasises that the target population should be involved early in the development stage to provide insights into their needs, preferences, and experiences (Skivington et al. 2021). This helps to ensure relevance to the target population and enhances the acceptability of the intervention (Skivington et al. 2021). Accordingly, musicians were consulted initially to understand their needs and inform key components of the intervention. Healthcare professionals were also considered relevant partners and were involved in the subsequent stage, as the MRC framework suggests that healthcare professionals should be involved in the early development stage to provide clinical expertise, insights into current practices, and perspectives on the feasibility and acceptability of the intervention (Skivington et al. 2021).

Although a recent review found no conclusive evidence that public engagement yields better health outcomes (Grindell et al. 2022), the consensus is that it helps to balance

power differentials and offers a sense of ownership, allowing participants to feel that their knowledge and ideas are valued (NICE 2019). As a result, participants may have greater trust in the process, and the outputs produced are more likely to be relevant and acceptable to all parties involved (NICE 2019). This may influence intervention uptake and adherence (NICE 2019), which is a consistent problem in musicians' health research, as previously discussed (Chapter 2, Section 2.5). Moreover, public engagement aligns with the BCW's emphasis on tailoring interventions to user needs through participatory research (Michie et al. 2011).

3.4 Multiphase Mixed Methods Design

To implement this collaborative approach effectively, a mixed methods approach utilising a multi-phase design was adopted. Multiphase designs are commonly used in healthcare science studies when multiple phases need to be conducted over time in a single project, with each phase building on the previous one (Creswell and Clark 2017). According to the MRC framework, it is important to explore and build on different partners' perspectives to ensure that the intervention is comprehensive and relevant to all involved (Skivington et al. 2021). Therefore, as well as the systematic review methodology adopted in Phase 1, Phase 2 employed a sequential explanatory design with a participant selection model (Creswell 2014). This phase began with an online survey (Phase 2/Part 1) designed to provide a broad understanding of the management methods musicians use for PRMSDs, their perceived effectiveness, their treatment needs and preferences, including the use of DHIs. The survey findings then informed subsequent online focus groups (Phase 2/Part 2), where participants provided more detailed insights into the survey results and shared their views on barriers and facilitators to PRMSD self-management, as well as their views on DHIs,

including key intervention components, facilitators, and barriers to using DHIs for PRMSD self-management. The findings from both parts of Phase 2 were integrated during interpretation, with greater emphasis on the qualitative focus group data. These results then informed the subsequent phase, which involved online interviews with healthcare professionals (Phase 3). Further details on the study design and methods are presented in Chapters 5 (Section 5.3), 6 (Section 6.3), and 7 (Section 7.3)

Chapter 4: Phase 1: Scoping Review

Digital Health Interventions for Playing-Related Musculoskeletal Disorders in Musicians: A Scoping Review

4.1 Introduction

As outlined in Chapter 2 (Section 2.5), PRMSDs represent an emerging topic with a current evidence base that is heterogeneous and inconsistent in quality (Stanhope et al. 2022a; Laseur et al. 2023; Iglesias-Carrasco et al. 2024). Although recent systematic reviews on the management of PRMSDs have been conducted (Stanhope et al. 2022a; Iglesias-Carrasco et al. 2024), none specifically explored DHIs for PRMSDs self-management. Therefore, further investigation in the form of a scoping review for DHIs for PRMSDs self-management was deemed necessary. This scoping review was conducted to systematically map and synthesise the available evidence on DHIs for PRMSD self-management. Specifically, it aims to explore how DHIs are currently being designed and implemented for PRMSDs, including their theoretical underpinnings, types of DHIs used, settings and dose, their impact on intended outcomes, and any potential adverse effects. These investigations align with the MRC framework (Skivington et al. 2021), which emphasises the need to map available evidence to refine future intervention development and implementation (Chapter 3, Section 3.3.2).

4.2 Study Design and Methods

The scoping review methodology was guided by the JBI framework (Peters et al. 2020) which is divided into the following six steps: (1) Identifying the research question, aim and objectives; (2) Identifying relevant literature; (3) Selecting the literature; (4)

Charting the data; (5) Collating summarising and reporting the results; (6) Consultation (if applicable) (Peters et al. 2020).

4.2.1 Stage 1: Review Question, Aim and Objectives

4.2.1.1 Review Question

The review question for the scoping review was as follows: **What is the current evidence base for DHIs for PRMSD self-management in musicians?**

4.2.1.2 Aim

The aim of this scoping review was to map the available evidence on DHIs for PRMSD self-management in musicians to inform future interventions.

4.2.1.3 Objectives

The objectives of this scoping review were to explore:

- The content and structure of DHIs for PRMSD self-management in musicians.
- The use of the theoretical framework underpinning intervention development.
- The mode of delivery and adherence monitoring of the interventions.
- The frequency and duration (i.e., dose) of the interventions.
- The overall effect of the interventions on musculoskeletal symptoms, musicians' ability to perform, other health-related outcomes, and any adverse effects.

4.2.2 Stage 2: Identifying Relevant Literature

Identifying the relevant literature involved a systematic process that includes defining the eligibility criteria, developing a search strategy and screening and selecting the relevant studies (Peters et al. 2020).

4.2.2.1 Eligibility Criteria

To ensure that all the relevant studies were included, clear and relevant inclusion and exclusion criteria were set (Jesson et al. 2011). The PCC (population, concept, and context) mnemonic was used to develop the inclusion criteria for the scoping review, as recommended by the JBI guidance (Peters et al. 2020). As outlined in Table 4.1, the population comprised adult musicians with current or previous PRMSDs or musculoskeletal symptoms related to practicing or performing music (Zaza et al. 1998). The study explored DHIs aimed at supporting the self-management of PRMSDs in musicians, regardless of the setting. For this study, the definition of DHIs was adapted from the WHO (2023b), which defines DHIs as specific functionalities or capabilities provided by digital technologies that aim to fulfil particular goals related to health and quality of life. DHIs can be categorised based on the primary users, patients, healthcare providers, and health management personnel (WHO 2023b). For patients, DHIs may include:

- **Internet-based programmes:** Websites or applications with which participants can interact via mobile devices or computers (WHO 2023b).
- **Mobile health applications (mHealth):** Apps that deliver health-related services through smartphones, tablets, or similar devices (WHO 2023b).
- **Virtual reality:** Immersive, three-dimensional environments that enable individuals to interact, explore, and manipulate objects within a simulated sensory experience (Riva 2000).
- **Video teleconferencing:** Systems combining audio and video over internet networks to facilitate real-time interactions between patients and healthcare providers (Riva 2000).
- **Video-based content:** The use of pre-recorded videos to remotely deliver health interventions (Riva 2000).

- **Text messaging (SMS):** The use of SMS or other messaging services to deliver health-related information, reminders, and support directly to individuals' mobile devices (WHO 2023b).

Table 4.1: Eligibility Criteria

	Inclusion criteria	Exclusion criteria
Participants	- Adults aged 18 years or older. - Musicians working in a music-related setting (e.g. orchestra, conservatoires). - University-level music students - Current or previous playing-related-related musculoskeletal symptoms such as pain, reduced range of motion, muscle weakness, inability to perform	- Musculoskeletal conditions caused by trauma, inflammatory conditions, genetic conditions, neurological conditions or any other condition not related to practicing or performing music
Concept	- Any digital health intervention that supports self-management of playing-related musculoskeletal disorders in musicians	- Passive interventions such as ice and heat application, taking medications, using creams/gels, resting, ergonomic equipment. - Post-surgical rehabilitation
Context	- Any setting (e.g., home or the workplace)	
Studies	- Any primary research study in English including grey literature.	- Secondary research studies (literature reviews, editorials) - Conference abstracts

4.2.2.2 Developing a Search Strategy

As recommended in all JBI reviews, a three-step search strategy was used (Peters et al. 2020). An initial search was carried out in Medline using the search terms outlined in Table 4.2 to identify search terms and phrases relevant to the review question. The search terms were identified by reviewing abstracts and using keywords or subject lists relevant to this study. The identified search terms were then grouped into three categories: those relating to musicians, those relating to PRMSDs, and those relating to DHIs (Appendix 1, Table 1).

The following databases were searched: Embase (Ovid), CINAHL (EbscoHost), the Allied and Complementary Medicine Database (AMED) (Ovid), TripPro, and Music Index (EbscoHost). EMBASE contains vast quantities of healthcare-related

references, while CINAHL indexes the leading allied healthcare literature available (Bahaadinbeigy et al. 2010). Music Index was also searched, as this is a comprehensive database incorporating music-specific literature (Vaaler 2021).

Furthermore, to include non-published grey literature, the ProQuest database was searched to identify potentially relevant studies. Throughout the search process, the guidelines provided by the databases were consulted and followed as necessary to ensure that the search was conducted correctly and effectively. Additionally, hand searches and citation chaining of journal bibliographies were undertaken (Boland et al. 2017). The total number of articles captured from each database search is included in Appendix 1, Table 2.

As the majority of studies retrieved were published in the *Medical Problems of Performing Artists Journal*, the journal's bibliographies from 2000 to 2024 were searched for relevant studies. In addition, the reference lists of the systematic reviews on PRMSDs in musicians were also searched (Stanhope et al. 2022a; Iglesias-Carrasco et al. 2024). The search was not restricted by publication date, as the JBI guidelines advise against applying date restrictions where the main aim is to map all the available evidence on a certain topic (Peters et al. 2020). Further, DHIs and PRMSDs are both emerging topics and restricting the date of publication may have limited the scope of the search.

Furthermore, the search was limited to English-language literature, as the research team conducting the review had no access to translation services and was only proficient in English. This is unlikely to have had a significant effect on the scope of the review because previous studies indicated that excluding non-English language records from a systematic review had a minimal effect on the results (Nussbaumer-

Streit et al. 2020). Initial searches were carried out in June 2021, with an updated search conducted in August 2024.

Table 4.2: Results of Initial Search in Medline

Search terms	Records
(Playing-related musculoskeletal disorders OR performance-related musculoskeletal disorders OR PRMDs OR PRMSDs) AND (musicians OR music playing) AND (E-health interventions OR Electronic health OR digital health interventions)	163

4.2.3 Stage 3: Study Screening and Selection

Studies identified in the search were imported into bibliographic management software Endnote (Hupe 2019). Articles were initially evaluated based on titles and abstracts to determine if they met inclusion criteria. In cases where eligibility remained unclear after reviewing titles and abstracts, the full text was examined using a data screening sheet (Appendix 1 Table 3). The researcher made the final selection decisions with guidance from the supervisory team (RH, VS, LS).

4.2.4 Stage 4: Charting the Data

Charting the data involves systematically extracting and organising key information from the included studies that align with the review's aims and objectives using tables and graphs (Peters et al. 2020). Therefore, all relevant information was extracted from each study (reported in Section 4.4.3 Tables 4.4 and 4.5). Table 4.4 summarises the general characteristics of the included studies (i.e., authors, year of publication, study designs, population and demographic characteristics, control group). Table 4.5 documents the categories of need, including the intervention content, dose, method of delivery and settings, and the intended outcomes.

4.2.5 Stage 5: Collating, Summarising and Reporting Results

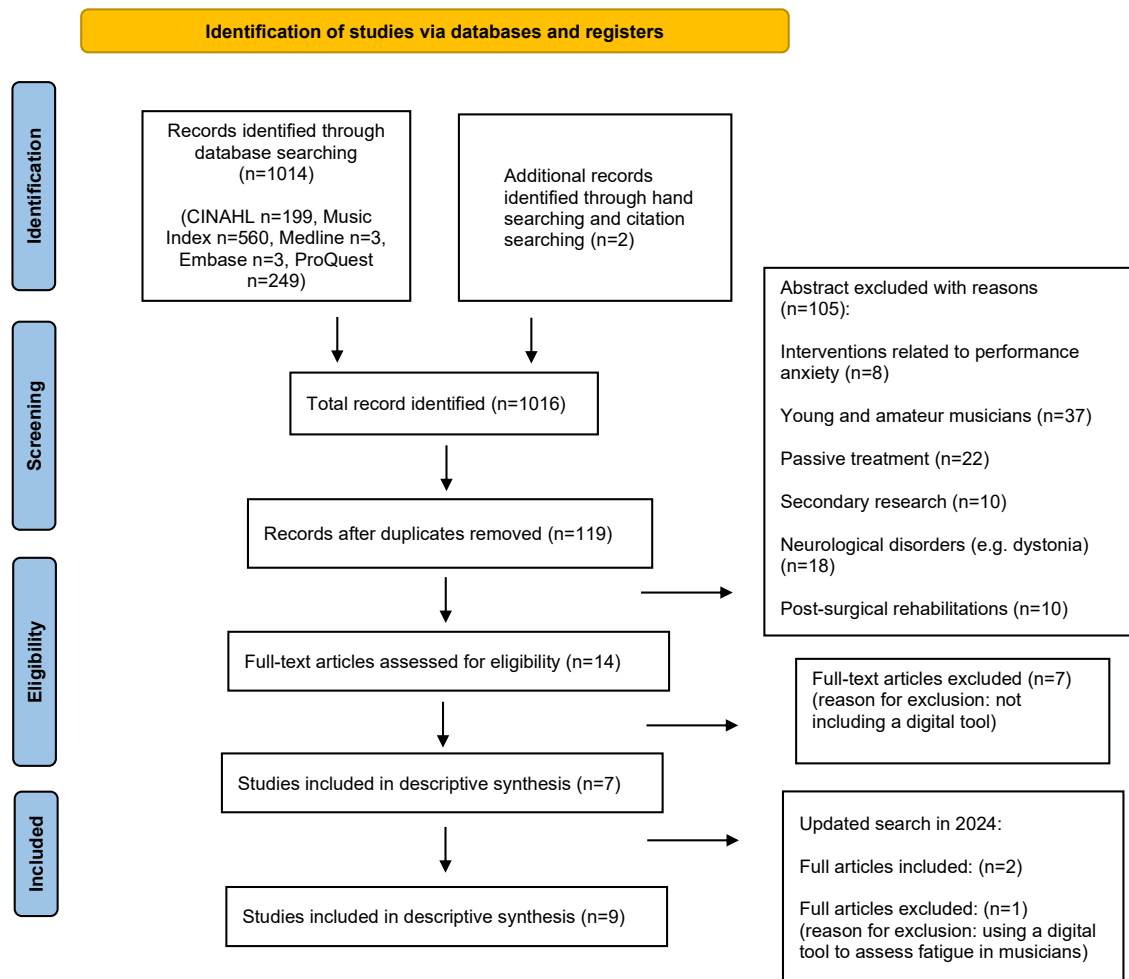
This stage includes compiling a descriptive summary of the key findings from the included studies, highlighting main themes and trends (Peters et al. 2020). The report of the results involved counting the studies to summarise the results related to each objective (reported in Section 4.2.1). Further, all the studies were analysed to identify any factors that had a positive or negative impact associated with the use of DHIs for PRMSD self-management in musicians to provide meaningful insights into the summary results (Peters et al. 2020).

Generally, critical appraisal or risk of bias assessment is not recommended in scoping reviews, as the aim is to map the available evidence, rather than to provide a synthesised and clinically meaningful answer to a question or estimate the strength of the evidence (Peters et al. 2020). However, the field of DHIs is rapidly evolving, and the quality of research can vary significantly (Hewitt et al. 2020; Kelly et al. 2022). Therefore, it was considered important to critically appraise the studies to determine the validity of their results and to distinguish between robust insights and those affected by methodological flaws (Almutairi et al. 2024). The studies were critically appraised using the JBI critical appraisal tools for RCTs (Barker et al. 2023) and quasi-experimental research studies (Barker et al. 2024). The tools evaluated domains including randomisation procedures, allocation concealment, blinding of participants/personnel/assessors, completeness of outcome data, and reporting. One reviewer conducted the critical appraisals for each study (NE) and the results were discussed by the supervisory team (RH, VS, LS).

4.3 Search Results

The initial search in May–June 2022 identified 1014 references, from which seven full articles were included (Su et al. 2012; Chan et al. 2013b; Ingle 2013; Cerveró et al. 2018; Roos and Roy 2018; Kuo et al. 2020; Porter 2021). An updated search in August 2024 resulted in the inclusion of two additional studies (Austen et al. 2024; Roos et al. 2024). Seven of the included studies were journal articles, comprising four RCTs and three quasi-experimental research studies (Su et al. 2012; Chan et al. 2013b; Cerveró et al. 2018; Roos and Roy 2018; Kuo et al. 2020; Austen et al. 2024; Roos et al. 2024). One was an undergraduate thesis (Porter 2021) and one was a master’s thesis (Ingle 2013). Details of study selection, inclusion and exclusion are presented in the PRISMA flow chart below (Figure 4.1).

Figure 4.1: PRISMA Flow Chart (adapted from Page et al. 2021)



4.3.1 Risk of Bias

The risk of bias assessment of the reviewed studies is summarised in Table 4.3. Among the four RCTs (Roos and Roy 2018; Porter 2021; Austen et al. 2024; Roos et al. 2024), only Roos et al. (2024) and Roos and Roy (2018) provided details on the generation and concealment of the random allocation sequence. Austen et al. (2024) reported significantly different baseline characteristics between the control group and the intervention group (pre-recorded stretching warm-up exercises), while Porter (2021) did not mention any statistical comparisons between the control group and the intervention group (isometric and warm-up exercises supported with Zoom online consultations). This raises concerns about potential imbalances between the groups, which could confound the results and limit the validity of the findings (Austin et al. 2010).

Furthermore, none of the studies blinded participants or researchers to the treatment assignment, which might have been challenging given that participants were required to engage in an exercise or educational programme. Nevertheless, this lack of blinding may lead to performance and detection bias, particularly since only Roos et al. (2024) and Roos and Roy (2018) reported blinding of assessors. Performance bias refers to systematic differences in care provided in addition to the intervention being evaluated, which often arises when participants or researchers are aware of the assigned intervention (Gluud 2006). Detection bias involves systematic differences in outcome assessment, which can occur when outcome assessors are aware of the intervention received by participants, potentially influencing the measurement and interpretation of outcomes (Gluud 2006).

Moreover, several studies reported significant deviations from the intended protocol. Austen et al. (2024), Roos et al. (2024) and Roos and Roy (2018) included participants who received additional treatment outside the intervention being investigated. Austen et al. (2024) indicated that two participants in the waitlist control group (out of seven) attended physiotherapy sessions. Roos and Roy (2018) indicated that in the exercise group, two participants (out of 15) received additional interventions: one saw a physiotherapist and another saw a chiropractor. In the control group, three participants received additional interventions: one saw a physiotherapist, one received acupuncture, and one visited an osteopath (Roos and Roy 2018). Roos et al. (2024) mentioned that participants received additional interventions for PRMSDs, including consultations with physiotherapists, osteopaths, and massage therapists. However, they did not specify the numbers or in which group. Additional treatment could introduce confounding factors, making it difficult to determine whether the outcomes were due to the intervention being investigated (Gluud 2006).

Furthermore, Porter (2021) did not specify the exercises included. Similarly, Ingle (2013), and Su et al. (2012) did not provide enough details regarding the health education course to be able to fully evaluate and replicate the protocol. Four studies (Chan et al. 2013b; Ingle 2013; Kuo et al. 2020; Austen et al. 2024) lacked complete follow-up data and intention-to-treat analysis, potentially introducing attrition and reporting bias (Page et al. 2019). Furthermore, Ingle (2013) did not employ statistical testing due to the very small number of participants who completed the course (only four out of 25). This limits the ability to draw reliable conclusions from the data (Hicks 2010). Overall, the quality of the studies was variable, with risks of bias primarily due to the lack of blinding, incomplete follow-up, and issues with baseline comparability. While some studies (Roos and Roy 2018; Roos et al. 2024) demonstrated better

methodological rigor, with appropriate randomisation procedures and assessor blinding, the majority of studies had significant methodological limitations that may affect the validity of their findings.

Table 4.3: Risk of Bias Summary – Evaluated Using the Johanna Briggs Institute Quality Appraisal Checklists for Randomised Controlled Trials (Barker et al. 2023) and Quasi-Experimental Studies (Barker et al. 2024).

Study	True randomisation	Allocation concealment	Similar baseline characteristics	Deviation from intended protocol	Assessor blinding	Missing outcome data	Appropriate statistical analysis
Austen et al. 2024	Unclear	No	No	Yes	No	Yes	Yes
Cerveró et al. 2018	N/A	N/A	N/A	Unclear	N/A	No	Yes
Chan et al. 2013b	N/A	N/A	N/A	Yes	N/A	Yes	Yes
Ingle 2013	N/A	N/A	N/A	Yes	N/A	Yes	No
Kuo et al. 2020	N/A	N/A	N/A	Yes	N/A	Yes	Yes
Porter 2021	Unclear	No	Unclear	Unclear	No	No	Yes
Roos and Roy 2018	Yes	Yes	Yes	Yes	Yes	No	Yes
Roos et al. 2024	Yes	Yes	Yes	Yes	Yes	No	Yes
Su et al. 2012	N/A	N/A	N/A	Unclear	N/A	No	Yes

Key: N/A indicates non-applicable for quasi-experimental studies with a single-group pre-post-test design.

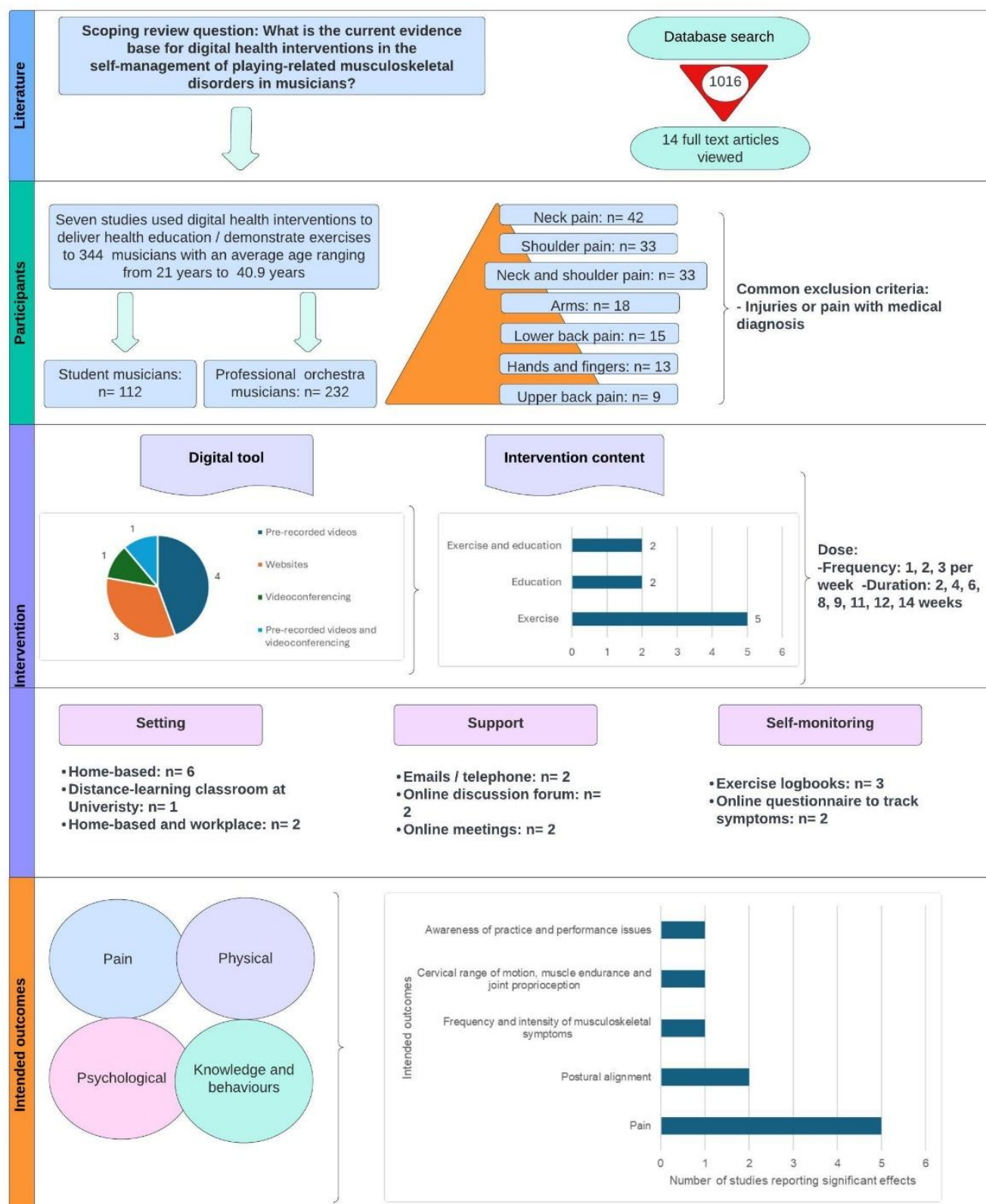
4.3.2 Overall Findings

As outlined in Figure 4.2, the review identified nine studies involving a total of 344 musicians, including both students and professionals, with mean ages ranging from 21 to 40.9 years. The studies reviewed mainly included exercises and health education. The studies reviewed mainly incorporated one of three intervention approaches: exercise programmes alone, health education components alone, or a combination of both exercise and health education. The digital tools used included pre-recorded videos, websites, and videoconferencing (i.e., Zoom). The interventions were delivered in various settings, predominantly home-based, with some using online support and self-monitoring tools. The intended outcomes included pain, physical and psychological health, as well as knowledge and behaviours. Five out of the nine included studies reported significant positive improvements in pain, range of motion, postural alignment and awareness of practice and awareness issues (Chan et al. 2013b; Cerveró et al. 2018; Kuo et al. 2020; Porter 2021; Roos et al. 2024).

None of the reviewed studies included a theoretical framework that explains the underlying mechanisms and assumptions of how and why an intervention is expected to achieve its intended outcomes. Roos et al. (2024) employed the Knowledge-To-Action framework (Graham et al. 2006), but this is not truly a theoretical framework for the intervention itself. Rather, the Knowledge-To-Action Framework is a conceptual model designed to guide the implementation process by translating research evidence into practical actions (Graham et al. 2006). While the framework guided steps such as identifying the problem and adapting knowledge to the local context by including focus groups to explore barriers and facilitators to program implementation (Roos et al. 2021), Roos et al. (2024) did not explain the ways in which this feedback shaped the

content of the educational materials and exercise components. Moreover, during the design stage, consultation was limited to orchestra classical musicians rather than a broader range of musicians from different genres and employment statuses, such as freelance musicians, session players, or music teachers (Roos et al. 2021). In the implementation phase, the majority of participants were full-time orchestra musicians, with only six freelance orchestral musicians included (Roos et al. 2024). Consequently, the findings may only be applicable to orchestral musicians and classical musicians.

Figure 4.2: Summary of the Key Findings of the Scoping Review



4.3.1.1 Study Design of the Reviewed Studies

As shown in Table 4.4, five studies employed quasi-experimental research designs, with two conducted in Australia (Chan et al. 2013b; Ingle et al. 2013), two in Taiwan (Su et al. 2012; Kuo et al. 2020), and one in Spain (Cerveró et al. 2018). Furthermore, two were pilot RCTs conducted in Canada and the UK (Roos and Roy 2018; Austen et al. 2024), while two were full RCTs conducted in the USA and Canada (Porter 2021; Roos et al. 2024). Five studies compared the effect of therapeutic exercises as a single intervention: two included a control group that received no intervention (Austen et al. 2024; Porter 2021), and three did not include a control group (Chan et al. 2013b; Cerveró et al. 2018; Kuo et al. 2020). Two studies explored the effect of health education, focusing on musicians' musculoskeletal health, psychological well-being, preventative care for PRMSDs and perceived knowledge (Su et al. 2012; Ingle et al. 2013); while two studies combined health education and exercise (Roos and Roy 2018; Roos et al. 2024).

4.3.1.2 Characteristics of Participants

The studies, in total, included 344 musicians, comprising 112 student musicians and 232 orchestra musicians, with mean ages ranging from 21 to 40.9 years. Only three studies purposely examined musicians with PRMSDs, although PRMSDs were defined differently across these studies (Cerveró et al. 2018; Roos and Roy 2018; Austen et al. 2024). The most widely accepted definition, by Zaza et al. (1998), describes PRMSDs as pain, weakness, numbness, tingling, or other symptoms that interfere with a musician's ability to play their instrument at their usual level. However, Cerveró et al. (2018), Roos and Roy (2018) and Roos et al. (2024) excluded participants who could not regularly play their instrument or played for less than 15 hours per week, potentially overlooking those whose PRMSDs had reduced their

playing time. Therefore, it is possible that those most affected by PRMSDs may have been excluded (Lauser et al. 2023).

In contrast, the other studies included participants with and without PRMSDs and then explored the effect of the intervention on physical outcomes, such as pain, frequency and severity of PRMSDs, and perceived level of exertion (Chan et al. 2013b; Ingle 2013; Roos and Roy 2018; Porter 2021). Participants without PRMSDs may have different baseline characteristics and may not show significant changes, whereas improvements may be more noticeable in symptomatic individuals (Stanhope et al. 2022a). This increased variability could reduce the statistical power of the studies, leading to conclusions that underestimate the efficacy of the interventions for those with PRMSDs (Roos and Roy 2018).

Table 4.4: General Characteristics of the Included Studies

Author/ Year	Country	Research design	Control group	Intervention group	
				Population	Excluded participants
Austen et al. 2024	UK	Pilot RCT	Waitlist control group consisting of nine conservatoire student musicians with self-reported musculoskeletal symptoms Mean age: 23.74 years Four participants had no intervention Two participants had physiotherapy sessions Two participants had psychological help One participant had pain medication	Ten conservatoire student musicians with self-reported musculoskeletal symptoms Mean age: 23.22 years Two participants had psychological help. Four participants missed between 1–4 days due to travelling or being sick.	- Current or previous injuries that required medical treatment - Chronic pain conditions that were not related to playing an instrument - Neurological disorders
Chan et al. 2013b	Australia	Quasi-experimental study with a single-group pre-post-test design	No control group	144 professional orchestra musicians with and without musculoskeletal symptoms Mean age: 45 years	- Injuries managed under worker's compensation
Cerveró et al. 2018	Spain	Pilot quasi-experimental study with a single-group pre-post-test design	No control group	Ten professional clarinettists with joint pain due to instrumental practice Mean age: 28.4 years	- Musicians who could not regularly play their instrument - Musicians who had postural injuries with a medical diagnosis
Ingle 2013	Australia	Quasi-experimental study with a time-series design	No control group	Twenty-five conservatoire student musicians with and without musculoskeletal symptoms Mean age: 23 years	Not reported

Kuo et al. 2020	Taiwan	Quasi-experimental study with a single-group pre-post-test design	No control group	Twenty-four student violinists with non-specific neck pain for more than 3 months or at least two pain episodes in the last 3 months Mean age: 21.2 years	- Previous neck or shoulder surgery - Neurological symptoms of the upper extremities - Red flags suggesting cancer, infection, etc.
Porter 2021	USA	RCT	Nine student string musicians with and without musculoskeletal symptoms that received no intervention	Ten student string musicians with and without musculoskeletal symptoms Mean age: 21 years	- Musculoskeletal symptoms diagnosed by a physician
Roos and Roy 2018	Canada	Pilot RCT	Eleven professional orchestra and four student musicians with and without musculoskeletal symptoms that received no intervention Mean age: 39.3 years Three participants had physiotherapy, osteopathy and acupuncture sessions	Twelve professional orchestra musicians and three student musicians with or without musculoskeletal symptoms Mean age: 36.8 years One participant attended two of three supervised exercises sessions. Four participants were unavailable for the educational presentation. Two participants had physiotherapy and chiropractor sessions.	- Musculoskeletal injuries /symptoms not related to music playing - Participants who practiced music for fewer than 15 hours per week. - Prescribed anti-inflammatory medications
Roos et al. 2024	Canada	RCT	Thirty-two professional and student orchestra musicians Mean age: 40.9 years Fifteen participants received cointerventions such as consulting a physiotherapist, massage therapist and osteopath	Thirty-two professional and student orchestra musicians Mean age: 40.2 years Twelve participants received cointerventions such as consulting a physiotherapist, massage therapist and osteopath	- Musculoskeletal injuries /symptoms not related to music playing - Participants who practiced music for fewer than 15 hours per week - Prescribed anti-inflammatory medications
Su et al. 2012	Taiwan	Quasi-experimental study with a single-group pre-post-test design	No control group	Fifteen student musicians Mean age: 25 years	Not reported

4.3.1.3 Interventions

The interventions broadly consisted of digitally delivered exercise and health education, as summarised below.

4.3.1.3.1 Exercise-Based Programmes

As shown in Table 4.5 and Figure 4.2, six studies included therapeutic exercises delivered through various digital platforms: video-conferencing (Porter 2021), pre-recorded videos (Chan et al. 2013b; Roos and Roy 2018; Austen et al. 2024), and websites (Ingle et al. 2013; Cerveró et al. 2018; Roos et al. 2024). Three studies adopted the same exercise programme and video delivery (Chan et al. 2013b; Roos and Roy 2018; Roos et al. 2024). This exercise programme, initially developed by Chan et al. (2012), focused on improving motor control and proprioception in the shoulder and scapular region, as well as strengthening the deep neck flexors and core stabilisers, as described in Chapter 2 (Section 2.6.3). Each body region was targeted by a series of six exercises that progressively increased in difficulty over the 12-week intervention period. Participants were advised to advance to the next level within an exercise series only once they could complete the current level without fatigue and without experiencing delayed-onset muscle soreness from the previous session.

The study by Chan et al. (2013b) was conducted with a sample of 144 professional musicians from eight Australian orchestras (only 50 were included in the final analysis due to non-compliance). The setting was within the orchestral environment, with participants engaging in a DVD-based exercise programme designed to reduce PRMSDs. The study involved administering the VAS questionnaire to assess the frequency and severity of musculoskeletal disorders before and after a 12-week intervention period. The study found that PRMSD frequency mean scores decreased

significantly, from 3.3 (SD 2.9) pre-intervention to 2.1 (SD 2.1) post-intervention ($t=-2.82$, $p<0.01$). Similarly, PRMSD severity decreased significantly from 2.9 (SD 2.4) to 1.9 (SD 1.9) post-intervention ($t=-2.79$, $p<0.01$). However, no follow-up assessment was conducted to evaluate long-term maintenance of these improvements.

In terms of preference, 55% of participants rated the exercise video programme as better, 39% as the same, and only 6% as worse (Chan et al. 2013b) when compared with the face-to-face group exercise classes. However, the adherence rate was only 41% among the original 144 volunteers, excluding participants who withdrew due to major illness, injury, or unexpected family circumstances. In contrast, Roos et al. (2024) and Roos and Roy (2018) reported no dropouts and higher adherence rates (97.7% and 70%, respectively). However, only the study by Roos et al. (2024) found significant improvements in pain as a result of combining health education, exercise videos, and supervised exercise classes.

Roos et al. (2024) conducted an RCT involving professional and tertiary-level orchestral musicians from one conservatory orchestra and five professional orchestras in Quebec City and Montreal. The study aimed to evaluate the effectiveness of a musculoskeletal health intervention, with a sample size of approximately 65 participants (33 in the intervention group and 32 in the control group). The intervention group experienced a statistically significant reduction in pain intensity compared to the control group, with a between-group difference of -4.2 points (95% CI: -7.49 to -0.88) out of 40 at 14-week follow-up ($p < 0.05$). At 11 months, the difference was -3.7 (95% CI: -7.06 to -0.32).

Moreover, two studies investigated the effects of warm-up exercises in student musicians and found contrasting results (Porter 2021; Austen et al. 2024). Austen et

al. (2024) conducted a pilot RCT involving conservatoire music students in the United Kingdom and Ireland who experienced PRMSD. The sample consisted of 19 participants aged 19–31 years divided into two groups: an exercise group (n=9) and a waitlist control group (n=7). The setting was an online intervention where participants engaged in a two-week musician-specific warm-up exercise programme, with pre- and post-survey assessments measuring pain, mood, and related variables.

Austen et al.'s (2024) study did not show significant effects of the intervention on pain intensity, pain interference, anxiety, or depression (all $p > 0.05$). However, controlling for factors such as sleep, anxiety, depression, and physical activity revealed a significant reduction in pain intensity for the exercise group compared to controls (i.e., ANCOVA with anxiety: F-test (1,11)=5.09, $p=0.04$; depression: F-test (1,11)=4.99, $p=0.04$). Post-hoc t-tests comparing pre- and post-test scores within groups showed no significant differences (exercise group: $t(8)=2.11$, $p=0.07$; control group: $t(6)=-1.50$, $p=0.18$), and no significant differences between groups at either pre- or post-test (all $p > 0.05$).

Meanwhile, Porter (2021) conducted an RCT with a sample size of 19 student string musicians. The study setting involved online sessions via Zoom due to COVID-19 restrictions, with both control and experimental groups completing pre- and post-intervention questionnaires. The experimental group participated in an eight-week isometric exercise and stretching warm-up program, while the control group continued their regular practice routines. The experimental group showed a statistically significant decrease in head and neck pain during self-practice, with a mean change score of -0.90, compared to the control group's mean change of 0.44 ($p=0.045$). Additionally, in large ensemble practice, the experimental group experienced a significant decrease in back pain, with a mean change of -1.57, whereas the control

group's mean change was 0.43 ($p=0.017$). However, the pain scale used was developed by the author and was not validated. This raises concerns about the reliability and validity of the results (Hicks 2010).

Furthermore, two studies explored the effect of specific exercises on pain and posture in clarinettists and violinists and found significant improvements in postural alignment, pain perception, cervical range of motion, cervical muscle endurance, and cervical proprioception (Cerveró et al. 2018; Kuo et al. 2020). Cerveró et al. (2018) conducted a quasi-experimental study involving a sample of 10 professional clarinettists from musical ensembles in Valencia, Spain, with a mean age of 28.4 years and an average of 19.7 years of clarinet playing experience. The study included a pre-test/post-test design where participants underwent assessments such as the Langlade postural test, and completed questionnaires on pain and exertion. The exercise intervention lasted nine weeks, with progression monitored via face-to-face evaluations and online questionnaires.

The results indicated a significant decrease in muscle pain post-intervention, from 6 ± 0.816 to 4.8 ± 0.632 points ($p=0.001$). Specifically, initial muscle pain was 5.67 ± 0.816 in women and 6.50 ± 0.577 in men, with statistically significant differences ($p=0.042$ and $p=0.006$, respectively). Postural assessment scores for items L-1 (vertex of head and neck stays horizontal), L-3 (acromion aligned with earlobe and greater trochanter), and L-11 (shoulder blades touch vertebral border with inferior angle connected to the rib cage) all showed significant improvement, with p-values of 0.015, 0.000, and 0.000, respectively.

Meanwhile, Kuo et al. (2020) evaluated the effects of a cervical stabilisation exercise programme on 20 university violinists in Taiwan, aged 21.2 years (± 3.2 years).

Participants exhibited mild to moderate neck pain (Numerical Pain Rating Scale [NPRS] 3–7) and low disability (Neck Disability Index [NDI] 4–18%) at baseline. The study utilised a quasi-experimental, single-group pretest-posttest design, in which assessments were carried out at baseline (week 0), pre-intervention (week 4), and post-intervention (week 10). The intervention consisted of a six-week home-based exercise programme with initial face-to-face instruction supported by instructional videos. Significant improvements were observed post-intervention, including reductions in neck pain (median decrease of 4 points, $p < 0.01$), disability (NDI reduction of 4%, $p < 0.01$), and improvements in deep cervical flexor control as measured by the craniocervical flexion test ($p < 0.01$). Additionally, cervical muscle endurance significantly increased ($p < 0.01$), and cervical range of motion improved in all directions except flexion, with $p < 0.01$ for extension and $p < 0.05$ for lateral flexion and rotation.

4.3.1.3.2 Health Education

Four studies delivered digital educational programmes (Su et al. 2012; Ingle 2013; Roos and Roy 2018; Roos et al. 2024). Roos and Roy (2018) conducted a pilot RCT involving a sample of 30 professional orchestral musicians, randomly allocated into two groups: an experimental group and a control group, each with 15 participants. The experimental group in the study included participants who received a rehabilitation program comprising an educational presentation and a series of exercise videos. Participants were evaluated at baseline and again at the end of the 11-week intervention. There were no statistically significant differences between the groups in terms of symptom prevalence or frequency over the 11-week follow-up period.

Similarly, Ingle (2013) conducted a quasi-experimental study, using a one group pre-test/post-test design. The initial sample size of participants recruited for the study comprised 25 music students from the Australian National Academy of Music. Participants initially completed baseline questionnaires assessing musculoskeletal pain, health knowledge, exertion, and psychological symptoms, with subsequent assessments after four weeks to evaluate the impact of a web-based health education course. Due to the low participation in the follow-up phase, only four students completed the course. Consequently, no p-values were reported for changes in injury prevalence or psychological measures. Participant feedback indicated implementation issues and a preference for in-person sessions, which probably contributed to the low completion rate (16%) and the limited improvements in knowledge of injury prevention, physical fitness, nutrition, emotional well-being, behavioural changes, and physical and psychological health outcomes observed.

In contrast, Su et al. (2012) and Roos et al. (2024) found significant improvements in students' awareness of practice and performance issues and pain, respectively. Su et al. (2012) implemented an eHealth programme that included video presentations and reported significant improvements in students' awareness of practice and performance issues at one-month follow-up, after the intervention was implemented. The Self-Assessment Questionnaire (SAQ) was used to evaluate knowledge changes concerning (1) Practice and Performance issues and (2) Health and Lifestyle issues in 15 music students. The SAQ scores on the one-month follow-up test for Practice and Performance issues were significantly higher than the pretest ($t=2.731$, $p<0.05$). On the other hand, no significant differences were found between the posttest and pretest or between the follow-up test and posttest. Regarding Health and Lifestyle

issues, comparison at all three measurement points did not reveal any significant differences.

Meanwhile, Roos et al.'s (2024) intervention included three 25-minute PowerPoint presentations and short exercise videos: the first presentation was delivered live at the musicians' workplaces, while the subsequent presentations were provided as narrated PowerPoints on a website one and two months later. Roos et al. (2024) reported that the intervention group experienced a statistically significant reduction in pain intensity compared to the control group, with a between-groups difference of $-4.2/40$ points at 14 weeks follow-up and a 95% confidence interval of $-7.49, -0.88$ ($p < 0.05$).

4.3.1.3.3 Setting and Related Factors

As shown in Table 4.5 and Figure 4.2, six studies were home-based (Chan et al. 2013b; Ingle 2013; Cerveró et al. 2018; Kuo et al. 2020; Porter 2021; Austen et al. 2024), one was conducted at a university (Su et al. 2012), and two included a combination of home-based and workplace sessions (Roos and Roy 2018; Roos et al. 2024). Chan et al. (2013b) did not provide any supervision or guidance while three of the six studies using regular email and phone check-ins (Cerveró et al. 2018; Kuo et al. 2020; Austen et al. 2024) and two employing online meetings and discussion forums (Su et al. 2012; Porter 2021). It is unclear whether supervision and guidance affected outcomes or adherence, as the results were mixed (Cerveró et al. 2018; Roos and Roy 2018; Porter 2021; Austen et al. 2024). However, studies that incorporated self-monitoring methods and in-person supervision tended to report higher adherence and completion rates compared to those that did not (Cerveró et al. 2018; Roos and Roy 2018; Kuo et al. 2020; Porter 2021; Roos et al. 2024). Self-monitoring methods included online questionnaires to log exercise completion (Roos and Roy 2018; Kuo

et al. 2020; Porter 2021; Roos et al. 2024) and self-reported pain and exertion levels after each exercise session (Cerveró et al. 2018; Roos et al. 2024).

4.3.1.3.4 Dose and Time of Follow-Up

The frequency, duration, and number of sessions varied across the studies, even among those using the same exercise programme and DHI (pre-recorded videos) (Chan et al. 2013b; Roos and Roy 2018; Roos et al. 2024). The number of sessions ranged from daily (Austen et al. 2024) to once weekly (Su et al. 2012), with programme durations spanning from 2 weeks (Austen et al. 2024) to 14 weeks (Su et al. 2012; Roos et al. 2024) and follow-up data provided 11 months later (Roos et al. 2024). Session lengths varied from 15 minutes (Austen et al. 2024) to 45 minutes (Roos et al. 2024). This variability could be related to different contexts, such as whether the participants were student musicians or orchestral musicians, and whether the intervention focused on exercises (e.g., warm-up or strengthening exercises) or an educational programme.

4.3.1.3.5 Outcome Measures and Time of Follow-Up

As reported in Figure 4.2, pain (including intensity, interference, and perception), physical, psychological, and behaviour change outcomes were evaluated, with a maximum follow-up of 11 months after the intervention was implemented (Roos et al. 2024). Pain was the most frequently assessed outcome across the studies (8/9); however, only four exercise-based studies observed significant improvements in pain (Chan et al. 2013b; Kuo et al. 2020; Porter 2021; Roos et al. 2024). Other physical outcomes evaluated included the frequency and severity of PRMSDs (2/9), cervical range of motion, muscle endurance and joint proprioception (1/9), postural alignment (2/9), perceived exertion (4/9), and global health (2/9). Improvements were reported

in the frequency and severity of PRMSDs (Chan et al. 2013b), postural alignment (Cerveró et al. 2018; Kuo et al. 2020), and cervical range of motion, muscle endurance, and joint proprioception (Kuo et al. 2020). While educational interventions investigated psychological outcomes, such as anxiety and depression (2/9), and changes in knowledge and behaviours (2/9), only one found significant improvements in students' awareness of performance and practice issues (Su et al. 2012).

Furthermore, patient experiences were investigated in four studies. Three of these studies reported that DHIs were perceived to be as effective as or better than face-to-face delivery (Chan et al. 2013b) and that the interventions were enjoyable and helpful (Porter 2021; Austen et al. 2024). However, one study indicated a preference for face-to-face sessions, possibly due to issues reported by the participants including poor internet connection, technical issues with the website, and administrative difficulties (Ingle 2013).

4.3.1.3.6 Adverse Effects

Only three studies investigated and reported data on adverse effects, which raises concerns about the overall safety of DHIs (Chan et al. 2013b; Roos and Roy 2018; Roos et al. 2024). Roos et al. (2024) and Roos and Roy (2018) indicated that there were no significant adverse effects during their studies; however, Roos and Roy (2018) noted that three participants experienced slight increases in pain during the home-based sessions. These increases in pain were alleviated after correcting their technique during the supervised sessions. Similarly, Chan et al. (2013b) reported that one participant experienced a mild exacerbation of a chronic hip condition following one of the exercises. This participant was advised to cease that specific exercise and consult their physiotherapist.

Table 4.5: Summary of Interventions, Intended Outcomes, Completion and Adherence Rates in the Reviewed Studies (n=9)

Author/ Year	Intervention					Intended outcomes / Effect (Yes= significant improvement No= no significant improvement)	Completion rate (CR) / reasons for drop out Adherence rate (AR)/ reasons for non-adherence
	Digital tool	Content and structure	Setting	Monitoring and support	Dose and time for follow-up		
Austen et al. 2024	Exercise videos	Upper limb warm-up, aerobic exercises	Home-based	Check-in emails	15 min daily × 2 weeks	Pain intensity – Yes Pain interference – No Anxiety and depression – No Perceived exertion – No Participants' experiences – overall positive	CR - 84.21% (reasons not reported) AR – not reported
Chan et al. 2013	Exercise videos	5 exercise series (neck, shoulder, abdominal, lumbo-pelvic, hip); 6 difficulty levels; warm-up/cool-down	Home-based	Not reported	40 min × 2/week × 12 weeks	Frequency and severity of PRMSDs – Yes Perceived exertion – No Participants' experience - Intervention same as or better than face-to-face delivery	CR – 35% (Reasons: Illness/injury, too busy, unforeseen family commitments, being overseas, administrative error, participants who completed less than the recommended exercises were excluded from the final analysis) AR – 41%
Cerveró et al. 2018	Website	Three phases: adaptation→skills→functional development; cat-camel, trunk rotation, arm exercises	Home-based	Check-in emails, pain questionnaire	3×/week × 9 weeks	Improvements in postural alignment – Yes Pain perception – Yes Perceived exertion – No	CR – 100% AR – not reported
Ingle 2013	Website	Six modules: anatomy, posture, performance, biomechanics, psychology, injury prevention	Home-based	Online discussion board	40 min/module × 4 weeks	Increased knowledge of injury prevention, physical fitness, nutrition and emotional well-being – No Behavioural changes – No Physical and psychological health outcomes – No	CR - 16% (Reasons: timing conflicts, lack of awareness or interest in the course, limited internet access, technical difficulties, course length) AR - not reported

						Participants' experiences – further improvements required	
Kuo et al. 2020	Exercise videos	Cervical exercises: axial elongation, flexion, extension, scapulothoracic strengthening	Home-based	Phone/ video calls, exercise log	20 min × 3/week × 6 weeks	Reduction in neck pain and disability – Yes Improvement in cervical muscle endurance – Yes Improvement in cervical range of motion – Yes Improvement in postural alignment – Yes Improvement in cervical proprioception – Yes	CR - 83.33% (four participants who dropped out of the study were excluded from the analysis) AR – 90.1%
Porter 2021	Video conferencing	Isometric/stretching exercises: neck, wrists, chest, back, arms	Home-based	Scheduled Zoom meetings, logbook	20 min × 2/week × 8 weeks	Pain reduction – Yes Participants' experiences – positive	CR and AR were not reported
Roos and Roy, 2018	Exercise videos	In-person education + supervised sessions + home videos	Home-based and in workplace	Exercise logbook	2×/week × 11 weeks	Intensity and frequency of musculoskeletal symptoms – No. Functional limitations – No Global Physical Health – No	CR – 100% AR in intervention group – 97.7% AR in control group – 89%
Roos et al. 2024	Website	Health education (3 presentations) and exercise videos	Home-based and in workplace	Patient-reported outcomes	20 min × 4/week × 14 weeks	Pain intensity – Yes Pain interference – No Pain frequency – No Global physical health – No	CR: 95.4%. AR of the intervention group: 70% AR of home exercises: 65% AR of supervised sessions: 83%
Su et al. (2012)	Videos and video conferencing	3 courses: foundation (anatomy, fitness), advanced (anxiety, hearing), application (stress management, techniques)	Home-based	Online discussion, teaching assistants	60 min lecture + 40 min discussion × 14 weeks	Awareness of performance and practice issues – Yes Awareness of health and lifestyle issues – No	CR – 100%. AR – Not reported

4.4 Discussion

The overall aim of this review was to map the available evidence on DHIs for PRMSDs self-management in musicians, summarise the key characteristics of current DHIs including content, mode of delivery and theoretical underpinning and assess its effect on musicians' ability to continue to play, and explore any reported adverse effects, to inform future interventions. The literature search yielded nine studies, five quasi-experimental research design (Su et al. 2012; Chan et al. 2013b; Ingle, 2013; Cerveró et al. 2018; Kuo et al. 2020), two RCTs (Porter 2021; Roos et al. 2024) and two pilot RCTs (Roos and Roy 2018; Austen et al. 2024). The studies utilised exercise videos, video conferencing, and websites; however, the integration of DHIs lacked underpinning theories and their applications varied across the studies, primarily targeting pain, physical outcomes (i.e., range of motion, physical exertion, muscle endurance), and psychological outcomes (i.e., anxiety and depression). The interventions did not establish an optimal dose and were primarily home-based, with supervision and guidance provided through emails, phone calls, and online discussion forums. Exercise-based interventions showed greater improvements in pain and physical outcomes compared to educational interventions.

4.4.1 Exercise-Based Interventions

As previously reported, three studies incorporated motor control exercises (Chan et al. 2013b; Roos and Roy 2018; Roos et al. 2024). Chan et al. (2013b) reported that using exercise videos was more successful in reducing the frequency and severity of PRMSDs compared to the face-to-face programme (Chan et al. 2014); however, no follow-up assessment was conducted (Chan et al. 2013b). In terms of preference, 55% of participants rated the DVD programme as better, 39% as the same, and only 6% as worse (Chan et al. 2013b) when compared with face-to-face delivery (Chan et al. 2014). However, in the DVD

programme study, only 35% of the original 144 participants provided post-test data, with an exercise adherence rate of 41% (Chan et al. 2013b). This, coupled with the exclusion of dropouts from the final analysis, and the absence of an intention-to-treat analysis, suggests that the results may be skewed, thus limiting the generalisability and reliability of the findings (McCoy 2017).

In contrast, Roos and Roy (2018) reported high adherence rates and no dropouts, possibly due to the combination of supervised and home-based exercise sessions (Lin et al. 2019). However, there were no significant improvements observed in musculoskeletal symptoms or functional limitations (Roos and Roy 2018). A possible explanation is that the study included participants with and without musculoskeletal symptoms, which may have increased the variability in the data, thus making it more difficult to observe significant changes (Roos and Roy 2018). Furthermore, confounding factors could have influenced the results. For example, five members of the exercise group (out of fifteen) missed the educational presentation and some supervised exercise sessions. Meanwhile, in the control group, three participants (out of fifteen) received additional treatments, including several sessions of acupuncture, physiotherapy, and osteopathy.

Two studies explored the effects of warm-up exercises in student musicians (Austen et al. 2024) and string players (Porter 2021), while two examined the impact of instrument-related exercises on clarinettists and violinists (Cerveró et al. 2018; Kuo et al. 2020), achieving mixed results. These studies shared similar methodological limitations, such as a paucity of standardised outcome measures (Cerveró et al. 2018; Porter 2021) and exercise programmes that were poorly justified given the overall evidence on warm-up exercises (as discussed in Chapter 2, Section 2.6.4) (McCrary et al. 2015). Porter (2021) reported significant improvements in pain in string players after implementing a warm-up routine;

however, their study did not specify the pain scale used, which is a significant limitation, as the choice of outcome measure can impact the reliability and validity of the results (Velentgas et al. 2013).

In contrast, Austen et al. (2024) did not find significant improvements in pain or physical outcomes following the warm-up exercise. A possible contributing factor could be the short duration of warm-up periods (10 minutes), as well as the short follow-up periods of two weeks (Austen et al. 2024). However, it is important to note that in sports research, warm-up durations longer than 10 minutes have generally not shown differential effects (Bishop 2003). Furthermore, the studies did not specify warm-up exercise protocols (Austen et al. 2024; Porter 2021). Warm-up exercises generally consist of stretching, isometric exercises, and aerobic exercises (Brukner et al. 2012). The primary goal was to increase blood flow to the muscles, enhance the elasticity of muscle fibres, and reduce the risk of overuse injuries, which may be effective for activities requiring maximal strength and power (McCrary et al. 2015). In contrast, low-intensity activities, such as playing an instrument, involve sustained muscle activity at a lower intensity, which may not benefit from the acute physiological changes induced by aerobic warm-ups (McCrary et al. 2015). Furthermore, while static stretching may improve flexibility, it can temporarily reduce muscle strength and performance by decreasing muscle-tendon stiffness (Small et al. 2008). Reduced muscle-tendon stiffness, in turn, decreases the force that the muscle can generate which is not ideal for activities requiring sustained muscle effort, such as playing music (Small et al. 2008). There is also growing evidence that the routine application of static stretching does not reduce overall sports injury rates (Brumitt and Cuddeford 2015). This is based on the assessment of several RCTs most of which found no significant reduction in the risk of injury associated with static stretching (Brumitt and Cuddeford 2015; McCrary et al. 2015). Therefore, there is limited

evidence to support warm-up exercise as a standalone exercise for musicians (McCrary et al. 2015).

Similarly, Kuo et al. (2020) implemented an exercise programme that may not have fully aligned with the needs of their patient population. The study included cervical stabilisation exercises aimed at strengthening the deep cervical muscles and improving muscle coordination in violinists with non-specific neck pain (Viljanen et al. 2003; Ylinen et al. 2003). However, changes in cervical muscle control and coordination are typically observed in individuals with chronic neck pain (Falla et al. 2004; Jull et al. 2004; Steinmetz et al. 2015), whereas Kuo et al. (2020) included musicians with only mild to moderate neck pain. This could explain why the minimal clinically important difference of the Neck Disability Index was only 4% in Kuo et al.'s (2020) study, which is significantly less than the 19% reported in similar studies the implemented cervical stabilisation exercises for chronic neck pain (Griffiths et al. 2009; Kaka et al. 2018). Therefore, understanding musicians' health needs is important to establish prior to developing interventions, as factors such as stress and inadequate sleep may also contribute to neck pain and should be addressed alongside exercise (Saragiotto et al. 2016; Cramer et al. 2018). None of the reviewed studies explored musicians' health needs or involved musicians in the design of interventions, which is an issue repeatedly criticised in the wider literature on MSDs and the development of DHIs, as it can lead to suboptimal care, poor treatment adherence, and poor self-management (Kress et al. 2015; Cranen et al. 2017).

4.4.2 Health Education

Four studies explored health education in orchestra and student musicians. Roos and Roy (2018) delivered a single face-to-face session, while Roos et al. (2024) and Ingle (2013) offered a web-based health education course for student musicians. Of these studies, only

Roos et al. (2024) found significant improvements in pain, but it is difficult to attribute this result to the education course alone, as the intervention was combined with online and supervised exercise sessions. In addition, Roos et al. (2024) did not investigate acquired knowledge or changes in behaviour, which could be relevant outcomes for investigating the impact of health education on PRMSDs.

In contrast, Su et al. (2012) combined pre-recorded lectures with interactive online discussions, and theirs was the only study to find significant improvements in students' awareness of performance issues. Therefore, it is possible that a blended and interactive approach might be more appropriate for health promotion in musicians in the management of PRMSDs. However, the study was delivered in a formal educational setting, and musician teaching assistants were involved in delivering the intervention and data collection. This might have created an environment where students felt compelled to provide socially desirable responses, potentially leading to an overestimation of their awareness, or changes in behaviour related to health practices (Van der Schyff et al. 2023). In addition, the follow-up period was only one month following the intervention, which may not be sufficient to assess the long-term impact of the curriculum on students' knowledge retention and behavioural changes (Cash et al. 2023).

Expanding beyond these individual studies and looking more broadly at health education for musicians, whether delivered in a traditional setting or through DHIs, limited efficacy is a recurring theme, as discussed previously (Section 2.6.3) (Stanhope et al. 2022a). Musicians' health research has not consistently employed a pedagogical lens or adequately defined teaching and learning outcomes (Evans et al. 2024). Elements of active learning, such as reflection, evaluation, analysis, synthesis, and communication, are rarely implemented (López-Íñiguez and Bennett 2021). Without these components, musicians may struggle to

see the relevance of the information to their own lives, making them less likely to apply knowledge in practice (Evans et al. 2024). Modern educational frameworks suggest that effective education must be transformative rather than simply focused on information transfer and skill development (Paul and Quiggin 2020). Consistent with these educational principles, health education should transcend basic instruction about healthy practices and instead focus on influencing underlying beliefs, attitudes, and decision-making processes (Nutbeam 2019).

Another challenge is that all the reviewed health education programmes were led by musician researchers alone, without expert knowledge of recent evidence-based approaches or musicians' health issues from a medical perspective (Evans et al. 2024). Matei et al. (2018) suggested that for high-quality, evidence-based health education programmes, there is a need for rigorous scientific approaches that incorporate the best available research evidence. Hornby and Greaves (2022) defined effective evidence-based teaching practices as integrating current research evidence of meaningful change, relevant clinical knowledge and skills, and consistency with the school and community cultures. This is vital for future implementations of musicians' health education, not only to ensure relevant course content but also to determine how the content is delivered to achieve desired learning outcomes (Evans et al. 2024). Therefore, while there have been attempts to develop and implement health education for musicians, further research is still needed.

4.4.3 Method of Delivery

The interventions identified in the studies in this scoping review were delivered through pre-recorded videos (Su et al. 2012; Chan et al. 2013b; Roos and Roy 2018; Kuo et al. 2020), videoconferencing (Su et al. 2012; Porter 2021), and websites (Ingle 2013; Cerveró et al. 2018; Roos et al. 2024). While previous research suggests that exercise videos can significantly improve physical performance (Gothe et al. 2015; Özden et al. 2022), the

reviewed studies yielded mixed results in terms of pain, disability, and health awareness, possibly due to limitations in research design, as discussed in Section 4.4.2.

Nevertheless, almost all the studies (5/6) suggest that video-based interventions were well-received by participants (Chan et al. 2013b; Roos and Roy 2018; Kuo et al. 2020; Austen et al. 2024; Roos et al. 2024). This may be due to video-based interventions offering several advantages over traditional delivery methods, including the ability to pause and replay demonstrations (Peek et al. 2023), flexibility in accessing content (Darley et al. 2022), and the capacity to review techniques multiple times (Peek et al. 2023). A qualitative study by Donaghy et al. (2019) provides additional support for video-based delivery methods, finding that patients valued exercise videos. Interview participants reported feeling more engaged and connected compared to audio-only interactions (Donaghy et al. 2019).

In contrast, the perception of websites was mixed, with Ingle (2013) reporting the lowest completion rate (16%). Participants generally found the website convenient, as they could access the material at their own pace and from any location; however, some noted a lack of engagement and interaction, as well as technical issues in platform access and navigation (Ingle 2013). Consequently, participants expressed a preference for more interactive elements, such as face-to-face discussions rather than DHIs: a sentiment echoed in a recent systematic review (Stanhope et al. 2022a). It is important to note that this study took place in 2013, and many of these issues may no longer be relevant due to advances in technology (WHO 2023b).

DHIs are now being incorporated into online learning platforms, and the broader healthcare contexts including online consultations and self-management of various health conditions (WHO 2023b). For instance, a systematic review of 63 studies evaluating primary care online consultation systems found that 46% (29/63) of the studies reported improvements in access

to primary care services (Darley et al. 2022). It was easier and more convenient to make initial contact, as patients could submit an online consultation query at any time without waiting on the phone or attending in person (Darley et al. 2022). Similarly, Aschentrup et al. (2024) investigated the effectiveness of gamified digital interventions in mental health promotion and prevention by analysing 16 studies. The most commonly used game elements in these interventions were reward, audio feedback to user actions, progress bars, checklists and levels, goal setting features, and avatars. The study reported significant positive effects on engagement, psychological well-being and depressive symptoms across all the included studies (Aschentrup et al. 2024).

Furthermore, DHIs for MSDs have shown promising results across multiple systematic reviews and meta-analyses (Hewitt et al. 2020; Cargnin et al. 2023). A recent review included 25 RCTs exploring DHIs for MSDs suggested moderate positive effects on various outcomes, including pain reduction, improved disability, improved function, enhanced quality of life and better emotional functioning, with standardised mean differences ranging from 0.14 to 0.24 (Cargnin et al. 2023). However, limitations such as heterogeneity in intervention design, moderate quality of evidence and high risk of bias in some studies underscore the need for further high-quality research to determine optimal intervention strategies for specific conditions (Cargnin et al. 2023). Despite these challenges, the potential of DHIs to provide scalable, cost-effective solutions for managing MSDs remains promising, warranting continued exploration and refinement in this rapidly evolving field.

4.4.4 Settings and Related Factors

The setting and implementation of the interventions may have influenced the outcomes. Most of the studies reviewed were home-based (Chan et al. 2013b; Cerveró et al. 2018; Kuo et al., 2020; Porter 2021; Austen et al. 2024), while few were conducted in workplace (Roos and

Roy 2018) and university settings (Su et al. 2012). Studies with supervised exercise classes and interactive sessions achieved higher adherence and completion rates (Su et al. 2012; Roos and Roy 2018; Roos et al. 2024; Kuo et al. 2020), consistent with findings by Lin et al. (2019) for individuals with chronic MSDs.

Bandura's (1977) social learning theory posits that observing peers successfully managing similar conditions reinforces positive behaviours, potentially explaining the short-term benefits of group exercises (Chapter 2, Section 2.7). Peer support in group settings also offers psychological benefits absent in home-based programmes (Michie et al. 2014). However, supervised group interventions face sustainability challenges for musicians: they require costly logistical resources (e.g., facilities, healthcare professionals) and clash with musicians' irregular touring schedules, making fixed-location attendance impractical (Guptill and Zaza 2010; Baadjou et al. 2021). Even when initially effective, as in Nyberg et al.'s (2020) three-month programme, which improved cardio-metabolic risk factors, gains often diminish without ongoing support (e.g., outcomes fell below baseline after 22 months). This underscores the need for strategies to maintain accountability and long-term adherence in PRMSD interventions for musicians.

According to the reviewed studies, self-monitoring (e.g., monitoring exercise adherence) promoted accountability and showed positive outcomes in intervention adherence (Roos and Roy 2018; Cerveró et al. 2018; Kuo et al. 2020; Porter 2021; Roos et al. 2024). Self-monitoring involves individuals observing and recording their behaviours, leading to increased self-awareness and behaviour modification (Michie et al. 2013; Khan and Maes 2021). However, research suggests self-monitoring is more effective when combined with other techniques like goal setting and feedback (Khan and Maes 2021; Peiris et al. 2023). For instance, Marques et al. (2021) improved outcomes by incorporating self-monitoring

within a theoretical framework that fostered motivation and coping strategies. In contrast, the reviewed studies used self-monitoring merely to assess adherence rather than as part of a comprehensive behaviour change approach. Altogether, this highlights the need to integrate evidence-based BCTs into self-management interventions for musicians with PRMSDs.

4.5 Strengths and Limitations

This is the first review to systematically scope the available evidence on DHIs for PRMSD self-management in musicians. An important strength of this review is the accurate reporting of the review process and adherence to the JBI guidance (Peters et al. 2020). In addition, the supervisory team (RH, LS, VS) actively engaged in the review process through ongoing conversations about inclusion criteria and clarified ambiguities when selecting studies or extracting data, which enhanced the scoping methodology and minimised possible bias. Nonetheless, scoping reviews are inherently limited because the focus is to provide breadth rather than depth of evidence (Peters et al. 2020). Therefore, it is not possible to draw definitive conclusions about the effectiveness of DHIs for PRMSD self-management in musicians.

4.6 Summary and Future Recommendations

The overall aim of this review was to map the available evidence DHIs for PRMSD self-management in musicians. This included summarising the key characteristics of current DHIs, such as content, mode of delivery and theoretical underpinning, assessing their effect on musicians' ability to continue playing, and identifying any reported adverse effects to inform future interventions. Exercise-based DHIs showed promise in reducing pain and improving physical outcomes compared to educational interventions that appeared to be of little benefit. Support, guidance through supervised exercise classes and self-monitoring

methods contributed to the positive reception of DHIs, and the higher completion and adherence rates observed in some studies. However, this did not necessarily lead to improvements in musculoskeletal outcomes.

Furthermore, there were several common limitations in the studies. First, there was a narrow focus on student and professional orchestral musician populations, as also discussed in Chapter 2 (Section 2.5.3). Future research should consider recruiting from broader musician populations, including freelance performers and individuals in community or non-professional ensembles. This broader recruitment may facilitate more comprehensive intervention designs and in turn enhance the external validity and generalisability of findings. Second, only three of the nine studies explored and reported adverse effects of DHIs. Given that rigorous harm–benefit assessments are standard in health interventions, more robust monitoring of safety outcomes should be integrated into trial designs. This is particularly critical for interventions targeting high-level performers whose livelihoods depend on the maintenance of fine motor skills and endurance (Stanhope et al. 2022a).

Third, none of the studies explored the effect of DHIs on musicians' ability to perform. While a reduction in pain and improvements in physical metrics are valuable, the primary goal for musicians is the ability to perform at or near their prior level (Warrington 2003). Therefore, future studies should adopt outcomes directly related to performance capacity. Fourth, none of the studies were underpinned by a theoretical framework guiding the development and design of the intervention components. Willis et al. (2019) indicated that the absence of theory-driven research limits the progress that can be made in the performing arts medicine field, as well as the development of evidence-based interventions. In addition, Davis et al. (2015) suggested that designing interventions without considering the target behaviour and the factors influencing that behaviour may lead to poor treatment outcomes. Finally, none of

the studies explicitly considered psychosocial risk factors, despite the multifactorial nature of PRMSDs. High levels of stress, anxiety and other psychological or social factors can exacerbate musculoskeletal complaints and influence exercise adherence and coping strategies (Fernholz et al. 2019). Future work should therefore integrate appropriate theoretical frameworks and ensure that interventions address both physical and psychosocial risk factors of PRMSDs.

Chapter 5: Phase 2 / Part 1 – Survey Study

Exploring Musicians' Perspectives on the Management of Playing-Related Musculoskeletal Disorders and the Role of Digital Health Interventions: A Survey Study.

5.1 Introduction

As outlined in Chapter 2 and 4, the literature on PRMSDs reveals several critical knowledge gaps, particularly regarding risk factors and affected populations. The relationship between age and PRMSDs remains unclear, with multiple studies finding no significant correlation (Crnivec 2004; Baadjou et al. 2016; Kenny et al. 2018; MacDonald et al. 2022). Contrasting evidence exists, however, with Berque et al. (2016) reporting higher PRMSD prevalence with age, whilst Abréu-Ramos and Micheo (2007) suggested that injury rates correlate more strongly with intensive practice patterns than with age alone.

A significant limitation in current research is its disproportionate focus on professional orchestral musicians, despite self-employed musicians constituting the majority of the profession (Stanhope et al. 2022b; see Chapter 2, Section 2.3). Only one study, conducted in Australia, has investigated the health of self-employed musicians, finding no significant differences in the prevalence of PRMSDs in this group, though this may be attributed to methodological limitations (see Chapter 2, Section 2.5.5). This gap is particularly concerning given broader evidence that self-employed workers generally experience elevated stress levels, worse mental health, and higher rates of MSDs compared with employed workers (International Labour Office 2017; Park et al. 2020; Willeke et al. 2021).

Finally, the literature on PRMSD management reveals two critical shortcomings: (1) no conclusive evidence supports specific interventions (Stanhope et al. 2022a), and (2) prior studies have not explored musicians' health needs or treatment preferences for PRMSDs

(see Chapter 2, Section 2.5.5). The closest research addressing treatment preferences comes from Stanhope et al.'s (2014) study of 14 student woodwind players and MacDonald et al.'s (2022) study of 223 orchestral and student oboists, which collected ratings for different treatments. However, since 38% and 25.1% of their participants reported no PRMSDs, respectively (Stanhope et al. 2014; MacDonald et al. 2022), the data are likely to reflect hypothetical rather than experience-based preferences. Moreover, neither study investigated musicians' specific needs regarding intervention content or delivery mechanisms, including the use of DHIs. Understanding these needs is crucial for developing more targeted interventions.

5.2 Research Question, Aim and Objectives

5.2.1 Research Question

The research question for the survey study was as follows: **What are the characteristics and needs of musicians with PRMSDs?**

5.2.2 Aim

The aim of this study was to investigate the characteristics and needs of musicians with PRMSDs, including self-employed musicians.

5.2.3 Objectives

The objectives of this study were to:

1. Map the characteristics of musicians with current or previous PRMSDs (age, type of employment, weekly working hours, weekly practice hours).
2. Compare the frequency of PRMSDs across demographic characteristics (age) and work-related characteristics (type of employment, weekly working hours, and weekly practice hours).

3. Explore musicians' experiences, needs and preferences regarding PRMSD self-management, including the use of DHIs.

5.3 Study Design and Methods

An online cross-sectional survey method was utilised as an efficient method for gathering information through targeted questions, providing an overview of a specific problem within a single data collection episode (Check and Schutt 2011; Maier et al. 2023). Compared to qualitative interviews or multiple studies for each variable, this approach saves time and reduces costs while allowing for the simultaneous collection of data on multiple variables (Check and Schutt 2011).

However, cross-sectional surveys have limitations, including their inability to assess changes over time or establish causal relationships (Bowling 2014). They are also prone to biases, such as selection bias, where the sample may not represent the population (Kesmodel 2018), information bias, where respondents provide socially desirable responses (Tripepi et al. 2010), and recall bias, which affects the accuracy of retrospective self-reported data (Hassan 2006). Non-response bias can further impact validity if non-participants differ significantly from respondents (Hassan 2006).

To mitigate these biases, key recommendations from Maier et al. (2023) were implemented. Transparent reporting was ensured by outlining eligibility criteria, sample size, and sampling methods. Causal language was avoided, using associative terms such as “related to” or “associated with” (Maier et al. 2023). A detailed sampling process was followed to enhance representativeness and statistical power (Maier et al. 2023). Additionally, a mixed methods approach was incorporated to complement the cross-sectional data and provide a more

comprehensive understanding (Creswell 2014; Maier et al. 2023). The following sections outline these methodological considerations in detail.

5.3.1 Eligibility Criteria

Eligible participants were professional instrumental musicians aged 18 years or older, including full-time tertiary music students (i.e., university-level students majoring in a musical instrument), whose primary source of income was derived from working in the music industry (e.g., professional orchestral musician, freelance musician, chamber musician, or music teacher), and who had current or previous (past five years) self-reported PRMSDs, defined as pain, weakness, numbness, tingling, or burning sensations that had interfered with their ability to play their instruments at their usual level (Zaza et al. 1998). The five-year time frame was selected because the study was conducted during the COVID pandemic (2021–2023): a period that had a significant negative impact on the music industry (Musicians' Union 2021).

Exclusion criteria included participants who had non-PRMSDs (e.g., injuries from trauma, surgery), inflammatory conditions (e.g., rheumatoid arthritis), or any other specific musculoskeletal conditions (Zaza et al. 1998). Additionally, participants were excluded if they were unable or unwilling to provide informed consent, had no internet access, or were unable to read and understand English.

5.3.2 Sampling Method

Convenience sampling, a non-probability sampling method, was used due to its efficiency in terms of time and resources, as participants were readily accessible (Jager et al. 2017). In contrast, probability-based methods such as random or stratified sampling require extensive lists of musicians, and demand significant time and financial investment (Taherdoost 2016).

However, convenience sampling is subject to selection bias, as participants who self-select may have greater interest or awareness of PRMSDs, potentially limiting the study's external validity (Taherdoost 2016). While this makes convenience sampling less suitable for causal research (Taherdoost 2016), this limitation was not considered critical in the context of this study. Given its mixed methods explanatory design, with a cross-sectional survey followed by online focus groups, the primary aim was to inform the next phase rather than establish causality. Nonetheless, to enhance sample representativeness, an appropriate sample size was calculated, and recruitment methods were diversified.

5.3.3 Sample Size

In 2022, the total population of working musicians in the UK is estimated to be around 37,800 (Statista 2023). Using the most conservative prevalence assumption (50% for the maximum sample size required), a margin of error of 5%, and a 95% confidence level, a sample size of 381 musicians was calculated using G Power (Faul et al. 2007). This sample size calculation assumes an ideal scenario where every selected individual responds (Field 2013). However, as this was the first study of its kind in the UK, achieving the full sample size within the strict timeline imposed by the PhD project stipend was challenging. Given these constraints, it was decided to proceed with data analysis based on the available sample (n=100) while acknowledging this limitation.

5.3.4 Recruitment Strategy

The recruitment strategy for this study included collaborating with gatekeepers from key industry organisations, including the British Association of Performing Arts Medicine (BAPAM) and the Musicians' Union. BAPAM is the leading healthcare provider for performing artists and facilitated recruitment of musicians who had experienced PRMSDs through their established networks. The Musicians' Union serves as the collective voice for musicians in

the UK, and thus has a wide reach across this population. This collaboration was facilitated through the Senior Project Manager at BAPAM and the Regional Organiser at the Musicians' Union. The survey was circulated through the organisations' monthly newsletters and a recruitment poster posted on their websites and their X platforms (Appendix 3, Figure 3).

Moreover, the researcher liaised with The Music Agency (<https://themusicagency.com>) which provides orchestral and events management, to distribute the survey by email to their musician lists (including English Symphony Orchestra, BBC National Orchestra of Wales, Welsh National Opera and freelance musicians nationally). Finally, the survey was circulated to students at the Royal College of Music, the Royal Welsh College of Music and Drama, and Cardiff University School of Music. The survey link was further disseminated via the Instagram pages of these universities' music societies. In addition, the survey link was posted on professional musicians' Facebook groups and Instagram pages.

5.3.5 Survey Questions

The survey questions were developed based on the information from the literature review, with questions adapted from similar studies exploring musicians' experience with PRMSDs (Stanhope et al. 2014; Berque et al. 2016; MacDonald et al. 2022; Stanhope et al. 2022b). Leedy and Omrod's (2015) recommendations for developing survey questions were deployed. This approach involved using straightforward language, avoiding jargon, providing clear instructions for respondents, and conducting pilot testing to refine the questions and ensure effective data collection (Leedy and Omrod 2015).

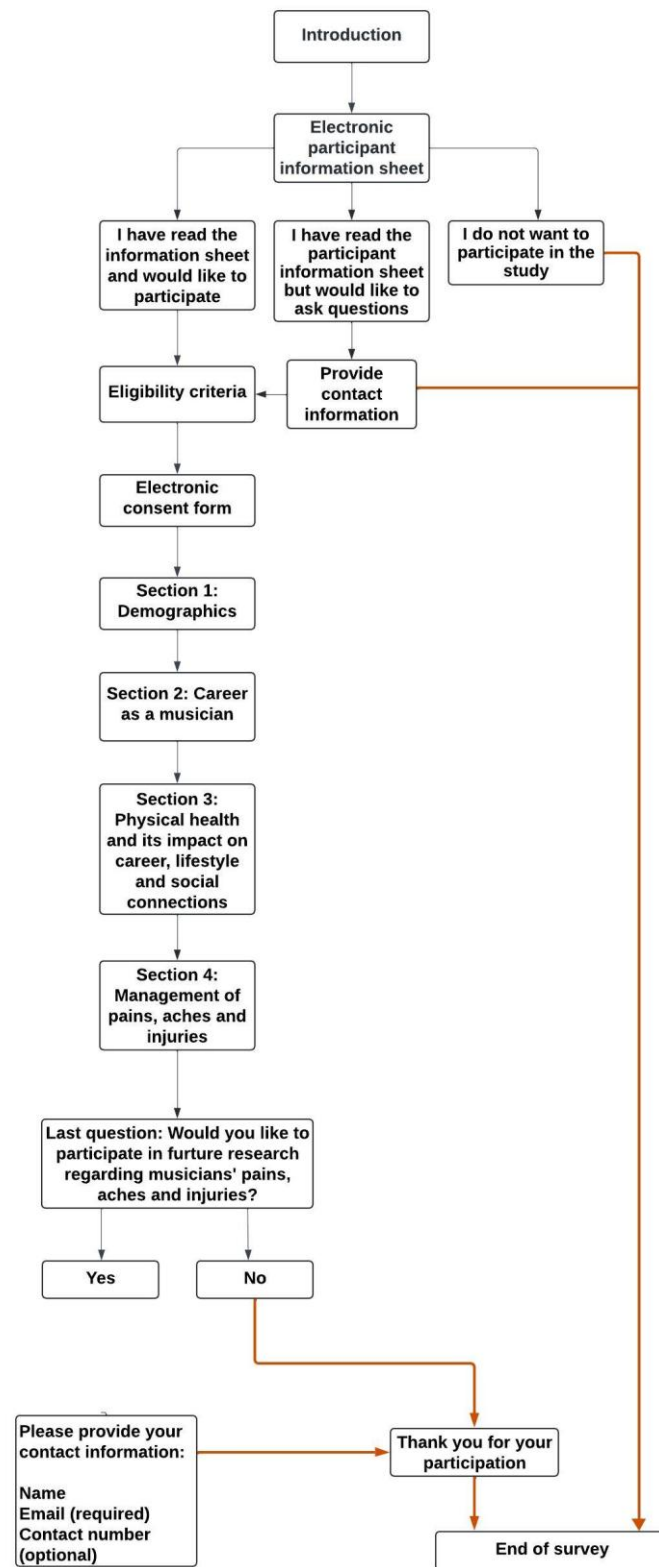
Initially, the researcher compiled a list of potential questions and reviewed them with the research supervisors (RH, LS, VS). The initial survey is provided in Appendix 4. Several amendments were made through the development process to ensure that the survey was not

too long for participants to complete and was effective in gathering the necessary data to fulfil the study aim. Amendments to the survey questions prior to pilot testing included:

- Streamlining response options: Detailed checklists for each affected body region (e.g., right shoulder, left elbow) were consolidated into broader categories (e.g., shoulders, elbows) to prevent confusion about the affected side.
- Altered question formats: Some questions were changed from open to closed formats to simplify the response process and reduce the time required to complete the survey (Nulty 2008).
- Refining terminology: Initially, PRMSDs were described as “musculoskeletal problems” but this was later refined to “pains, aches, and injuries” to ensure clarity and improve respondents' understanding.
- Adding “None” and “Other” to ensure that participants who did not fit into the predefined categories could still provide accurate responses.
- Questions about sleep and smoking were removed, as they did not fit the aims and objectives of the study and might have increased the time needed to complete the survey.

The final survey (Appendix 5) consisted of four main sections: 1) Demographics; 2) Career as a Musician; 3) Musculoskeletal Health and impact on career and social relationships; 4) PRMSD Management. A flow chart of the survey is presented in Figure 5.1.

Figure 5.1: Survey Flowchart



The survey included primarily closed questions (Fowler 2013; Babbie 2020) with defined categories, such as: 1) questions limiting answers to one of two responses (e.g., yes or no); 2) multiple-choice questions providing several possible answers where the participants were asked to select all that apply or the one that is most applicable; 3) rating scales requiring participants to rate a list of items; 4) questions requiring a numeric response, such as age. Further, nine survey questions included the response “Other (Please specify)” to enable further comments to be recorded. A summary of each type of question, response types, and the rationale behind these choices is provided in Table 5.1.

Table 5.1: Survey Questions, Type, Response and Rationale for Inclusion

Question	Type	Response	Rationale for inclusion
Section 1: Demographic characteristics			
Q1: Gender	Closed	Nominal	Collecting demographic data is essential to gather information about the participants' background. This data allowed the researcher to identify key characteristics associated with musicians who experience PRMSDs How: the questions were adopted from other studies which investigated PRMSDs in musicians (Stanhope et al. 2014; Berque et al. 2016; MacDonald et al. 2022).
Q2: Age	Open	Numeric	
Q3: Primary instrument	Open	Free text	
Q4: Additional instruments	Open	Free text	
Section 2: Career as a musician			
Q5: Job title	Closed	Nominal	Different employment types may involve varying work conditions, levels of institutional support, financial stability, and work-related stress, all of which can influence the prevalence and management of PRMSDs (Section 2.5.3). This is a gap in the current literature which this survey aimed to address. How: the questions were developed by the researcher to align with the aims and objectives of this study
Q6: Type of music-specific employment	Closed	Nominal	
Q7: Weekly practice hours	Open	Numeric	
Q8: Distribution of practice time	Closed	Ordinal	
Q9: Additional employment	Closed	Binary (Yes/No)	
Q10: Type of additional employment	Closed	Nominal	
Q11: Weekly working hours	Open	Numeric	
Section 3: Musculoskeletal health and impact on career and social relationships			
Q11: Frequency of PRMSD episodes in the past five years	Closed	Ordinal	PRMSDs follow a recurrent or chronic pattern, with episodes that flare up intermittently over time (Zaza et al. 1998; Cruder et al. 2020). Therefore, the aim of these questions was to explore the severity and recurrence of PRMSDs, as well as how these conditions affect various aspects of respondents' lives, including their musical career, mental wellbeing and social life. Questions 11 was developed by the researcher, while questions 12, 13, 14, 16 were adapted from a survey study by Stanhope et al. (2014).
Q12-13: Body areas affected	Closed	Nominal	
Q14: Perceived cause of PRMSDs	Closed	Nominal	
Q15: Impact of PRMSDs on ability to play music	Closed	Ordinal	
Q16: Impact of PRMSDs on musicians' career	Closed	Nominal	
Q17: Impact of PRMSDs on stress and anxiety	Closed	Nominal	
Q18: Impact of stress on physical symptoms	Closed	Nominal	
Q19: Impact of PRMSDs on social relationships	Closed	Nominal	
Section 6: Management of playing-related musculoskeletal disorders			

Q20: Professional help for PRMSDs	Closed	Binary (Yes/No)	The aim of these questions was to gain a general overview of the treatment methods used by musicians and understand their preferences, including the potential of using DHIs for self-management of PRMSDs. How: questions 20-26 were adapted from a survey study by McDonald et al. (2022). Other responses were added to give more options for the participants to choose from. Questions 27 and 28 were developed by the researcher to align with the aims and objectives of this study
Q21: Type of professional help	Closed	Nominal	
Q22-23: Treatment provider	Closed	Nominal	
Q24-25: Perceived effectiveness of treatments	Closed	Rating	
Q26: Musicians’ needs for self-management of PRMSDs	Open	Free text	
Q27: Experience of using health technology	Closed	Binary (Yes/No)	
Q28: Preference of health technology for self-management of PRMSDs	Closed	Nominal	
Q 29: Would you be interested in participating in further research?	Closed question	Binary (Yes/No)	To recruit respondents for the subsequent online focus groups. How: Yes/No question because respondents may or may not agree to participate in Phase 2. Participants who agreed were asked to provide their contact details.
This table is based on Burns et al. (2008) framework for developing and implementing self-administered surveys. The response types include: ordinal (using ranges), nominal (using named categories or labels), free text (allowing open-ended answers), rating (requiring evaluation based on significance), and binary (offering yes/no options).			

5.3.6 Survey Tool

A self-administered online survey collected descriptive and numerical data. Compared to paper-based methods, online surveys offer cost efficiency, convenience, and adaptive features like skip logic to personalise question flow and reduce respondent fatigue (Dillman et al. 2014; Regmi et al. 2016). However, limitations include the digital divide, response bias, survey fatigue, and reliance on implicit consent, which may compromise informed participation (Singer 2012; Dillman et al. 2014; Ponto 2015).

To address these limitations, participants were offered a paper survey alternative, and the study used the Joint Information Systems Committee (JISC) Online Surveys (JISC 2025) platform, which ensures Secure Sockets Layer encryption for secure data transmission. Its minimalist design and mandatory question settings minimised skipped responses, while straightforward navigation improved readability and engagement (JISC 2025).

5.3.7 Pilot Survey

A pilot survey was conducted to improve the clarity of questions and responses; however, data from this pilot survey were not included in the final analysis. Three musicians who satisfied the inclusion criteria were recruited using convenience sampling. The participants received an email explaining the purpose of the research and providing instructions on how to complete the survey, including a request to record the time it took them to answer the survey (Appendix 3, Figure 6). The email also included a link to a feedback form which the participants were asked to complete after answering the survey (Appendix 6). The survey feedback form consisted of seven questions, which sought to address the following points (Leung 2001):

- Time needed to complete the questionnaire
- Questionnaire clarity
- Survey accessibility
- Additional questions that needed to be included

5.3.7.1 Pilot Survey Results

The average time taken to complete the survey was 15 minutes, which aligns with the recommended length for an online survey of ideally 10–20 minutes (Revilla and Ochoa 2017). Participants' feedback and suggestions were carefully considered and implemented to improve the clarity of the questions. A summary of the participants' feedback and the changes implemented is provided in Table 5.2.

Table 5.2: Pilot Survey Results

Feedback	Changes
One participant indicated that it was unclear whether the musculoskeletal symptoms referred to in the survey were music-specific pain or whether they included other health conditions that were not attributable to music.	This was adjusted throughout the survey as “playing-related pains, aches and injuries”, and defined at the beginning of the survey.
One of the questions asking about the frequency of PRMSDs in the last five years were left as an open question. The answers provided were not specific (e.g., “About twice”, “Approximately 30 times”, “A few times”) and, thus, would be difficult to analyse.	This question was changed to a multiple-choice question, allowing the selection of only one choice.
There was an issue with the survey logic model at the end of the survey because participants who did not indicate that they wanted to participate in future studies were directed to submit their contact information.	This was adjusted according to medium provided in the online survey.

5.3.8 Data Analysis

The online survey platform provided a summary of the data using basic descriptive statistics, including numbers, percentages and written comments. All the questions and responses were gathered from the survey platform and exported into Microsoft Excel sheets. Demographic data, including age (expressed as median and standard

deviation [SD]) and gender (expressed as frequencies and percentages), were summarised accordingly. Summary statistics were calculated for each item in the survey as a percentage of responses.

To explore associations between the frequency of reported PRMSDs and participants' characteristics (employment status, working and practice hours, and age), several statistical tests were employed. For the categorical data, such as type of employment (1=employed, 2=self-employed), the Chi-square test was used to establish whether there were any statistically significant differences or associations between the type of employment (independent variable) and PRMSD (dependent variable). This test was considered appropriate because the variables were categorical (Field 2013). Meanwhile, for continuous data such as working hours and playing hours, the Shapiro-Wilk test was used to test for normality (Field 2013). If the data were normally distributed, the one-way analysis of variance (ANOVA), with Tukey post-hoc tests, was used (Field 2013). If the data were not normally distributed, the Kruskal-Wallis test and Dunn's test were used (Field 2013). Statistical significance was set at $p \leq 0.05$.

Results that were statistically significant ($p \leq 0.05$) in the bivariate analyses were then examined using an ordinal logistic regression model (Field 2013). This regression model is appropriate when the dependent variable is ordinal (i.e., frequency of PRMSDs was categorised as 0–2, 3–5 and more than 5 times), as it estimates how likely it is for participants to move into higher or lower categories of that outcome, based on changes in the independent variables (Field 2013). All the statistical analysis is reported in Appendix 8.

Content analysis was utilised to examine open text questions (O'Cathain and Thomas 2004), as the written responses did not form narratives but rather provided brief confirmations in one or two sentences (O'Cathain and Thomas 2004). The content analysis followed this process: Codes were assigned to all written comments and grouped into categories according to their content. Subsequently, quantitative data were produced by tallying the number of codes in each category to recognise additional responses not included in the predetermined options (i.e., when participants chose "Other" and supplied their own response) or to identify patterns in participants' expressed needs for PRMSD self-management. All written comments and their corresponding categories are provided in Appendix 3 (Table 1). Having established the methodological approach for data collection and analysis, the following section outlines the ethical considerations and procedures implemented to ensure participant protection and data security throughout the study.

5.4 Ethical considerations

5.4.1 Ethical Approval

Ethical approval for Phase 2 and Phase 3 was obtained from the Ethics Committee of the School of Healthcare Sciences, Cardiff University, on 5th July 2022 (REC 889): see Appendix 3, Figure 1.

5.4.2 Data Collection

The survey was delivered via Online Surveys (JISC 2025) platform. This platform was chosen because it does not collect identifying information such as name, email address, or IP address. Electronic informed consent was obtained from all participants prior to participating in the survey (Appendix 3, Figure 2). Participants were asked to

initial each box of the statements in the consent forms to confirm that they had read and understood the information given and consented to take part in the study.

Furthermore, to ensure informed consent, participants were first informed about the nature and the overall aim of the study on the welcome page and then prompted to read the electronic participant information sheet (Appendix 7) including an opportunity to ask questions. This included an option for participants to leave their name, email address and/or contact number so that the researcher could contact them to address any questions before they proceeded. Following the eligibility checklist (Appendix 3, Figure 6), participants were directed to the electronic consent form (Appendix 3, Figure 2), where they were required to give consent by “ticking” a box next to each statement on the consent form. Overall consent was secured by asking the participants to click on the “Submit” button. Any participants who were ineligible or who did not want to participate in the study were thanked for their time. This method of obtaining informed consent was approved by the Ethics Committee (REC889) (Appendix 3, Figure 1). A flow chart of this process is presented in Figure 5.1.

5.4.3 Risk Assessment

It was not anticipated that there would be any risks associated with participating in this study. However, it was possible that the topic or some of the questions might have been distressing to participants. Therefore, participants were informed that they could close the survey at any point. Participants were directed to relevant resources and services in the Participant Information Sheet (Appendix 7), including BAPAM, NHS counselling, and Help Musicians, in case they felt negatively affected in any way.

5.4.4 Data Storage and Handling

All data were de-identified and coded and then stored securely on password-protected computers accessible only to the researcher and the research supervisors (LS, VS, RH). The participants were informed in the participant information sheet that this data would be retained for 15 years following the completion of the study and subsequently destroyed. Participants who provided their contact information were informed that although their responses would remain confidential, they would not be fully anonymous due to this detail. Names and email addresses were stored separately from the survey data. This contact information was retained until recruitment for the focus group study had been completed, after which it was destroyed.

5.5 Results

5.5.1 Participants' Characteristics

A total of 100 musicians who met the inclusion criteria participated in the survey. Although the estimated required sample size was 381, recruitment was stopped at 100 participants due to time constraints imposed by the PhD project timeline. The recruitment effort reached approximately 8,100 potential participants across different channels. Response rates varied considerably across recruitment channels, with social media (Facebook/Instagram) yielding the highest response rate, at 35.4%, while institutional channels had lower rates, ranging from 0.3% to 6.8% (Table 5.3). However, this estimate should be interpreted with caution due to potential overlap in recruitment channels (Table 5.3).

Table 5.3: Survey Response Rate

Organisation	Potential reach	Number of responses	Response rate
Royal College of Music	800	14	1.8%
School of Music, Cardiff University	280	19	6.9%
Royal Welsh College of Music and Drama	890	5	0.6%
Facebook/Instagram	Approx. 130	46	35.4%
British Association of Performing Arts Medicine	Approx. 6000	16	0.3%

As shown in Table 5.4, the sample consisted of 67.0% (n=67) women, 28.0% (n=28) men, and 5.0% (n=5) non-binary individuals, with ages ranging from 18 to 76 years (median 24 years, SD 13.63) with most aged between 20 to 29 years (54.0%, n=54). String instrumentalists made up the largest group (52.0%, n=52), and 54.0% (n=54) of respondents indicated that their practice time consisted of playing a range of musical instruments. More than a third of participants (38.0%, n=38) were university-level student musicians, while 62.0% (n=62) were professional musicians. Of the 62.0% (n=62) of professional musicians who participated in this study, 49.0% (n=49) were self-employed professional musicians, 8.0% were full-time employed musicians, and 5.0% (n=5) were both employed and self-employed professional musicians.

In terms of job titles, 27.4% (n=17) were orchestral musicians, 25.8% (n=16) were solo artists, 12.9% (n=8) were band members, 14.5% (n=9) were music teachers, and 1.6% (n=1) were theatre musicians. The “Other” category included improvisers, academic staff, chamber musicians, session musicians, choir members, freelance performing musicians, and music teachers. The number of weekly music practice hours ranged from 1 to 45 hours (median 10 hours, SD 9.24), while the number of weekly working hours across all different jobs (including music-specific and additional employments) ranged from 0 to 168 hours (median 30 hours, SD 20.66).

Several participants reported holding multiple jobs, 30% (n=30) of participants reported holding additional employment outside the music industry. Of these, 36.7% (n=11) worked in education, while 23.3% (n=7) worked in retail and hospitality. Healthcare and social services, media and the internet accounted for 10.0% (n=3) each. The “Other” category, representing 23.3% (n=7) of responses, included roles such as bar work, operations managers in market and social research, landscape gardening, recruitment, instrument building, and online coaching/education.

Table 5.4: Summary of Participants’ Characteristics

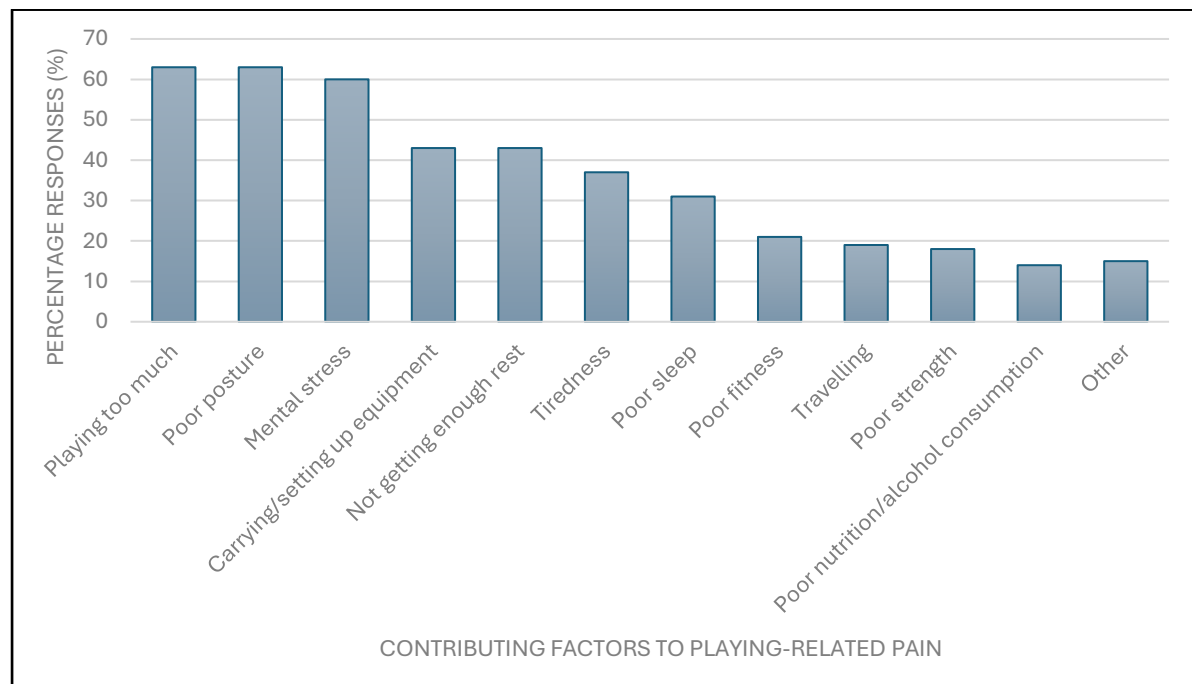
Characteristic	Category	Percentage of responses
Gender	Women	67% (n=67)
	Men	28% (n=28)
	Non-binary	5% (n=5)
Age	Under 20	4.0% (n=4)
	20-29	54.0% (n=54)
	30-39	24.0% (n=24)
	40-49	7.0% (n=7)
	50-59	5.0% (n=5)
	60-69	4.0% (n=4)
	70+	2.0% (n=2)
Instrument groups	String instruments	52.0% (n=52)
	Woodwind instruments	22.0% (n=22)
	Percussion instruments	20.0% (n=20)
	Brass instruments	5.0% (n=5)
Music-specific employment	Self-employed professional musicians	49.0% (n=49)
	Employed musicians	8.0% (n=8)
	Employed and self-employed	5.0% (n=5)
	Student musicians	38.0% (n=38)
Weekly practice hours	1-10 hours	55.0% (n=55)
	11-20 hours	26.0% (n=26)
	21-30 hours	13.0% (n=13)
	31+ hours	6.0% (n=6)
Additional employment	Retail and hospitality	23.3% (n=7)
	Other	23.3% (n=7)
	Education	36.7% (n=11)
	Healthcare and social services	10.0% (n=3)
	Marketing and advertising	3.3% (n=1)

	Media and Internet	10.0% (n=3)
	Administrative services	6.7% (n=2)
Total working hours	1-20 hours	37.0% (n=37)
	21-40 hours	44.0% (n=44)
	40+ hours	19.0% (n=19)

5.5.2 The Frequency of Playing-Related Musculoskeletal Disorders in the last Five Years

Thirty-eight percent of the participants experienced PRMSDs 0 to 2 times, 24.0% (n=24) experienced them 3 to 4 times, and the remaining 38.0% (n=38) reported having PRMSDs more than 5 times in the past five years. The participants indicated that the main contributing factors for their PRMSDs were excessive playing, poor posture, mental stress, heavy lifting, and lack of rest (Figure 5.2). Other responses included chronic pain and poor breathing techniques. The most common affected anatomical regions were the cervical spine, shoulders, wrists, hands and fingers, and the back. Specifically, 36.0% (n=36) indicated they had ongoing pain in the shoulders, 33.0% (n=33) in the cervical spine, 25.0% (n=25) in the wrists, hands and fingers, 21.0% (n=21) in the thoracic spine, and 20.0% (n=20) in the lumbar spine. These percentages varied across age groups and number of weekly playing and working hours, as discussed in the following sections.

Figure 5.2: Contributing Factors to Playing-Related Musculoskeletal Disorders in Musicians



5.5.2.1 Age

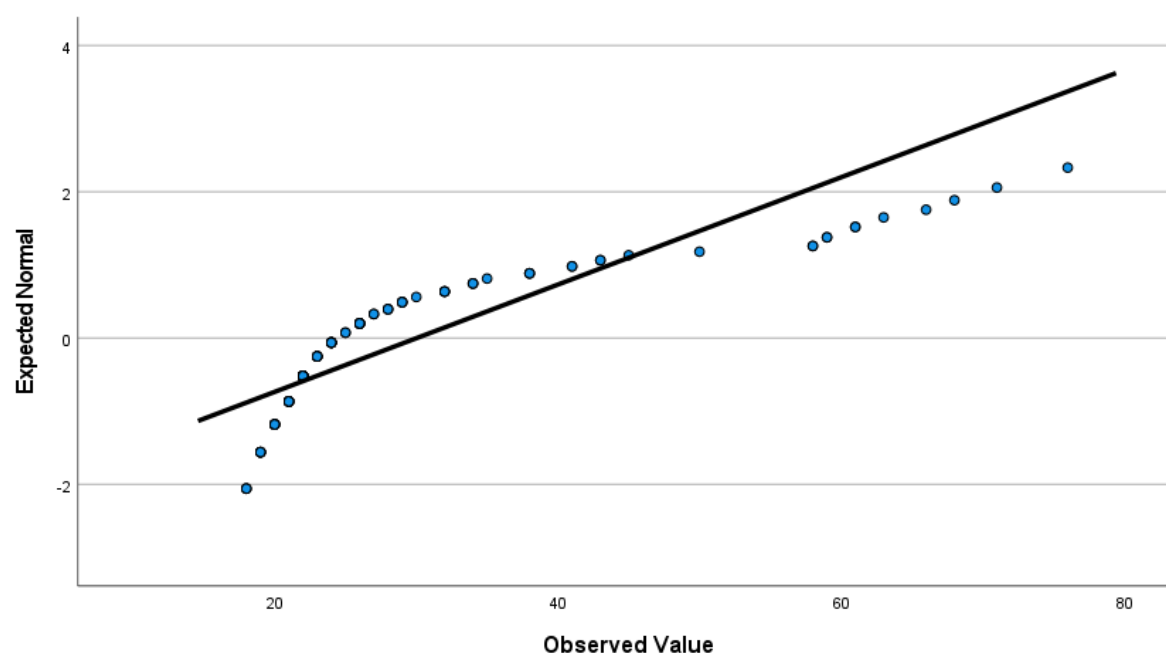
As outlined in Table 5.5, the distribution of PRMSDs was similar across the different age categories: 18–24 years, 25–31 years, and 32+ years. As the data were not normally distributed (Figure 5.3), the Kruskal-Wallis test was used to evaluate differences in PRMSD frequencies across different ages, returning a p-value of 0.691. This indicates that there was no statistically significant difference between age groups in the frequency of experiencing PRMSDs.

Table 5.5: Playing-Related Musculoskeletal Disorders in Different Age Groups over the Previous Five Years

PRMSDs frequency	Age group		
	18–24 years (31.0%, n=31)	25–31 years (32.0%, n=32)	32+ years (37.0%, n=37)
0–2 times	16.0% (n=16)	16.0% (n=16)	20.0% (n=20)
3–5 times	8.0% (n=8)	9.0% (n=9)	6.0% (n=6)
More than 5 times	7.0% (n=7)	7.0% (n=7)	11.0% (n=11)

Key: PRMSDs: playing-related musculoskeletal disorders

Figure 5.3: Assessment of Normality for Participant Age Distribution



5.5.2.2 Type of Employment

Self-employed musicians comprised the largest employment group (49.0%, n=49), followed by students (38.0%, n=38), as shown in Table 5.6. The chi-squared test indicated that there was no significant difference between employment types in terms of PRMSD frequency ($p=0.789$).

Table 5.6: Playing-Related Musculoskeletal Disorders across Different Employment Groups

PRMSDs frequency	Employment status			
	Employed (8.0%, n= 8)	Employed and Self-employed (5.0%, n=5)	Self-employed (49.0%, n= 49)	Students 38.0%, n=38)
0–2 times in the last five years	4.0% (n=4)	1.0% (n=1)	20.0% (n=20)	13.0% (n=13)
3–5 times in the last five years	1.0% (n=1)	2.0% (n=2)	10.0% (n=10)	12.0% (n=12)
More than 5 times in the last five years	3.0% (n=3)	2.0% (n=2)	19.0% (n=19)	13.0% (n=13)

Key: PRMSDs: Playing-related musculoskeletal disorders

5.5.2.3 Playing-Related Musculoskeletal Disorders and Weekly Practice Hours

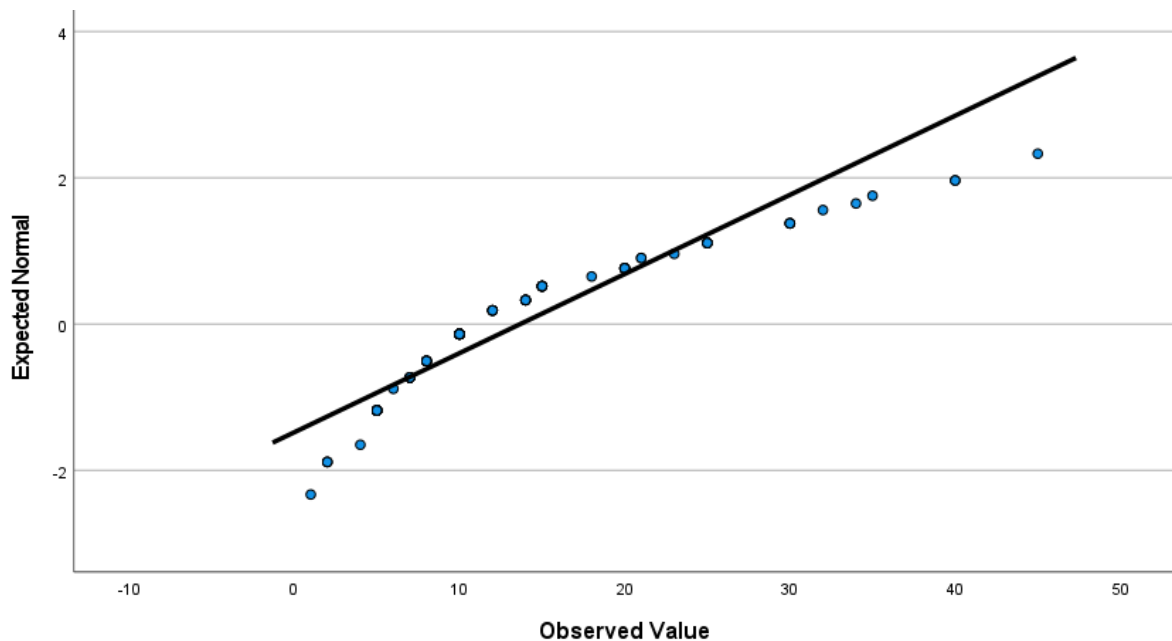
The results suggest that musicians with fewer weekly practice hours tended to report a higher frequency of PRMSDs, although the pattern was not entirely consistent (Table 5.7). As the data were not normally distributed (Figure 5.4), the bivariate statistical analysis using the Kruskal-Wallis test was used. The results showed no statistically significant difference between the categories of weekly practice hours and the frequency of PRMSD ($p=0.123$).

Table 5.7: Playing-Related Musculoskeletal Disorders and Weekly Practice Hours

PRMSDs frequency	Weekly practice hours			
	1–10 hours (55.0%, n=55)	11–20 hours (26.0%, n=26)	21–30 hours (13.0%, n=13)	30+ hours (6.0%, n=6)
0–2 times in the last five years	20.0% (n=20)	9.0% (n=9)	7.0% (n=7)	2.0% (n=2)
3–5 times in the last five years	10.0% (n=10)	8.0% (n=8)	4.0% (n=4)	2.0% (n=2)
More than 5 times in the last five years	25.0% (n=25)	9.0% (n=9)	2.0% (n=2)	2.0% (n=2)

Key: PRMSDs: Playing-related musculoskeletal disorders

Figure 5.4: Assessment of Normality for Weekly Practice Hours



5.5.2.4 Playing-Related Musculoskeletal Disorders and Weekly Working Hours

Based on the cross-tabulation analysis (Table 5.8), musicians working 21–40 hours per week represented the largest group (44.0%) of respondents. The frequency of PRMSDs and weekly working hours were investigated statistically. As illustrated in Figure 5.5, the tests for normality indicated that the data were not normally distributed. As outlined in Table 5.9, the Kruskal-Wallis test was used. The test determined a statistically significant difference between the weekly working hours groups in terms of the frequency of reported PRMSDs in the past five years ($p=0.022$). The post-hoc analysis indicated that the significant difference was between the “0–2 times” and “more than 5 times” PRMSDs groups ($p=0.033$). The ordinal regression results indicated a negative association between weekly working hours and PRMSD frequency ($\beta=-0.030$, $p=0.025$), suggesting that musicians reporting longer weekly working hours tended to report fewer PRMSDs. However, this finding should be

interpreted with caution, as it may reflect differences in work capacity or the possibility that individuals with higher PRMSDs reduce their working hours (Table 5.9).

Table 5.8: Playing-Related Musculoskeletal Disorders and Weekly Working Hours in Musicians

PRMSDs frequency	Weekly working hours		
	1-20 hours (37.0%, n=37)	21-40 hours (44.0%, n=44)	40+ hours (19.0%, n=19)
0–2 times in the last five years	8.0% (n=8)	21.0% (n=21)	9.0% (n=9)
3–5 times in the last five years	9.0% (n=9)	11.0% (n=11)	4.0% (n=4)
More than 5 times in the last five years	20.0% (n=20)	12.0% (n=12)	6.0% (n=6)

Key: PRMSDs: Playing-related musculoskeletal disorders

Figure 5.5: Assessment of Normality for Weekly Working Hours

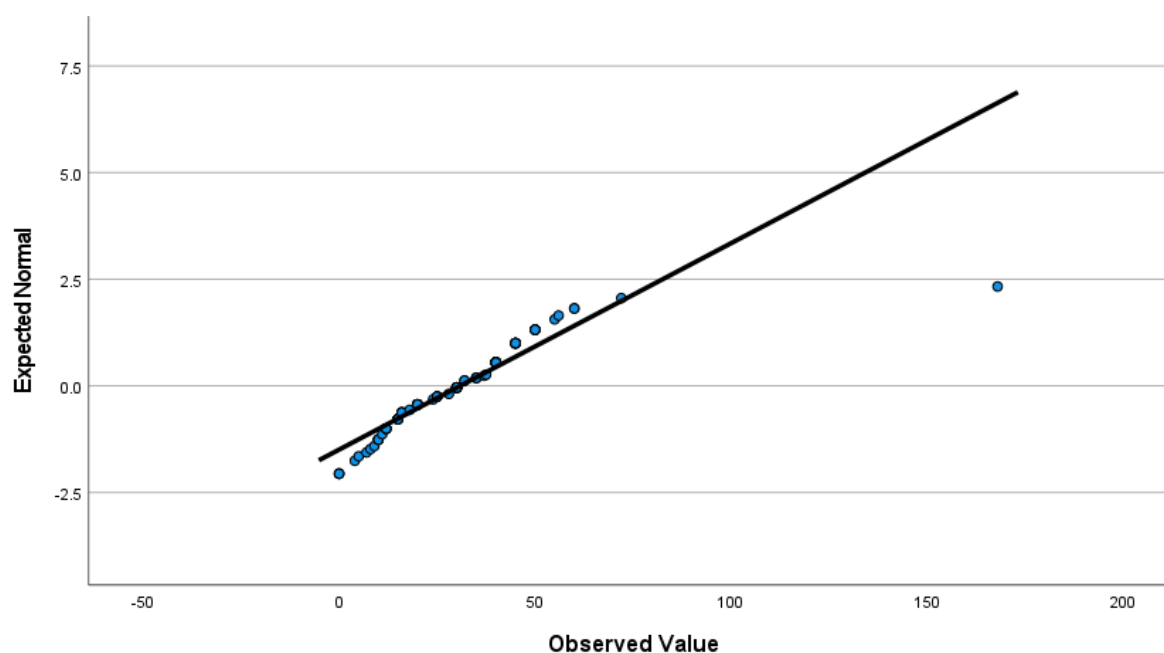


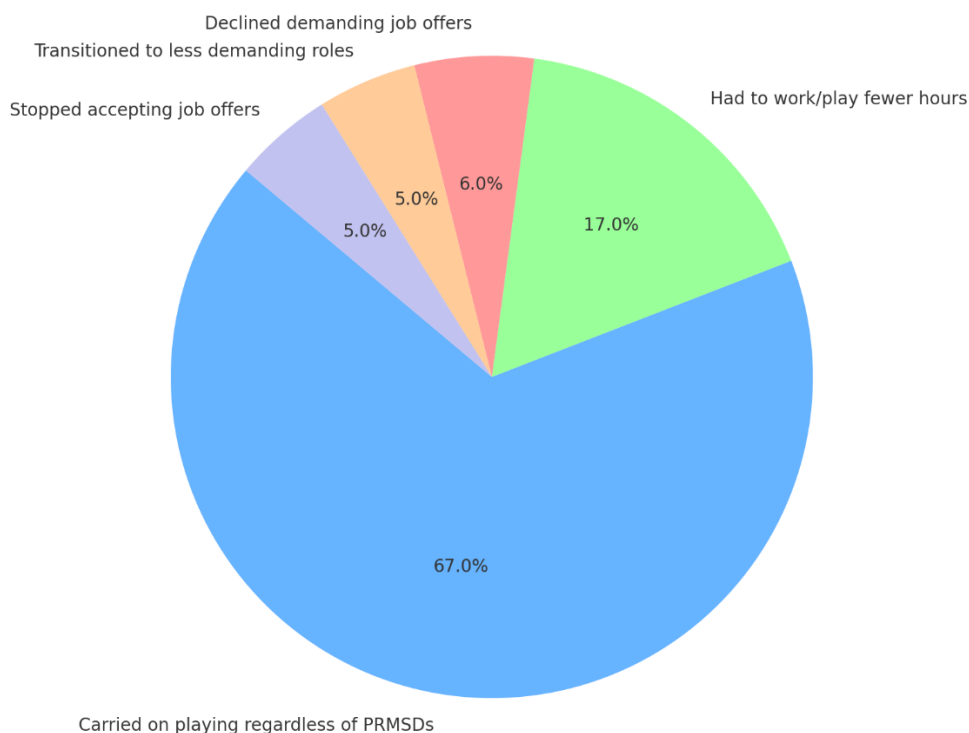
Table 5.9: Statistical Analyses examining the Association between Weekly Working Hours and Frequency of Playing-related Musculoskeletal Disorders

Statistical test	Association between weekly working hours and playing-related musculoskeletal disorders	p-value
Kruskal-Wallis	Significant difference across playing-related musculoskeletal disorders frequency groups	0.022
Post-hoc analysis	Difference between “0–2 times” vs. “>5 times” playing-related musculoskeletal disorders	0.033
Ordinal regression	Weekly working hours negatively associated with playing-related musculoskeletal disorders (β –0.030)	0.025

5.5.3 Impact of Playing-Related Musculoskeletal Disorders on Musicians’ Career, Stress and Social Connections

As outlined in Figure 5.6, a large percentage of the participants (67.0%, n=67) indicated that they carried on playing regardless of experiencing PRMSDs, while 17.0% (n=17) indicated that they had to work/play less hours. Moreover, 6.0% (n=6) declined music-related job offers with demanding schedules, such as tours, due to PRMSDs, and 5.0% (n=5) transitioned to less demanding roles or stopped accepting job offers altogether (5.0%, n=5). Furthermore, most participants (77.0%, n=77) indicated experiencing stress and anxiety due to PRMSDs, and almost half (43.0%, n=43) indicated that stress had worsened their symptoms. However, only a small percentage (22.0%, n=22) indicated that stress had a negative impact on their social connections with family and friends.

Figure 5.6: Impact of Playing-Related Musculoskeletal Disorders on Musicians' Career



5.5.4 Management Methods of Playing-Related Musculoskeletal Disorders

The survey also explored how musicians managed PRMSDs, including where they sought professional help, the self-perceived efficacy of different management methods, and their needs for better managing these disorders, including the use of DHIs.

5.5.4.1 Professional Help

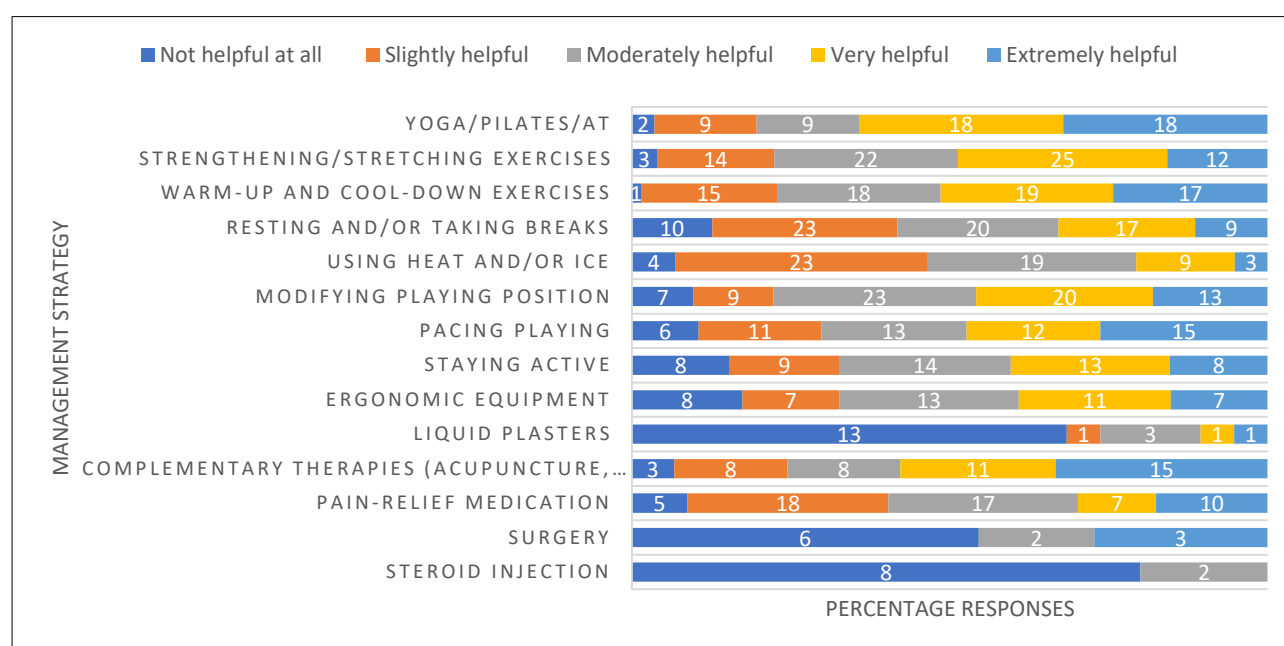
The majority of participants (73.0%) (n=73) sought professional help for their PRMSDs, either through private healthcare insurance or self-funded private routes (74%). Almost half of the participants (35.0%, n=45) reported that they sought help from physiotherapists, while 21.0% (n=30) went to General Practitioners (GPs). Only

3.0% (n=4) turned to their employer or employing organisation for help. Other responses were Feldenkrais teachers, Alexander Technique specialists, Acupuncturists, yoga teachers, and massage therapists.

5.5.4.2 Self-Perceived Efficacy of Various Management Methods for Playing-Related Musculoskeletal Disorders

The survey also explored musicians' self-perceived efficacy of various management methods (Figure 5.7). Among these methods, yoga, Pilates, and strengthening and stretching exercises were seen as being beneficial, with 36.0% of respondents (n=36) rating yoga and Pilates, and 37.0% (n=37) rating strengthening and stretching exercises, as very to extremely helpful. Furthermore, music-specific advice such as modifying playing position was also considered beneficial, with 20.0% of respondents (n=20) rating it as very helpful and 13.0% (n=13) rating it as extremely helpful. In contrast, passive methods such as heat, ice, complementary therapies such as acupuncture and steroid injections were among the lowest-ranking methods. For example, only 9.0% (n=9) of musicians indicated that heat and/or ice was considered very helpful, and 3.0% (n=3) considered it extremely helpful. Also, steroid injections were seen as the least beneficial, being extremely helpful for only 2.0% (n=2) of the participants.

Figure 5.7: Self-Perceived Effectiveness of Management Methods Utilised by Musicians



5.5.5 Participants' Needs and Preferences for Improved Management of Playing-Related Musculoskeletal Disorders

The final section explored the participants' preferences for improved management of PRMSDs using an open question. The participants' responses were organised into six main categories, as shown in Table 5.10. The category 'Pain Management and Recovery Information' contains the most responses, totalling 20, and includes strategies such as pain management education that enables continued play, methods to avoid pain, and insights into the long-term effects and recovery probabilities from chronic pain. Following this, 'Instrument advice' has 17 responses, and includes practical aspects like instrument-related strengthening, proper playing posture, and techniques to avoid muscle tension. 'Accessible Information' was cited 9 times and includes the need for resources where musicians can access information on injury prevention and pain management. 'Early Prevention' appeared in 10 responses and

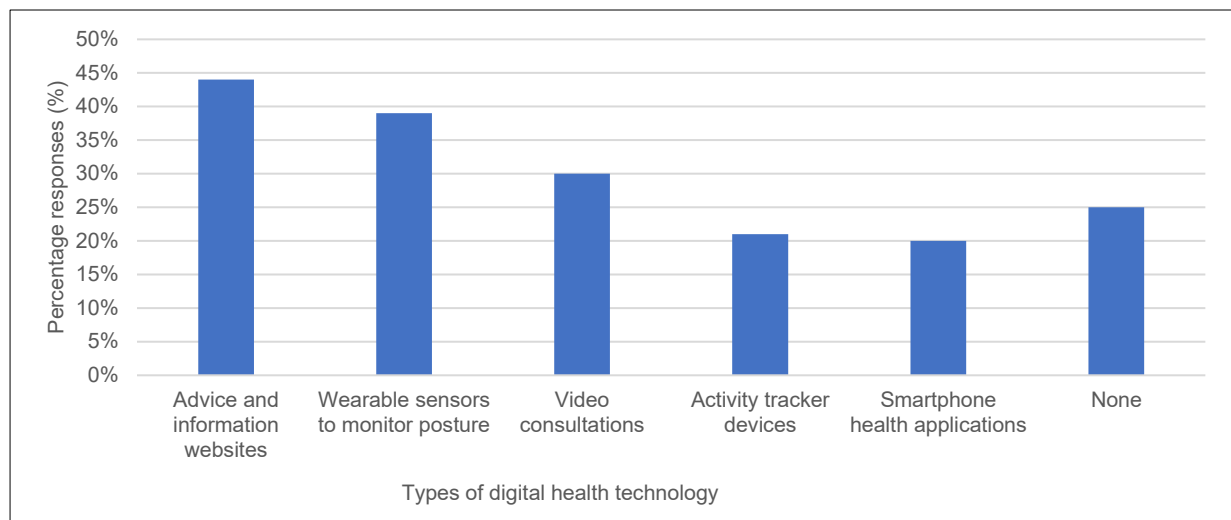
includes proactive measures such as training for optimal posture from a young age and recognising early warning signs of potential injuries. 'Peer Support' was noted in 6 responses and includes the importance of support from peers and professionals through masterclasses, shared experiences and collective educational sessions. Lastly, 'Cultural and Organisational Changes' were mentioned in 7 responses, and includes suggestions for broader acceptance of musicians' health issues in the community and institutional reforms to support this.

Furthermore, 98.0% (n= 98) of participants reported they have never used DHIs to manage their conditions, except for the 2.0% (n=2) who used exercise videos on YouTube. However, 75.0% (n=75) of the participants indicated that DHIs could help them manage their PRMSDs, with advice and information websites ranked as the highest (44.0%) (n=44) and smartphone applications as the lowest (20.0%) (n=20), as illustrated in Figure 5.4. Nonetheless, it is worth noting that the participants were able to select as many responses as they wanted; therefore, the percentages mentioned represent the proportion of all responses that included each category, not exclusive choices.

Table 5.10: Participants' Needs and Preferences to Better Manage Playing-Related Musculoskeletal Disorders

Category	Frequency	Examples
Instrument advice	17	- Instrument-related posture advice - Instrument-related strengthening/stretching and warm-up exercises. - Injury risks associated with each instrument. - Exercises for playing without experiencing muscle tension. - Reminders for maintaining good practice habits.
Pain management and recovery information (without having to stop playing)	20	- Pain management education without stopping playing. - What to do to avoid pain, and what to do to mitigate it when it happens. - Probability of developing chronic pain and its long-term effects. - Probability of complete recovery after injury/pain.
Early prevention	10	- Better training for posture at a young age. - Warning signs of injury to prevent injury. - More information on differences, and self-help for tendinitis, carpal tunnel, RSI.
Cultural and organisational changes	7	- More acceptance and understanding in the musical community. - Support from university professors and music teachers.
Accessible information	9	- Knowledge of websites or resources where musicians can access information regarding PRMSDs. - Availability of resources for pain management.
Peer support	6	- Masterclass demonstrations from professional instrumentalists on posture. - Suggestions from others who have similar related pains.

Figure 5.8: Participants' Preferences for Digital Health Technology



5.6 Discussion

The study sought to: 1) map the characteristics of musicians with current or previous PRMSDs; 2) compare the frequency of PRMSDs across demographic and work-related characteristics; 3) explore the impact of PRMSDs on musicians' careers and social relationships; 4) explore musicians' experiences, needs, and preferences regarding PRMSD self-management.

The study examined the characteristics of 100 musicians who met the inclusion criteria, focusing on their age, type of employment, practice hours and weekly working hours. The study included 49 self-employed musicians, 38 student musicians, eight employed musicians, and five musicians who were both employed and self-employed. Most participants were recruited through social media (Facebook and Instagram). Haynes and Marshall (2018) noted that self-employed musicians depend on social media for professional connections, which may explain the high response rate from this recruitment channel. This contrasts with the majority of research recruiting

musicians through specific professional or educational institutions (Stanhope et al. 2014; Berque et al. 2016; MacDonald et al. 2022).

The frequency of PRMSDs varied across employment groups, with 19% of self-employed musicians reporting >5 occurrences. However, there was no statistically significant difference between employment types in terms of the frequency of PRMSDs ($p=0.789$), as also reported in previous studies (Stanhope et al. 2022b). This may indicate that there is no difference between employed and self-employed musicians. Another potential explanation for these results is the sample size. In the current study, self-employed musicians accounted for 49.0% ($n=49$) of the total sample of 100 musicians. Small sample sizes and categorisation into employed and self-employed musicians may have resulted in type II error, thus impacting the statistical power to detect differences between groups (Cohen 1988).

Recruitment challenges further compounded these issues. In a qualitative study exploring research engagement methods for remote communities, Pelletier et al. (2020) found that participants were more likely to engage when they perceived clear, tangible benefits rather than merely theoretical outcomes. This pattern was evident in the current study, where gatekeepers reported that musicians requested compensation for their time, and one participant specifically sought health-related support (e.g., funding for massage therapy). These responses probably reflect broader challenges within the music industry related to financial security and health management (MacNamara et al. 2008; Pecun et al. 2016; Perkins et al. 2017). Additional recruitment barriers emerged when some musicians expressed reluctance to discuss personal health issues in a research context, citing potential negative career impacts. This aligns with previous qualitative reports indicating that musicians often

avoid discussing PRMSDs due to reputation concerns (Guptill 2011) (Chapter 2, Section 2.4.4). While such non-disclosure may serve as a protective mechanism, it can ultimately lead to worsening symptoms (Prizeman et al. 2024).

Beyond employment status and recruitment challenges, several demographic and behavioural factors may influence PRMSDs' development and severity, although the evidence in this study was not clear. The analysis of PRMSDs' frequency across age groups showed similar distributions, with no significant difference between age groups in terms of the frequency of PRMSDs ($p=0.691$). The sample's age distribution deviated from established musician demographics, as 58.0% of participants were between 18–29 years old and only 18.0% were aged 40 and over (Table 5.4). Recent data from Help Musicians and Musicians' Union (2023), surveying 5,867 UK musicians, shows a broader age distribution: 8.0% aged 17–24, 24.0% aged 35–44, 20.0% aged 45–54, 16.0% aged 55–64, and 5.0% aged 65–74. The underrepresentation of older musicians in the present sample might have limited the detection of age-related patterns in PRMSDs. A possible reason for this is the reliance on social media (Facebook/Instagram) and emails for recruitment, which disproportionately engages younger demographics and fails to reach older musicians who may use alternative platforms or offline networks (Hargittai 2020).

Another reason for the lack of a statistical relationship between age and PRMSDs is that studies showing this link often reflect specific contexts. Research suggesting that PRMSD risks are age-related (Abréu-Ramos and Micheo 2007; Gembris et al. 2020) typically focuses on competitive environments or involves musicians with high playing intensity. For example, Gembris et al.'s (2020) study sampled from a national music competition in Germany, where practice demands probably exceeded those of the

general musician population. This contrasts with the current study's findings, where no significant relationship between PRMSDs and musical practice was found, and increased working hours corresponded with lower frequency of PRMSDs ($p=0.022$, $\beta=-0.030$). This inverse relationship aligns with some previous cross-sectional survey studies, which suggested that while PRMSD risk initially increases with practice time, it plateaus or decreases beyond a certain threshold (Ackermann et al. 2012; Berque et al. 2016).

Interestingly, this contrasts with findings from broader occupational health research; Lee et al. (2018) found that long working hours significantly increased work-related MSD risk among Korean workers, even after adjusting for demographic factors and work-related characteristics including posture and stress. This discrepancy may suggest that other factors such as improved technique or physical conditioning among experienced musicians may reduce the risk of PRMSDs (Ackermann et al. 2012; Berque et al. 2016). While the current study did not explore physical exercise engagement, previous research suggests that this may not be a critical limitation, as several studies found that exercise behaviour was unrelated to PRMSDs (Lonsdale et al. 2014; Baadjou et al. 2016). However, these findings may reflect statistical limitations in these studies, such as univariate analyses that do not control for confounders (Baadjou et al. 2016) or chi-squared tests that do not explore variable associations (Field 2013). Therefore, future research should incorporate multivariate analyses that are capable of handling bimodal distributions and control for potential confounders to better understand PRMSD risk factors in musicians.

While further research is needed to understand these risk factors, it is equally important to examine how PRMSDs impact musicians' lives beyond their practice

routines. The majority of participants (77.0%) indicated that PRMSDs caused them stress and anxiety, with 43.0% reporting that this stress aggravated their symptoms. One possible explanation for these results is that stress can cause increased muscle tension, leading to pain, stiffness, and soreness, as discussed in Chapter 2, Section 2.4.3 (Hannibal and Bishop 2014). Despite these physical and psychological impacts, most musicians (67.0%) continued playing regardless of their PRMSDs. In a similar study, 43.2% (n=69) of musicians reported that musculoskeletal symptoms affected their ability to engage in musical activities at their usual level, and while many experienced emotional stress related to these conditions, most continued playing despite the symptoms (Stanhope et al. 2022b).

Several factors may contribute to musicians' persistence to continue playing, including the physiological understanding of pain, the strong psychological connection they have with their profession, and the cultural pressures within the music industry (Stanhope and Weinstein 2021). Musicians often derive a strong sense of identity, self-worth, and community from their ability to perform (Rickert et al. 2014). Playing music is not only a profession but also a primary means of social interaction and connection, with musicians frequently engaging in communal activities such as rehearsals, performances, and social gatherings that strengthen their bonds within the music community (Perkins et al. 2017).

Physiologically, pain is a complex phenomenon, not always directly linked to tissue damage. According to the International Association for the Study of Pain (IASP 2019), pain can be classified as nociceptive, neuropathic, or nociplastic. Nociceptive pain arises from the activation of peripheral nerves due to harmful stimuli and may occur without actual tissue damage (IASP 2019). Neuropathic pain is associated with lesions

in the somatosensory nervous system, while nociplastic pain involves altered nociception without clear evidence of tissue or nerve injury (IASP 2019). This suggests that musicians might experience pain without significant physiological harm, and in such cases, continuing to play may not exacerbate underlying issues and could be beneficial for maintaining technique and psychological well-being (IASP 2019; Stanhope and Weinstein 2021). Both current pain science and evidence regarding musicians' pain indicate that public health advice directed towards musicians should not include suggestions that they do not play when experiencing pain (Stanhope and Weinstein 2021). This recommendation is in keeping with best practice for managing musculoskeletal pain, where the maintenance of normal physical activity is encouraged (Lin et al. 2020). Given the evidence to support continuing to play music, it is essential to understand how musicians manage PRMSDs and identify their specific needs to better address these conditions.

Physiotherapy emerged as the most frequently consulted healthcare option, with 32% of participants seeking physiotherapy services. This finding aligns with Stanhope et al.'s (2014) study of university-level woodwind players, which reported a 60.0% physiotherapy consultation rate, and MacDonald et al.'s (2022) research showing high rankings for physiotherapy and occupational therapy among oboists. The preference for these therapies may stem from their targeted approach to addressing musicians' specific biomechanical and ergonomic challenges, compared to more general medical interventions like medication (Chan and Ackermann 2014).

Active treatment methods received the highest efficacy ratings, particularly yoga, Pilates, strengthening and stretching exercises, and warm-up/cool-down routines. However, interpretation of these results requires caution due to varying exposure

levels to different treatment methods among respondents. Despite this limitation, the preference for active treatments aligns with current best practice evidence for MSDs (NICE 2019). The open-text responses further reinforced this preference, with participants specifically requesting guidance on stretching, strengthening, and muscle tension reduction exercises.

Furthermore, pain education emerged as an unmet need (Table 5.10), highlighting a crucial gap in training for healthcare provision for musicians (Chapter 2, Section 2.5.3; Stanhope and Weinstein 2021). Musicians are more likely to experience pain of greater intensity than any tissue damage indicates, compared with the general population, owing to neurological differences, and musicians having a higher prevalence of sleep problems (Vaag et al. 2016a) and psychological distress (Vaag et al. 2016b) which are both pain moderators. Moreover, instrument-related advice is rarely considered in exercise interventions or health education courses. The majority of existing evidence suggests general warm-up, cool-down, and motor-control exercises without considering the different instrument groups (Chapter 2, Section 2.5.4). The type of instrument played, including its size, weight, and playing technique, can influence the type of PRMSD experienced (Watson 2009). Therefore, it may be relevant to consider the type of instrument, similar to how athletes are rehabilitated differently depending on the sports they play (Horvath 2003; Stanhope et al. 2022a). This desire for personalisation aligns with broader healthcare trends toward tailored interventions (Chen et al. 2016). However, given the different types of instruments, it is unclear how this could be implemented in rehabilitation programmes. These healthcare gaps and potential solutions will be further explored in Chapters 6 and 7.

Another key finding from the survey was the need for more accessible information to help musicians better manage and prevent future injuries. This finding could be related to Perkins et al.'s (2017) finding that musicians often encounter barriers when seeking to access healthcare, including a lack of knowledge about available resources and financial constraints. These challenges could explain why advice and information websites were highly preferred, receiving the highest endorsement (44.0%) compared to other digital health technologies. Wearable sensor technologies to monitor posture also scored highly (39.0%) and posture was frequently mentioned as a health need (Table 5.9). Maintaining optimal posture is a subject of debate in the general population (O'Sullivan et al. 2012). For musicians, an unbalanced posture might result in physical injuries; however, it is unclear whether this is an unavoidable aspect of instrument design and music playing or whether musicians can modify their posture to reduce the risk of injury (Manchester 2014).

Nonetheless, wearable technologies, including accelerometers and inertial measurement units, can alert users to maintain correct posture (Wang et al. 2017). While preliminary studies with office workers (Abyarjoo et al. 2015) and construction workers (Kim and Cho 2015; Yan et al. 2017; Kim and Cho 2021) have shown promising results in laboratory settings, they lack validation in real-world environments. For musicians, additional concerns exist about sensors interfering with instrument contact points and disruptive alert sounds during performances. Given these findings, further research is needed to explore how digital tools can be optimally designed to overcome the current gaps in healthcare accessibility for PRMSDs, as will be explored in Chapters 6 and 7.

5.7 Strengths and Limitations of the Study

This study demonstrated several notable strengths, including its robust methodological approach following Maier et al.'s (2023) recommendations for cross-sectional surveys and representation of diverse musician groups, including self-employed, student, and employed musicians. However, the study also faced important limitations that warrant consideration. A key limitation was that the survey was developed without psychometric validation, meaning that it is difficult to benchmark findings against other studies or validated questionnaires. In addition, the study relied entirely on self-reported PRMSDs without clinical examination, which might have led to misclassification of conditions or inclusion of non-PRMSD conditions. Furthermore, the online survey format, while offering convenience and accessibility, might have introduced response errors through participants misunderstanding questions and/or accidentally selecting incorrect options.

The study also faced sampling limitations as the sample size fell short of the calculated ideal of 381 participants, stopping at 100, which particularly affected statistical power for subgroup analysis. This raises concerns about the statistical validity of the findings, including the higher risk of both Type I and Type II errors (Field 2013). Recruitment challenges and potential self-selection bias might have influenced the sample composition, with heavy reliance on social media recruitment potentially skewing participant demographics. Furthermore, the five-year retrospective nature of the study might have introduced recall bias. However, the study was conducted during the COVID-19 pandemic and given the overwhelmingly negative impact on the music industry during this period (Musicians' Union 2021), it was considered impractical to only consider musicians with current MSDs. This is because, at the time of the survey

(October 2022 – January 2023), live performances were only just beginning to resume, with many musicians having been out of work for at least two years and only recently returning to live performances (Musicians' Union 2021). Nonetheless, the results may vary in accuracy depending on individual awareness and willingness to report information and should therefore be approached with caution.

5.8 Summary and Future Recommendations

This study is the first to explore the health of self-employed musicians in the UK, as well as the first to explore the health needs of a diverse group of musicians. Therefore, its findings may have broader implications for musicians compared to previous studies (Stanhope et al. 2014; MacDonald et al. 2022; Stanhope et al. 2022b). Key findings revealed no significant relationships between the frequency of PRMSDs and age, type of employment or practice hours, but increased working hours were associated with reduced frequency of PRMSDs. However, the interpretation of these findings should be considered alongside the methodological limitations discussed.

According to the health needs identified in this study, healthcare interventions should focus on creating specialised pain education programmes, instrument-specific rehabilitation guidelines, and targeted exercise protocols. There is also a need to improve information accessibility, possibly by considering digital tools and resources that may address musicians' unique healthcare barriers, especially considering their financial constraints and professional challenges. While these results reveal novel insights, research should prioritise methodological improvements, including expanding the sample size to the calculated ideal of 381 participants and developing more comprehensive recruitment strategies to reduce bias.

Chapter 6: Phase 2 / Part 2 – Focus Group Study

**Musicians' Opinions and Views Towards Developing a Digital Health
Intervention for Self-Management of Playing-Related Musculoskeletal
Disorders in musicians.**

6.1 Introduction

Research on PRMSDs has primarily focused on understanding musicians' lived experiences. Two key qualitative studies, conducted in Canada (Guptill 2011) and South Africa (De Kock et al. 2023), explored these experiences in string musicians, identifying three primary themes: cultural challenges, psychological impacts, and social implications (Chapter 2, Section 2.5.4). However, these studies left a significant gap in understanding how musicians manage their PRMSDs, the individual barriers and facilitators that influence musicians' ability to self-manage their PRMSDs, and how they could be addressed (Chapters 2 and 4).

Recent research has begun to address aspects of PRMSD management, though with different focuses. Studies by Ajidahun et al. (2019), Baadjou et al. (2021), Roos et al. (2021) and Shoebridge and Osborne (2025) examined barriers and facilitators to implementing health education programmes in various musical settings: South African music schools, Dutch music schools, Canadian orchestras and Australian music institutes, respectively. These studies identified common barriers such as time constraints, pain culture and limited resources, whilst facilitators included institutional support, social support through group activities, flexibility, and programme simplicity. However, their scope was focused on programme implementation rather than individual self-management behaviours. Moreover, these studies were limited to specific populations: professional orchestral musicians (Roos et al. 2021) and student musicians (Ajidahun et al. 2019; Baadjou et al. 2021; Shoebridge and Osborne 2025).

None of the studies included self-employed musicians nor implemented a behaviour change theoretical framework.

The BCW framework suggests that effective intervention design begins with using the COM-B model to thoroughly analyse behaviours and identify key barriers and facilitators that the intervention intends to change (Michie et al. 2011). Therefore, the aim of this study was to build on the findings from the previous study (an online survey) to gain deeper insights into the barriers and facilitators to PRMSD self-management and musicians' health needs, and to investigate how DHIs could promote PRMSD self-management in musicians.

6.2 Research Question, Aim and Objectives

6.2.1 Research Question

The research question for the focus group study was as follows: **What are the barriers and facilitators to PRMSD self-management in musicians, and how can DHIs promote PRMSD self-management in musicians?**

6.2.2 Aim

The aim of this part of the study was to explore the barriers and facilitators to PRMSD self-management and to investigate how DHIs can promote PRMSD self-management in musicians.

6.2.3 Objectives

The objectives were as follows:

- Explore the barriers and facilitators to PRMSD self-management.

- Explore the perspectives of musicians on the key intervention components required within a DHI to support PRMSD self-management in musicians.
- Explore the perspectives of musicians on the potential facilitators, barriers, and potential solutions of implementing a DHI to support PRMSD self-management in musicians.

6.3 Study Design and Methods

According to the MRC framework on intervention development, qualitative data collection methods are recommended in the development stage, as they provide an in-depth understanding of relevant partners' needs and priorities (Skivington et al. 2021). Both individual interviews and focus groups are recommended at this stage but the choice depends on the context and rationale of the research being conducted (Skivington et al. 2021). Although individual interviews could have been used, DHIs are novel and have never been explored within the musician population. Interaction between participants in a focus group setting could lead to the emergence of new insights and ideas that might not surface in individual interviews (Kidd and Parshall 2000; Webb and Kevern 2001). Participants may build on each other's ideas or provide supporting examples, signalling agreement and consensus within the group (Kidd and Parshall 2000). This could serve as a basis for decision-making in intervention development by allowing the researcher to prioritise certain strategies or elements that have received widespread support (Kidd and Parshall 2000). Equally, participants may express conflicting opinions, which could offer an opportunity to explore alternative viewpoints, leading to a deeper exploration of the topic (Kidd and Parshall 2000).

Traditionally, focus groups have been conducted face-to-face in controlled settings (Morgan 2002). However, with the advent of technology, online focus groups offer

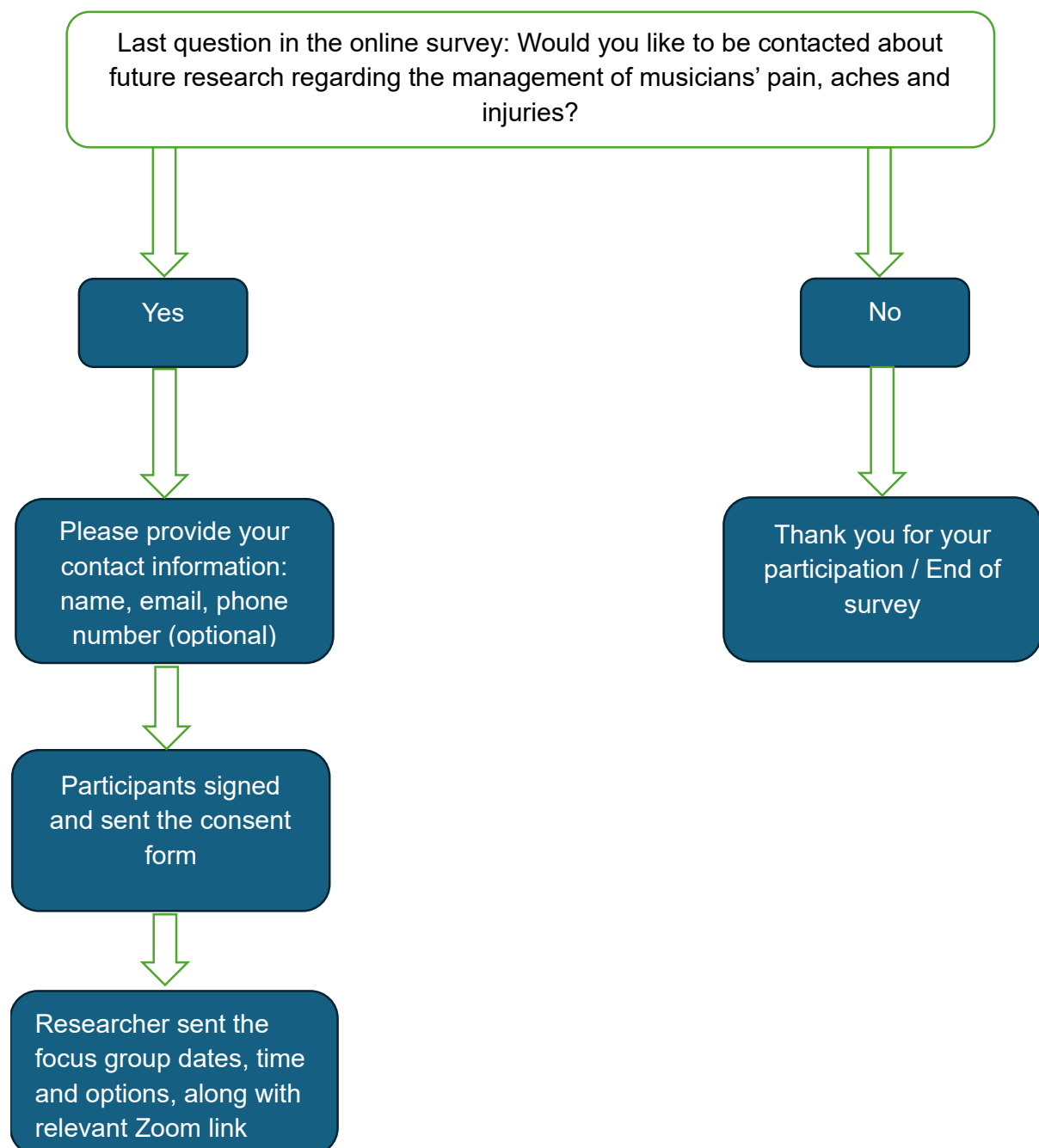
several advantages over their traditional counterparts (Stewart and Williams 2005; Reid and Reid 2005). One notable advantage of online focus groups is the ability to overcome geographical limitations, which could enable researchers to obtain a larger and more diverse sample (Stewart and Shamdasani 2017). However, they also present several challenges, such as difficulties with building rapport, technical issues, screen fatigue, and ethical concerns (Hay-Gibson 2009; Deakin and Wakefield 2014; Santhosh et al. 2021). Previous research addressed rapport challenges by establishing early contact through pre-session emails (Deakin and Wakefield 2014) and technical challenges by conducting trial runs and providing clear instructions to participants on how to use the online platform (Santhosh et al. 2021). In the present study, sessions were limited to one hour to prevent screen fatigue (Santhosh et al. 2021) and an information sheet was provided to explain potential ethical issues regarding privacy and confidentiality, with all procedures approved by Cardiff University's ethical committee (Santhosh et al. 2021: see Appendix 3, Figure 1). The following sections detail the sampling and recruitment processes employed in the study.

6.3.1 Sampling and Recruitment

The sample of participants for a qualitative study in a sequential explanatory design should be determined based on the preceding quantitative study (Creswell and Clark 2011). The survey participants who indicated in the survey study that they were willing to be contacted for future research were invited to participate in the focus group via email (Appendix 9). Sixty-nine participants agreed to further contact, and all participants were contacted via an email containing the Participant Information Sheet and consent form (Appendix 10 and 11). Twenty-five participants indicated that they were interested in participating in the focus group and each participant received an

email detailing the different dates and times of the focus group sessions (Appendix 9). Once the participants had provided their consent via an e-consent form and chosen their preferred date and time for the focus group, they received a Zoom invite link that included a unique meeting ID and password (Santhosh et al. 2021). They were also provided with instructions detailing the research process, what to expect, the necessary equipment for the online meeting, and general tips on using Zoom (Appendix 12) (Santhosh et al. 2021). The recruitment process is detailed in the flow chart below (Figure 6.1).

Figure 6.1: Flow Chart of the Recruitment Process of Participants in the Focus Group (following completion of the online survey)



6.3.2 Sample Size

In qualitative research, information saturation involves ongoing data collection until no new information is found and is often considered the gold standard for determining sample size (Charmaz 2008). Although widely accepted as a guideline (Morse 2015), it presents several challenges (Saunders et al. 2018). A key challenge is that determining saturation is subjective and can vary among researchers (Saunders et al. 2018). This variability could impact the consistency and replicability of results (Saunders et al. 2018). There are also debates over whether saturation can be reached (Braun and Clarke 2019). O'Reilly and Parker (2013) and Morse (2015) further argued that information saturation may be ambiguous in studies outside of grounded theory, as not all qualitative research aims for theory generation. Therefore, it is important for researchers to explore the applicability of information saturation to their specific methodological approach (Saunders et al. 2018).

There are different types of information saturation: theoretical saturation, data saturation, and inductive thematic saturation (O'Reilly and Parker 2013; Saunders et al. 2018). Theoretical saturation, which is relevant to grounded theory methodology (Glaser 1978), refers to the point at which no new theoretical insights or concepts are generated from the data collected. Since this study did not aim to generate theory, this approach was not considered appropriate. Data saturation relies on what the researcher hears during data collection, and the decision about saturation can be made before any data coding (Saunders et al. 2018). It is unclear how saturation can be achieved through this method because determining saturation requires analysing the information in relation to other collected data (Hennink et al. 2017).

Some research suggests that data saturation may encourage surface-level analysis by focusing on repeated information rather than exploring the depth and richness of the data, which contradicts the principles of qualitative research (Hennink et al. 2017; Hennink and Kaiser 2022). However, inductive thematic saturation involves simultaneous data collection and analysis until no new themes are identified (Saunders et al. 2018). Its focus on meaning rather than quantity made it more suitable for this study, allowing for an iterative process that ensured a thorough understanding of participants' perspectives while maintaining qualitative rigour (Hennink et al. 2017).

6.3.3 Number and Size of Focus Groups

The number of focus groups needed to reach thematic saturation can vary depending on several factors, such as the richness of the data collected and the level of variation in perspectives within the focus groups (Guest et al. 2006). Malterud et al. (2016) and Mason (2010) argue that while estimating sample size is valuable for planning purposes, researchers must continuously evaluate whether the final sample size is adequate throughout the research process. Three focus groups were initially considered appropriate for the present study; however, after the third focus group, additional themes were still being identified; therefore, a fourth focus group was conducted.

Another important consideration in focus group studies is group size. According to Holloway and Wheeler (2010) and Krueger and Casey (2015), focus groups might comprise between four and 12 participants, but the optimum number varies depending on the topic. While larger groups can offer a broader range of perspectives and dynamic interactions, they often present challenges in terms of control and depth of discussion (Holloway and Wheeler 2010; Krueger and Casey 2015). In contrast,

smaller focus groups, comprising four to six participants, can facilitate participation from each member and ensure that quieter individuals can contribute without being overshadowed by more dominant voices (Holloway and Wheeler 2010; Krueger and Casey 2015). In addition, it is easier for facilitators to manage smaller groups, especially in online settings, in terms of guiding conversations and maintaining control over the discussion flow (Holloway and Wheeler 2010). Therefore, having four to six participants in each focus group was considered appropriate for this study (Santhosh et al. 2021).

Efforts were made to over-recruit for the focus groups, with all sixty-nine participants who had expressed interest in the quantitative study being contacted. Although twenty participants confirmed their attendance, half subsequently failed to attend, resulting in smaller group sizes than originally planned. Two focus groups comprised two participants each, while the other two included three participants each, resulting in a total of ten focus group participants. According to Holloway and Wheeler (2010), the minimum recommended number of participants per focus group is three: the groups with two participants fell below this threshold, which may be considered a limitation.

Similar sample sizes ($n=13$ and $n=11$) have been reported in qualitative explorations of workplace rehabilitation programmes for orchestra musicians (Roos et al. 2021) and for music students (Ajidahun et al. 2019), respectively. While small group sizes may limit the breadth of perspectives captured, they do not necessarily undermine the depth of the analysis. Malterud et al. (2016) indicated that thematic saturation can often be reached with a relatively small number of focus groups, especially when the groups are homogenous, as was the case in this study, with all participants being

musicians with current or previous PRMSDs. In the current study, no new themes were identified by the end of the final focus group session.

6.3.4 Topic Guide and Development of Questions

The focus group topic guide was developed based on the study's aims and objectives. It underwent several rounds of refinements with the project's supervisors. The final version was structured into three parts. First, participants discussed the barriers and facilitators in managing their PRMSDs (referred to as pains, aches and injuries in the survey and focus groups). Next, the survey findings were explored in detail. The survey had identified three main treatment preferences – pain management, early prevention, and peer support – along with a need for accessible resources and cultural and organisational changes. The focus groups examined the first three themes in depth, as they aligned with the aim and scope of the study. The final set of questions explored the facilitators, barriers and solutions to using DHIs to support self-management of PRMSDs. Table 6.1 provides the topic guide for the focus groups.

Table 6.1: Topic Guide for the Focus Group Study

Section 1: Barriers and facilitators of managing your pain, aches and injuries	
1.	What has been your experience managing your pains, aches and injuries?
2.	What are the main challenges or difficulties you encounter in managing your pains, aches and injuries?
3.	What factors or information would help you to better manage your pains, aches and injuries?
Section 2: Exploring the survey findings	
In the survey study, three main needs were identified: pain management and recovery information, early prevention, and peer support.	
4.	What challenges do you face in finding this advice or support?
5.	How could health technology help facilitate pain management, recovery information, and early prevention education?
6.	What would motivate you to follow through with your treatment plan despite your busy schedule, and how could health technology provide this support?
7.	How could health technology help to facilitate peer support among musicians? Is there any additional support (e.g., healthcare support) that you think would be helpful?
8.	Are there any additional features or design elements you would like to see in a digital health intervention that could better support your management of pains, aches, and injuries?
Section 3: Facilitators, barriers and solutions to using digital health interventions	
9.	What support or resources do you think would be helpful for you in adopting and using health technology effectively for managing your pain, aches and injuries?
10.	What would make you less likely to use health technology? Why? How could that be improved?
Section 4: Closing and recommendations	
11.	Of all the things we discussed, what do you think is the most important/relevant to you as a musician?
12.	Is there anything that you feel is important that we missed in the discussion?

6.3.5 Pilot Study

A pilot focus group was conducted with two musicians who met the inclusion criteria. This pilot study served as an opportunity for the researcher to practice their interviewing skills and to ensure the clarity of the questions. Initially, there was one introductory question exploring musicians' experiences with PRMSDs and their impact on performance: "What has it been like for you to and manage your pains, aches and injuries, and how do these conditions impact your daily life and career as a musician?". During the pilot study, participants' responses to these questions took longer than anticipated and made it challenging to steer the conversation towards the primary aim

of the focus group. Therefore, this question was removed in the final version of the topic guide (Table 6.1).

Moreover, during the pilot study, the researcher found it challenging to introduce the topic of DHIs. After discussing this with the project's supervisors, a PowerPoint presentation (Appendix 13) was developed to facilitate the discussion. The presentation provided an overview of the aim of the entire project and the survey findings. This was followed by a short introduction to the development of DHIs, from electronic health (e-health) to mobile health (m-health) and personalised DHIs, and an explanation of how DHIs could be implemented to facilitate self-management of PRMSDs. Visual examples of existing DHIs to engage participants and illustrate practical applications were also included. The examples included mHealth for MSDs, exercise-tracking applications for athletes, and telehealth platforms for remote healthcare delivery. Despite the changes made following the pilot study, the data collected were still considered relevant to the research aim; therefore, the data from the pilot focus group were included in the final analysis.

6.4 Ethical Considerations

6.4.1 Ethical Approval

Ethical approval for this study was obtained from Cardiff University, School of Healthcare Sciences Ethics Review Committee SREC (Reference: REC889) on 5th July 2022 (Appendix 3, Figure 1).

6.4.2 Data Collection

Consent was obtained electronically prior to the focus groups (Appendix 10). They were informed that all discussions would be audio recorded. Participants were asked

to initial each box of the statements in the consent form to confirm that they had read and understood the information given and to consent to take part in the study. Prior to the recording, participants were informed that they were free to withdraw from the focus group at any time without giving any reason and that if they chose to do so, their recording would be destroyed. They were also informed that their decision to withdraw from the focus group would not affect their legal or medical rights.

6.4.3 Risk Assessment

It was anticipated that there would be no risks associated with participating in this study. However, it was possible that the topic or some of the questions might have been distressing to participants. Participants were informed that they could refuse to discuss any topics that made them uncomfortable or that they simply did not wish to discuss. Moreover, they were directed to support resources and services in the Participant Information Sheet (Appendix 11) and at the beginning of the focus group in case they felt negatively affected in any way.

6.4.4 Data Storage and Handling

Each participant was given a unique participation number when the audio files were transcribed. Focus group transcripts were anonymised and held on the researcher's OneDrive account. According to the research integrity and governance policies of Cardiff University, all collected anonymised data is retained for a maximum period of 15 years. Arrangements were put in place to secure data disposal or destruction after a fixed period of 15 years.

6.5 Data Collection and Processing

The online focus groups were conducted online using Zoom technology. Each focus group session lasted approximately one hour. The sessions were facilitated by one researcher and an assistant, who was another PhD student (AA). The assistant attended the sessions, took notes, kept track of the time, and ensured that all research questions were covered without interfering with the group discussion. The researcher was responsible for starting the session and admitting participants into the meeting room. The researcher started the session thirty minutes prior to the scheduled time to ensure that the video and audio volume were working appropriately and to allow time to address any technical difficulties (Santhosh et al. 2021).

To ensure anonymity, safety and confidentiality, the waiting room feature in Zoom was enabled to screen participants prior to granting them access to the meeting. During this screening process, participants' names and other identifiable information were cross-checked with the list of invited participants to confirm their eligibility. Once the participants had joined the session, the researcher locked the call to prevent any unwanted disruption and to ensure security. At the beginning of each focus group, the researcher and assistant introduced themselves and then participants took turns introducing themselves.

Initially, the researcher thanked the participants for their time and then gave a brief verbal overview of the aim of the entire project, the survey findings and DHIs. Following this, the participants were briefed on the focus group ground rules, including confidentiality, the absence of right or wrong answers, and the right to terminate the interview at any time. Verbal permission for audio recording was requested in addition to the written consent that was previously obtained.

The topic guide was used to guide the conversation; however, the order of questions was adjusted based on the participants' responses to allow the focus group to be more conversational and less rigid. This approach aligns with previous recommendations (Irvine 2018), and it was implemented to build trust and rapport with participants. Prompts such as "Can you explain more about this?" and "Can you give me an example?" were used to elicit more details on participants' answers.

Some groups were quieter than others. To overcome this, the researcher reframed some questions and provided examples relevant to musicians' lives regarding when and how DHIs could be relevant (e.g., fatigue after long performances or touring with limited access to healthcare). Conflicts of opinions did arise in some groups, particularly with regard to using DHIs and the specific design features. This was encouraged and further clarification was sought from the participants using prompts such as "Why do you think so?" and "Can you explain this further?".

All the focus groups ran smoothly, without technical issues, and at the end of each focus group, the researcher asked the participants if they had anything else they would like to add or if they had any questions. Once the participants' queries had been addressed, the researcher thanked the participants for their time and contribution to the research.

The audio-recording and transcription function within Zoom was used to generate a recording and a transcript. Both were then downloaded onto a Cardiff University computer, which was protected by a username and password only known to the researcher. Following this, all the recorded information was permanently deleted from Zoom Cloud. The automatic transcript generated within Zoom was transferred to a Microsoft Word document and checked against the audio recording several times and

then anonymised by changing participants' names to numbers and deleting any identifiable information.

6.6 Data Analysis

The underlying theory of the current study is pragmatism (Chapter 3, Section 3.2). Both content analysis and thematic analysis have been widely used for analysing qualitative data in studies underpinned by this approach (Savin-Baden and Major 2013). Both approaches share a similar goal, which is to understand a particular phenomenon from the perspective of those experiencing it (Vaismoradi et al. 2013). Thematic analysis was developed from content analysis but eventually evolved into a distinct approach with its own unique research goals (Joffe and Yardley 2004).

The purpose of content analysis is to describe what is said in the data, by whom, to whom, and what impact it has (Bloor and Wood 2006). This involves categorising data based on shared meanings and quantifying this data by counting the codes (Savin-Baden and Major 2013). This makes it useful for providing simple and straightforward reports on common topics or issues found in the data (Savin-Baden and Major 2013). However, content analysis has been criticised for potentially overlooking the broader context or meaning of the data, since the frequent occurrence of a word or code does not necessarily imply the significance of a topic (Vaismoradi et al. 2013; Braun and Clarke 2021a). Therefore, some studies indicate that content analysis is associated with the surface meaning of the data rather than the underlying meaning, which contradicts the purpose of qualitative research (Bloor and Wood 2006).

Alternatively, thematic analysis shares the structured aspect of content analysis while also providing the flexibility to analyse the data within a specific context (Joffe and

Yardley 2004). In this regard, the significance of a theme is not based on quantifiable data but on its relevance to the overarching research question and the broader context (Spencer et al. 2003; Braun and Clarke 2008). This includes how social, cultural and personal factors may shape participants' perspectives (Braun and Clarke 2008). Therefore, thematic analysis is considered suitable for exploring questions such as "What are the concerns of people about something?" and "What reasons do people have for using or not using a service or intervention?" (Ayres 2007). This is relevant to the context of this study, which sought to explore key components, facilitators, and barriers of using DHIs for PRMSD self-management in musicians. Therefore, for this study, thematic analysis was considered more appropriate than content analysis.

Reflexive thematic analysis was chosen because it encourages reflection on the researchers' subjectivity and how it impacts on the collection, analysis, and interpretation of the data (Braun and Clarke 2021a). This requires researchers to be more transparent about their own positionality and how that may influence the analysis, which enhances the rigor and trustworthiness of the research (Braun and Clarke 2021a). This was considered relevant given the nature of qualitative research, in which both the researchers and participants would mutually influence each other's perspectives (Braun and Clarke 2021b). Furthermore, reflexive thematic analysis offers greater flexibility in the analytical process (Braun and Clarke 2021b). It allows researchers to move back and forth between different phases of analysis, thus encouraging a more iterative and creative approach to theme development (Braun and Clarke 2021b).

Reflexive thematic analysis was undertaken using Braun and Clarke's (2021b) six-step approach, which involves: 1) Familiarisation; 2) Data coding; 3) Generating initial

themes; 4) Developing and reviewing themes; 5) Refining, defining, and naming themes and 6) Writing up.

6.6.1 Phase 1 – Familiarisation

The transcripts were generated automatically using the transcription technology provided by Zoom. To ensure accuracy, the researcher cross-checked the generated transcripts against the corresponding audio-recordings, taking notes of laughs, emphasis and pauses, and participants' names were replaced with pseudonyms to ensure anonymity (Braun and Clarke 2021b). Any discrepancies or errors identified were corrected by listening to the audio-recordings and making necessary adjustments. Following this, each audio-recording was carefully listened to twice and the transcripts were read three to five times throughout the data analysis phase. Annotations and initial codes were made physically around the transcript to note recurrent codes and concepts (Terry et al. 2017). An example of a focus group transcript and initial codes is provided in Appendix 15.

6.6.2 Phase 2 – Data Coding

The aim of this phase was to systematically analyse the data by coding it with concise phrases (Braun and Clarke 2021b). To conduct reflexive thematic analysis, two types of coding are usually adopted: inductive or data-driven, and deductive or theory-driven (Vaismoradi et al. 2013; Braun and Clark 2021b; Byrne 2022). The BCW was used as a theoretical framework to identify relevant themes that would be relevant to the research aims and objectives. However, this was considered as an initial guide rather than rigidly outlining all codes or themes before starting the analysis. As outlined by Braun and Clarke (2021b), using existing theories does not prevent iterative processes from being employed where new themes can surface via the induction approach.

However, usually one approach predominates over the other, and in this case, a predominately inductive approach was adopted because of the novelty of the research project. This ensured that the research gave voice to the participants to share their perspectives, concerns, and key priorities regarding the management of PRMSDs. The data were coded semantically, which means that the aim was to present the data as communicated by the participants (Braun and Clarke 2021b; Byrne 2022).

To facilitate data coding, a Microsoft Word document was created, featuring a table format that included the data and the annotations/initial codes as two separate columns (Appendix 14). Coding was undertaken systematically by highlighting extracts that addressed the research question. Extracts were coded more than once when they contained multiple meanings. All the codes identified during this process were copied and pasted into another Microsoft Word document with the participant number to prevent any data loss or error (Appendix 16). This process was completed for each focus group and then re-evaluated during the following data analysis of identifying patterns and themes. Codes were cross-checked retrospectively to check whether they were factual and made sense in the absence of the original text or the full transcript (Flick 2018).

6.6.3 Phase 3 – Generating Initial Themes

The aim of this phase was to identify shared meaning or themes across the codes identified (Braun and Clarke 2021b). A theme can be identified as a topic that organises a group of repeating ideas to answer a specific study question (Ryan and Bernard 2003). Therefore, once the entire dataset had been coded, relevant segments corresponding to each code label were compiled for further analysis (Braun and Clarke 2021b). This was a cyclical process in which the researcher revised the transcripts

and renamed the codes, if necessary, to provide a more accurate description, as well as merging or splitting codes when they referred to similar or different themes. For example, initial codes related to features of DHIs such as setting reminders and feedback and monitoring were grouped together as design features for DHIs.

6.6.4 Phase 4 – Developing and Reviewing Themes

The aim of this phase was to assess the fit of the provisional candidate themes to the data and the viability of the whole analysis by going over the whole data set (Braun and Clarke 2021b). This involved checking the coded texts in each theme and evaluating whether the coded data reflected the theme (Braun and Clarke 2021b). Several changes were made to the initial themes, and potential sub-themes were also identified (Appendix 17, 18). For example, there were differences between participants' views on using DHIs, whether they accepted them or not, the model of care they perceived would be beneficial, and the type of technology that they thought would facilitate their care. Therefore, a subtheme looking at participants' attitudes towards using DHIs was added (Figure 6.2). Another example is that initially, there was a general category of Perspectives on DHIs (Appendix 18). This was developed into the more specific theme (Views on DHIs) with clearly defined subthemes of Attitudes towards DHIs and Opinions on different types of DHIs (Figure 6.2).

6.6.5 Phase 5 – Refining, Defining and Naming Themes

Following review of the final set of themes, the scope of each theme was clarified and refined. A descriptive and an interpretative commentary of the themes was used for this task (Braun and Clarke 2021b). This phase involved selecting quotes from the participants to provide examples which would illustrate the analytic points made in the analysis.

6.6.6 Phase 6 – Writing Up

This constitutes the final phase of the analytic process of reflexive thematic analysis (Braun and Clarke 2021b). The findings were presented, incorporating quotations that captured the identified themes and subthemes (Braun and Clarke 2021b). Due to the iterative nature of reflexive thematic analysis, this phase overlapped with phases 4 and 5, as the narrative analysis often revealed new connections between themes, requiring further review (Braun and Clarke 2021b).

6.7 Rigour and Quality

In qualitative studies, the researcher and others involved in the data collection are the primary instrument for data collection (Leung 2015). Any researcher biases not adequately addressed, or errors in judgement, can affect the quality of data and subsequent research results (Leung 2015). Due to the creative, interpretative, and contextually bound nature of qualitative studies, the application of standards of rigour and adherence to systematic processes is essential (Yadav 2022). Guba and Lincoln (1994) proposed that research should satisfy four criteria: credibility, transferability, dependability, and confirmability.

6.7.1 Credibility

Credibility refers to the extent to which the results accurately represent participants' views (Guba and Lincoln 1994). Various techniques can be used to ensure credibility in research, including identifying the researcher's background, member checking, and triangulating results (Guba and Lincoln 1994). The researcher has a physiotherapy background with experience in treating patients with MSDs and WRMSDs. Despite lacking direct clinical experience with musicians specifically, the researcher was drawn

to this topic due to the high prevalence of PRMSDs and the fact that this area remains relatively under-researched compared to other performing arts fields such as dance.

On commencement of the PhD, several meetings were arranged with BAPAM to gain insights and guidance specific to the needs and challenges faced by musicians. These meetings highlighted several issues, including the alarmingly high rates of injuries among musicians, particularly conservatoire students. While BAPAM offers monthly webinars addressing musicians' physical health and psychological well-being, access to these sessions remain limited. These accessibility challenges prompted the researcher's interest in exploring DHIs as a potentially more accessible tool for musicians to support PRMSD self-management.

As a physiotherapist, the researcher acknowledges that their background in MSDs management and views on DHIs might have influenced the focus group study's data collection and analysis. Specifically, the researcher holds the view that exercise and education are components in managing PRMSDs. While posture is considered relevant, the researcher does not subscribe to the idea of a single “ideal” posture (e.g., always sitting upright), instead recognising that individuals naturally adopt a range of postures and that there is no universally correct position. Regarding DHIs, the researcher has a positive view of their potential to enhance self-management and offer a flexible, scalable approach to healthcare—particularly valuable given pressures on the NHS and the limited specialist support available to musicians. The researcher also believes that digital health trackers can be useful tools for recognising patterns in health-related behaviour and progress, but notes that over-reliance on such data may lead to unnecessary stress or anxiety for some individuals.

To address this potential influence, the researcher maintained a neutral stance throughout the focus groups, neither agreeing nor disagreeing with participants, to avoid shaping their responses. All perspectives and information shared by participants were included in the analysis, regardless of whether they aligned with the researcher's own views. Furthermore, the researcher kept a reflexive diary, as recommended by Finlay and Gough (2008), Reid et al. (2018), and Nadin and Cassell (2006). This reflexive diary was used to reflect the researcher's thoughts after each focus group and during the data analysis. This included reflections on the overall process, identification of any issues, personal experiences during data collection and analysis, and consideration of the impact of assumptions on the research. Extracts from the reflexive diary are provided in Appendix 17.

Moreover, Guba and Lincoln (1994) emphasised the importance of member checking during and after data collection, citing it as the most important aspect of ensuring the credibility of the research findings. This allows participants to review and comment on collected data to ensure their views are accurately captured (Kornbluh 2015). Therefore, participants were asked to review their transcripts to ensure that their statements accurately reflected the intended meaning (Shenton 2004; Cypress 2017). Participants were given two weeks to respond to the email. Only two participants replied to the email, indicating that no further changes or clarification were needed.

However, there is conflict over whether member checks can enhance the accuracy of the research. Thomas (2017) suggested that member checking, particularly participant feedback, does not necessarily guarantee validity within research. Similar concerns were also raised by Birt et al. (2016), specifically if member checking is used as the main way of assessing quality. Data triangulation involves comparing different data

sources to identify patterns, validate findings, and reduce bias (Shenton 2004; Noble and Heale 2019). As this sequential mixed methods study involved an online survey and online focus groups, a summary of the commonalities and differences of the findings of both studies is provided in the discussion chapter (Chapter 7, Section 7.3).

6.7.2 Transferability

Transferability refers to the extent to which the findings can be applied to other contexts or settings (Guba and Lincoln 1994). This can be achieved by providing a detailed description of the research process (Curry and Nunez-Smith 2014). Therefore, a detailed description of the methods used for the online focus group, including the sampling method, participant recruitment, data collection procedures, and data analysis, is provided in this chapter, and the coding process is provided in Appendix 16.

6.7.3 Dependability

Dependability refers to the extent to which the research process is described in sufficient detail to facilitate another researcher to repeat the work (Guba and Lincoln 1994). This means that the research process should be well-documented, so that others can review and verify the steps taken and ensure that the findings are supported by the data (Shenton 2004). This can be achieved by providing a detailed description of the research methods (as reported in the section on transferability) and involving a person not associated with the project in the analysis and interpretation of the results (Shenton 2004). In this study, a subset of the transcribed focus groups was coded by another PhD student who was experienced in qualitative research (AA).

6.7.4 Confirmability

Confirmability refers to the extent to which the findings of a study are shaped by the respondents and not by research bias, motivation, or interest (Guba and Lincoln 1994). Miles et al. (2014) suggested that a key aspect of confirmability is the degree to which the researcher acknowledges their own biases. To address this, they suggest that the underpinning decisions made and methods adopted should be acknowledged within the research report. The reasons for using one approach over others should be explained, and weaknesses in the techniques used should also be discussed (Miles et al. 2014). This was implemented throughout the thesis when deciding on research design, data collection methods and data analysis. Confirmability can also be achieved through reflexivity and detailing the decision made starting from the development of the topic guide to data collection and analysis (Shenton 2004) (Appendix 17, 18).

6.8 Results and Discussion

6.8.1 Participants

Four online focus groups were conducted with 10 musicians: two musicians in each of two focus groups and three musicians in each of the other two focus groups. The ages of the participants ranged from 20 to 68 years, with the average age being 28.7 years. The participants comprised five female musicians, four male musicians and one non-binary musician. Four were self-employed musicians, five were students, one was a retired/self-employed musician. Table 6.2 provides a summary of the participants' characteristics.

Table 6.2: Participants' Characteristics

Focus group	Participant code	Age (years)	Gender	Type of employment
1	P1	68	Female	Retired/self-employed
	P2	32	Male	Self-employed orchestral musician and music teacher
2	P3	22	Female	Self-employed musician
	P4	23	Female	Student
	P5	25	Non-binary	Self-employed musician
3	P6	22	Male	Student
	P7	24	Male	Student
	P8	21	Female	Student
4	P9	20	Female	Student
	P10	30	Female	Self-employed classical musician and music teacher

6.8.2 Themes

The overarching theme of the analysis was “Opinions and views of musicians on developing a DHI for PRMSD self-management in musicians”. As outlined in Figure 6.2, six main themes were developed:

Theme 1: Barriers to PRMSD self-management.

Theme 2: Needs and Facilitators to PRMSD self-management.

Theme 3: Views on DHIs.

Theme 4: Design features of DHIs.

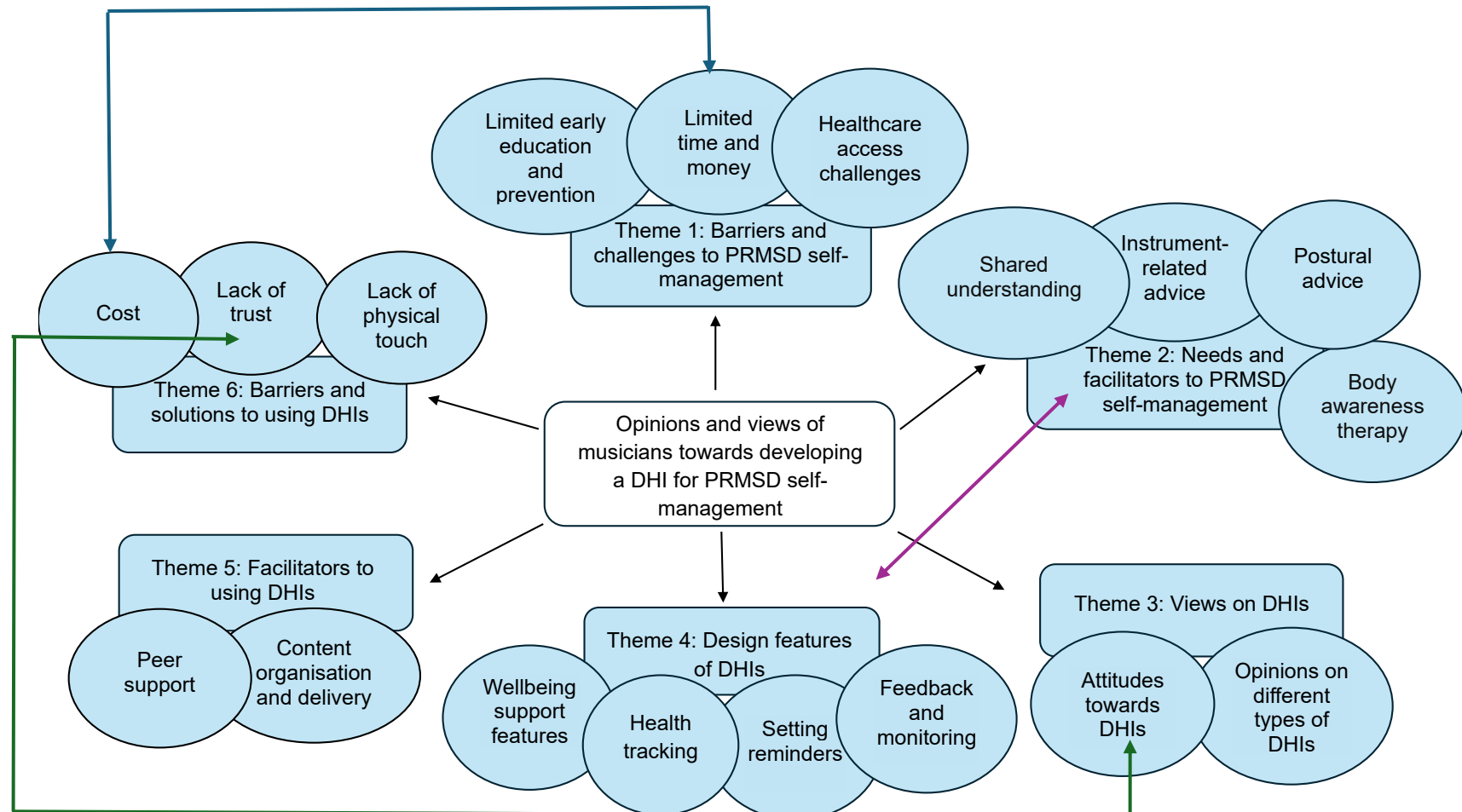
Theme 5: Facilitators to using DHIs.

Theme 6 Barriers and solutions to using DHIs.

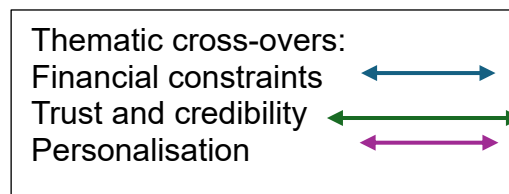
These themes were developed from 16 sub-themes, 13 main categories and 45 codes and subcodes developed from the qualitative data (Appendix 16). When a theme is discussed within this section, extracts from the focus groups are presented in blue.

Some changes were made to the extracts: for example, excessive information was deleted and replaced by "...". This approach was implemented to provide a concise and focused presentation of the qualitative data analysis findings (Braun and Clarke 2021b).

Figure 6.2: Thematic Map of Focus Group Results



Key: DHIs: Digital health interventions
PRMSDs: Playing-related musculoskeletal disorder



6.8.2.1 Theme 1: Barriers to Self-Management of Playing-related Musculoskeletal Disorders

This theme explores the challenges and barriers to PRMSD self-management that musicians encounter throughout their careers. The theme is divided into three subthemes: limited early education and prevention, limited time and money, and healthcare access barriers.

6.8.2.1.1 Subtheme 1: Limited Early Health Education and Prevention

Musicians often start their training at a young age, and because playing music relies heavily on muscle memory, long hours of practice are common. At this stage, teachers may shape the habits that musicians will follow in their career, as one participant discussed:

I was not fortunate, and I had a very bad piano teacher ... she was a very good pianist, but she wasn't a good teacher. And she didn't teach me how to relax when I played, just to keep practicing, and told me to sit still. No one told me what was right. So, even now if I play a lot of very fast passages, my hand gets tired, and I have permanent back pain now. (P1, focus group 1, retired / self-employed musician)

Another participant discussed similar issues by drawing from her experience as a music teacher:

I've seen this girl ... she came in for a lesson, and, like her chest, was like stuck out, and her head was down like this, and ... She's like only 6 ... and it's just very sad and annoying to see that, like there's not enough being done for

musicians at the start (P10, focus group 4, self-employed classical musician / music teacher).

Similar qualitative studies have indicated that music teachers often encourage overtraining, consider pain as a normal aspect of playing, and lack key knowledge about injury prevention and management (Guptill 2011; Ioannou and Altenmüller 2015; Rickert et al. 2015; Pecun et al. 2017). Although a previous qualitative study indicated that teachers may pass injury prevention principles on to their students, this may only be the case if the teachers themselves have experienced PRMSDs and have sought advice from healthcare professionals (Redmond and Tiernan 2001; Rickert et al. 2015). These teachers were more likely to teach optimal body mechanics and posture (Redmond and Tiernan 2001). However, the study found that there were significant gaps in musicians' health awareness regarding topics such as the importance of taking breaks, increasing practice load incrementally, and varying practice content (Redmond and Tiernan 2001).

The concerning aspect of limited emphasis on health awareness by teachers is that over-practicing and pain have become accepted as necessary steps in discovering one's physical limits. As one university student musician noted:

I think there's this culture of like you have to experience that (pain) to know your limit. There's some truth in that, like people have to figure out for themselves. But like we don't talk about it, and I think there's also not enough, like education or anything from universities to counter that (P9, focus group 4, student musician).

It is interesting that although the participant acknowledged the culture of over-practicing, they did not question it. In contrast, in another study, musicians viewed over-practicing as counterproductive, leading to burnout and higher risk of injuries (Pecen et al. 2017). This difference in opinion could be due to the sample in Pecen et al.'s (2017) study having an average age of 35 years, compared to the early-career musicians in this study, with an average age of 28.7 years. The first stage of a musician's career usually occurs between 20 and 30 years old, with fewer than 10 years of professional experience (Bennett and Hennekam 2018; López-Íñiguez and Bennett 2021). There is the challenge of establishing oneself in the profession and high competition for auditions, which may drive musicians to compensate by practicing for longer hours (Guptill 2011).

Furthermore, contrary to participant opinions, previous studies have shown that health education courses are widely implemented in UK music institutions (Matei and Ginsborg 2018). However, musicians' awareness of health risks and injury prevention remains inadequate (Matei and Ginsborg 2020). This may be because health education courses are often optional for musicians to attend (Wijsman and Ackermann 2019), which may limit their reach. Alternatively, as discussed in Chapters 2 and 4, it may be because education courses often focus on delivering theoretical information (Spahn et al. 2017; Bartos et al. 2022), while musicians prefer learning practical skills they can directly apply to their practice and performance routines (Matei and Ginsborg 2022). Another factor may be that current approaches to musician health primarily target individuals themselves, with limited attention given to addressing the organisational structures and institutional expectations that shape musicians' working conditions (Shoebridge and Osborne 2025). Several studies suggest that the broader

work environment has a more significant impact on musicians' health behaviours and outcomes than individual knowledge and skills (Oakman et al. 2018; Weale et al. 2022). This suggests that health education for musicians should combine practical skills with broader systemic changes to the cultural and institutional environments in which musicians learn and work.

6.8.2.1.2 Subtheme 2: Limited Time and Money

For the professional musicians in this study, transitioning into professional work introduced a range of struggles, including high performance demands and limited time and money:

The money's always a problem. So, we need to play most days, so usually if we play, for example, if we go for a week, we play one night and then we travel in the morning to the next place ... And if you do that for like 10, 14 or 20 days, that kills you, because you don't sleep very well, and everything hurts. And to be honest, you get to a point, you don't know where you are because you're just in another theatre. And there is no time to stretch or think about anything else (P2, focus group 1, self-employed orchestral musician / music teacher).

This account highlights multiple issues, including high performance demands, limited rest, and financial pressures, consistent with Shoebridge and Osborne's (2025) findings on the barriers to musicians' wellbeing. Musicians often feel compelled to continue working despite injuries, partly because of low pay and the lack of extended healthcare coverage, as also noted by Guptill (2011) and De Kock et al. (2023). This does not only affect physical health: Gross and Musgrave (2016) indicated that the

leading cause of mental health difficulties in professional musicians in the UK was financial and vocational precarity.

Alongside these financial difficulties, lack of time is consistently cited as a key barrier to musculoskeletal health management among professional musicians (Ackermann et al. 2012; Roos et al. 2021; Matei and Ginsborg 2022). For instance, 68% of orchestral musicians report skipping warm-ups or stretching due to time constraints: a practice directly associated with higher PRMSDs incidence (Ackermann et al. 2012). Touring further amplifies these issues by disrupting circadian rhythms; performances often run into late nights, followed by early departures (Arima et al. 2001). This pattern promotes sleep debt, a risk factor for musculoskeletal pain (Arima et al. 2001; Whale and Gooberman-Hill 2022) and creates a high-stress environment. Shoebridge and Osborne (2025) found that despite musicians' understanding of health practices, their ability to implement them is constrained by financial pressures, time limitations, and performance demands.

Such conditions can heighten susceptibility to emotional exhaustion and burnout (Maslach and Leiter 2016; WHO 2024). Although direct data on burnout in professional musicians are scarce, a cross-sectional study of over 300 conservatoire students in Australia, the UK, and Poland found that around 10% showed signs of burnout (Zabuska et al. 2018). The participants in Zabuska et al.'s (2018) study were conservatoire students, whereas the present focus groups included both students and professional musicians. This provides scope for comparison with student populations while also extending insights to early-career and established professionals.

6.8.2.1.3 Subtheme 3: Healthcare Accessibility Barriers

Despite these work demands, musicians face challenges in accessing appropriate care. The available healthcare support for musicians is very limited and often lacks specialised understanding, as one participant discussed:

In my case, well, when I went to the GP with back pain, they gave me medicines. That actually makes it worse because if you're not feeling the pain, then you carry on playing. That's just, and that's a very clear point where, well, the doctor didn't know what I'm actually doing, so I can't stop playing but I need to do something. So, what, what can I do? (P2, focus group 2, self-employed orchestral musician / music teacher).

Gaps in both the availability and suitability of health services have been identified as potential barriers to UK musicians getting the health support they need (Guptill 2011; Gross and Musgrave 2016). Austen (2020) suggested that without proper healthcare support, professional musicians risk exacerbating injuries, increasing sickness absence, and experiencing emotional distress, as one participant confirmed:

He (the physiotherapist) didn't understand what your hands mean to a musician. He bent my finger ... backwards ... and put it into a splint which hurt terribly badly. I cried all night with pain ... This went on for months. I went to a different hospital where they did the same thing, but more gently and I still can't move my finger (P1, focus group 1, retired / self-employed musician).

Resources like BAPAM aim to bridge the gap between musicians and the adequate health support they need by providing a directory of specialised private practitioners (BAPAM 2025). Despite this, musicians still face challenges, such as selecting the

right provider, and the high costs of treatment, which can range from £75 to £150 per session for private physiotherapy (Watson and Lowe 2024), as one participant discussed:

We have like a list of practitioners or clinicians, who, you know, have registered with us, who are licensed to do like all this stuff with us. But then, my wonder is like I have this huge list available to me. How do I pick that one person? And I think that's a tricky one to decide ... because cost is one thing. Time is another thing as well. We don't have the luxury of like money and time to try this one and ... maybe get another trial with another person. And yeah, I think that's one thing that I'm a little bit hesitant with, like going for physio ... So, I rather just be able to do it myself (P10, focus group 4, self-employed classical musician / music teacher).

Cost and financial pressures were discussed several times in this study; therefore, it is important to consider the context in which the research was conducted. The study was conducted between March 2023 and December 2023, and therefore, the financial challenges of the COVID-19 pandemic might have influenced participants' responses. Cohen and Ginsborg (2022) indicated that financial constraints have worsened after the pandemic due to higher competition and limited job opportunities. Surveys conducted by the Musicians' Union in 2020 and 2021 found that 90% of musicians reported that their work had been negatively affected by the pandemic, with average earnings losses since March 2020 amounting to £11,300 per musician. The live music sector saw revenues plummet by 81%, from £1.1 billion in 2019 to £200 million in 2020, and employment dropped by 35%, affecting approximately 65,000 jobs (Musicians' Union, 2021).

Subsequent studies in 2022 indicate that many musicians continued to earn less than before the pandemic (Musicians' Union and Help Musicians 2023; Cohen and Ginsborg 2022). The Musicians' Census which is the largest UK study including 5,867 musicians found that the average annual income from music work is £20,700 with 43% earning less than £14,000 a year from music, meaning many are left supplementing their income in other industries (Help Musicians and Musicians' Union 2023). While another report indicated that live performances have increased following the pandemic which could increase income, challenges remain, such as rising costs and difficulties with touring in the EU, which have negatively affected revenue recovery (Musicians' Union, 2021). Therefore, it is important to consider cost-effective solutions that could address these accessibility barriers while accommodating musicians' needs and constraints.

6.8.2.2 Theme 2: Needs and Facilitators for Self-Management of Playing-related Musculoskeletal Disorders

While musicians face significant barriers to PRMSD self-management, they also identified specific needs and facilitators that could help overcome these challenges. This theme explores the needs and facilitators to PRMSD self-management, with participants discussing three key subthemes: trust and shared understanding from healthcare professionals, personalisation (which includes instrument-related advice and postural advice), and body awareness techniques for reducing muscle tension during playing.

6.8.2.2.1 Subtheme 1: Shared Understanding from Healthcare Professionals

Four participants expressed trusting information from health professionals who understood the demands of musical performance, people who either played an instrument themselves or had experience working with musicians:

I've never had a good physio personally, but I would, whenever I get my information, I would always be, I'd be more receptive if a personally plays a similar instrument to me (P6, focus group 3, student musician).

One of the things I would know to look for now ... is someone who specialises in musicians, but, if that person actually plays an instrument themselves. That's even better because then they, they understand personally, you know So, he understands more than someone who doesn't play how terribly important, aside from earning your, your living, how important the love of music is and how terrible it is when it's taken away from you (P1, focus group 1, retired / self-employed musician).

So, I think maybe you don't need to be a musician, but you need to understand what we do. Or, or at least go with someone that's a musician and live the, the life of the musician rehearsing every day (P2, focus group 2, self-employed orchestral musician / music teacher).

These accounts highlight two important aspects: first, they emphasise musicians' deep emotional connection to their art, which extends beyond professional identity to encompass core elements of personal identity and wellbeing (Oakland et al. 2013; MacDonald et al. 2002). Participant P1's reference to "how terrible it is when it's taken

away from you" reflects research demonstrating that performance-related injuries can trigger significant psychological distress and identity crises among musicians (Zaza et al. 1998; Guptill 2011).

Secondly, they stress the importance of a shared understanding of musicians' careers and life. This aligns with broader research on specialised or elite populations in which domain-specific knowledge is crucial to establishing trust, tailoring treatment, and ensuring effective outcomes (López and Levy 2013; Pollard-Smith and Thompson 2017; Bolling et al. 2021). For instance, athletes frequently note that healthcare professionals who have either competed themselves or treated their sport in depth are better able to empathise, anticipate sport-specific barriers, and guide training modifications (López and Levy 2013). Similar trends appear in the dance medicine literature, where a practitioner's familiarity with choreography, dance terminology, and the unique physical demands of dance has been shown to foster greater rapport and improved injury management (Milan 1994; Motta-Valencia 2006; Weiss et al. 2008; Sabo 2013).

These findings can also be understood through the lens of Cultural Competence in Healthcare (Betancourt et al. 2002). This model emphasises that when healthcare professionals demonstrate an understanding of, and sensitivity to, the specific cultural context of their patients, they are better able to establish trust and effectively communicate treatment strategies (Betancourt et al. 2002). Research by Brandfonbrener (2003) and Chan and Ackermann (2014) further support this notion that musicians are more likely to adhere to treatment recommendations when healthcare providers demonstrate an understanding of performance constraints and adapt interventions accordingly.

6.8.2.2.2 Subtheme 2: Instrument-Related Advice

Participants also emphasised the importance of personalised advice that considers their specific instrument and playing technique. Five participants suggested the need for advice related to the type of instruments that they play given the varied physical demands:

I play mostly the clarinet and sax and he (another participant) percussion and I feel we probably have different places where we have pains. A lot of pains are kind of instrument-specific If there is very specific exercise that is applicable to ... let's say instrument groups, then I think it would be much more relatable and useful (P7, focus group 3, student musician).

Similarly, another participant suggested education about the different muscles being used:

“So, I think, maybe like learning about which muscles we need to strengthen, or we use for our instruments can help us understand how to move our bodies better” (P10, focus group 4, self-employed classical musician / music teacher).

These suggestions are consistent with the survey participants' suggestions for instrument-related advice from Chapter 5 (Section 5.4.5). The literature suggests that the type and severity of PRMSDs to which musicians are prone can be related to the type of instrument they play, as, for example, upper string instrumentalists tend to experience nerve compression syndromes in the neck and shoulders; while lower string instrumentalists tend to experience more pain in the lower back (Chapter 2 Section 2.5.2) (Kaufman-Cohen and Ratzon 2011). Therefore, instrument-related

advice may be relevant to include in PRMSD management, as advocated by several studies (Chan and Ackermann 2014; Stanhope et al. 2022a).

To further explore the effect of instrument-related exercises in violinists, Rousseau et al. (2021) compared scapular control exercises to general shoulder strengthening and found significant improvements in pain relief and functional ability in the former exercise group. This could be because scapular control exercises help to improve the stability and mobility of the shoulder girdle, which is important for supporting the instrument's weight and facilitating the movements required for bowing and fingering (Rousseau et al. 2021). However, limitations of the study are that Rousseau et al. (2021) included only twelve participants, assessed the immediate effects of the exercises without any follow-up, and relied on self-reported data from musicians. Self-reported data may introduce bias and inaccuracies in the results because musicians might have underreported or overreported their symptoms or adherence to exercise programmes, especially since no other objective data were reported (Hicks 2010).

Another study that aimed to investigate the effect of instrument-related exercises in violinists and ney players found significant improvements in pain and posture in both groups (Usgu et al. 2022). However, the study applied identical exercises to both groups, even though the violin (a string instrument) and the ney (a woodwind instrument) have different playing techniques and physical demands; therefore, the study's research design was inconsistent with its aim (Usgu et al. 2022). In addition, the study outlined a series of exercise approaches that were incorporated – for example, postural exercises, stretching exercises, and strengthening exercises – but did not specify the exercises that were used (Usgu et al. 2022). Given these results, it remains unclear whether instrument-related exercises are necessary or how such

interventions could be effectively implemented across varied instrument groups. Therefore, more robust evidence is needed to support the development of instrument-related exercises for musicians before it can be incorporated in a DHI.

6.8.2.2.3 Subtheme 3: Postural Advice

Beyond instrument-related considerations, postural advice emerged as another key aspect of personalisation. Three participants suggested postural advice:

“I play mostly the clarinet and sax and he (another participant) percussion and I feel we probably have different places where we have pains. A lot of pains are kind of instrument-specific If there is very specific exercise that is applicable to ... let's say instrument groups, then I think it would be much more relatable and useful” (P7, focus group 3, student musician).

“Posture – it seems very simple but just like learning how to sit straight and breathe while you play, that's very important for pain and injuries” (focus group 2, self-employed orchestral musician / music teacher).

However, another participant expressed a contrasting perspective by pointing out the potential drawbacks of rigid postural advice:

You know there's always the classic, sit up straight, and then you end up sticking your stomach out and curving your spine in, which then puts pressure to the like the bottom bit, which has been my whole issue with my back (P9, focus group 4, student musician).

All musicians are expected to maintain a straight spine for aesthetic purposes, although this may only be relevant for singers and woodwind instrumentalists (Nyman et al. 2007). This is because by keeping the spine straight and upright, the thoracic cavity remains open, allowing the lungs to expand freely, which is important for breath control and sound production (Watson 2009). However, there is no strong evidence supporting one optimal posture for all musicians or that maintaining a straight posture will prevent musculoskeletal pain (Slater et al. 2019). In fact, the current consensus is that maintaining a straight posture may be harmful advice for some people, leading to hypervigilance, anxiety, and a sense of failure (Slater et al. 2019).

Furthermore, there is no agreement between musician specialists or healthcare professionals about the ideal spinal posture for musicians (Spahn et al. 2014; Longo et al. 2020). For instance, Longo et al. (2020) suggested an erect position with aligned body axes, while Spahn et al. (2014) advocated for a symmetric standing posture with weight evenly distributed over both lower limbs. In contrast, a qualitative study exploring physiotherapists' perceptions of posture in the UK, the USA, and Canada favoured sitting postures that matched the natural shape of the spine and were comfortable and relaxed, without excessive muscle tone (O'Sullivan et al. 2012). Given that people have natural variations in spinal curvatures, postures can vary between individuals (Kent et al. 2015). Therefore, it may be more useful to explore different postures and movement patterns that feel natural and relaxed, rather than advising all musicians to maintain a straight posture (Slater et al. 2019; Stanhope et al. 2022a). One participant in the present study also expressed this opinion:

I think the most common thing is, can you stand up straight? Can you sit straight? Do you have good posture? And I find that's really annoying, because

there's no such thing as standing up straight. Like our spine is not straight, its curved in a natural way (P9, focus group 4, student musician).

6.8.2.2.4 Subtheme 3: Body Awareness Therapy

While advice on posture alignment was suggested by a few participants, all participants emphasised the importance of addressing muscle tension using body awareness therapies. These approaches aim to enhance bodily awareness and improve physical functioning through mindful attention to movement patterns (Klein et al. 2014). One of the most popular body awareness approaches among musicians is the Alexander Technique (Alexander 1932):

You know, there are methods out there like the Alexander Technique, which I just started to explore myself ... There's the body awareness, and noticing what feels wrong, essentially when you're playing but also the understanding of our bodies and like what muscles we're using on a daily basis (P9, focus group 4, student musician).

I know that comes with playing, but it's finding the things that you can do to release that tension and to relax a bit more. I think it's also that musicians tend to be quite tense people, anyway, because of the pressure you're under constantly. And to counter that ... I think ... body awareness, like the Alexander Technique and like body mapping is ... kind of meditative, and can also like, focus your mind before you play (P10, focus group 4, self-employed classical musician / music teacher).

The Alexander Technique focuses on improving movement and posture by teaching individuals to recognise and change habitual patterns of tension and misuse in their bodies (Alexander 1932). One of the main principles of this technique is that there is a tendency for the head and neck to be protracted from the centre of gravity (Alexander 1932). This is thought to create tension in the upper back and shoulders, and therefore, the aim of the Alexander Technique is to redistribute this postural tone from the neck to the rest of the body (Mozeiko 2011; Fung Ying et al. 2015; Wolf et al. 2017; Davies 2020). This is believed to potentially reduce tension in the rest of the body, and in turn, improve the quality of performance (Fung Ying et al. 2015).

However, the effectiveness of the Alexander Technique in redistributing postural tone has been questioned, with some researchers suggesting that evidence supporting this claim is limited or inconclusive (Klein et al. 2014). While some studies have reported benefits in terms of playing outcomes and the frequency and severity of PRMSDs (Mozeiko 2011; Fung Ying et al. 2015; Davies 2020), these studies included only student violinists and pianists, which limits the generalisability of the results to other musicians. Moreover, they lacked any validated tool or objective outcome measure and only reported mean scores and SDs, without any statistical analyses. Only Wolf et al. (2017) used electromyography and motion tracking to assess muscle activity and playing posture and found no significant changes in the activity of the splenius capitis, semispinalis capitis, and upper trapezius muscles after 10 weeks of Alexander Technique training.

Nonetheless, despite the limited evidence, the Alexander Technique is widely promoted in music institutions and by music teachers in the UK (Norton 2016). Given that some of the participants in this study were university students, their views may

have been influenced by the availability and promotion of the Alexander Technique within academic settings. Matei (2018) has cautioned against recommending treatments without sufficient empirical evidence, given the constraints of musicians' limited time and financial resources.

6.8.2.3 Theme 3: Views on Digital Health Interventions

This theme explores participants' perspectives on the use of DHI for PRMSD self-management. The theme is divided into two subthemes: attitudes toward DHIs and types of DHIs.

6.8.2.3.1 Subtheme 1: Attitudes towards Digital Health Interventions

Among the ten participants, one expressed reluctance towards using DHIs due to a lack of trust in online information:

I never went online. Maybe it's because I'm old, you know, I do not get it. There's so much rubbish ... My hands are so precious to me (P1, focus group 1, retired / self-employed musician).

Lack of trust toward technology in older age groups is a common barrier to DHI adoption and has been reported in several qualitative studies exploring DHIS for MSD self-management (Clohessy et al. 2024; Money et al. 2024). These trust issues are compounded by low digital literacy: a recent study conducted by Age UK (2023) found that 5,800,000 people aged 65 and over in the UK are either unable to use the internet safely and successfully or are not online at all. More than one in three people aged over 65 (4.7 million people) lack the basic skills to use the internet successfully (Age UK 2023). Approximately 2.3 million people aged 65 and over do not use the internet

at all, with almost half (48%) of these individuals being aged 75 or older (Age UK 2024).

Musicians often continue working well beyond retirement age (Oakland 2014), and both age and repetitive movements such as playing music are risk factors for arthritis (Barr and Barbe 2002; Anderson et al. 2011). Older musicians may have a higher risk of developing PRMSDs, and considering the participant's views, there may be a risk of digital exclusion. However, there is growing evidence that addressing digital exclusion might involve designing user-friendly interfaces. For example, Wildenbos et al. (2018) found that older patients preferred mobile applications with larger fonts and clear screens. Another potential alternative could be combined self-management and education programmes that provide interactive and ongoing access to peers, with trained facilitators or healthcare professionals often supporting them (Eaton et al. 2018).

However, most participants (9 out of 10) were receptive to using DIHs. These participants proposed a self-directed approach, initially attempting self-management techniques and then resorting to professional help if symptoms persist:

So, I think if there's something really bad, I think it's worth going to a physio. But overall, for most minor issues like aches and pains, having resources to help with that or make it easier would be very helpful (P6, focus group 3, student musician).

Another participant added:

Probably digital health will be the first choice for small things ... If you have an issue that's getting severe, you want to be able to have access to a professional (P7, focus group 3, student musician).

Unlike the participants' preference for self-directed approaches, previous research with MSD patients and healthcare professionals recommended initial professional consultations before using DHIs (Bennell 2021; Kelly et al. 2022). These initial consultations build rapport and empathy, enhancing trust, communication, and treatment adherence (Bennell 2021; Kelly et al. 2022). The discrepancy between these findings and this study might be due to differences in demographic characteristics. For instance, in Kelly et al. (2022), the average age of participants was 58 years while the average age in this study was 27.8 years. Multiple studies indicate that people under 45 years are more likely to select telehealth options when available (Polinski et al. 2016; Kruse et al. 2018; Jaffe et al. 2020; Garrett et al. 2022). Another possible reason is the flexibility of DHIs (Jaffe et al. 2020), cost concerns or previous negative experiences with healthcare professionals, as discussed in Section 6.6.2.1.

6.8.2.3.2 Subtheme 2: Types of Digital Health Interventions

While most participants were receptive to using DHIs in principle, they expressed different preferences about the specific type of technology. One participant was mainly interested in video consultations in situations where in-person care was not available:

I think the best, the best thing is ... one-to-one in person.... But if for any reason I can't, like, like you're saying, if, if, if I'm away ... and I don't know anyone in where I am, maybe a video call will be good also be, because then ... they can help me guide me better in that way ... just explaining how I'm feeling, where

I'm feeling the, the pain and ... I think that that, that that can work (P2, focus group 2, self-employed orchestral musician / music teacher).

This preference for video consultations aligns with findings from Kelly et al. (2024), who reported that participants preferred video consultations over other modalities, such as telephone consultations, because they felt video calls were more effective in replicating the experience of a face-to-face appointment. Participants in their study noted that video consultations allowed physiotherapists to observe their exercises, provide immediate feedback, and ensure exercises were performed correctly, similar to what the participant suggested.

Three participants felt that websites might be more intuitive, trustworthy and capable of providing more comprehensive information:

Probably, I feel like a website could be more intuitive. It's a really big thing on the app like to make. But I mean, if it was a really good app. If not, I probably trust the website more; it might give you more (P8, focus group 3, student musician).

These views are similar to previous studies that showed that users often perceive health websites as more credible than mHealth because of limited awareness of existing health applications and their functions and lack of healthcare provider recommendations (Peng et al. 2016). However, recent evidence suggests this trust gap is narrowing as health apps increasingly partner with healthcare institutions and established providers (Bhuyan et al. 2017; Zhao et al. 2018), with design factors and perceived usefulness emerging as stronger predictors of trust than platform type (Zhao et al. 2018). Six participants in the present study favoured mHealth because of its

personalisation, convenience, and ability to centralise resources, as one participant explained:

I think having a mobile app would be much more, I guess, personal to you and I think it would be much more accessible. You just open up your phone and you have it there (P4, focus group 2, student musician).

The participants also discussed the advantage of apps in consolidating relevant information in one place:

Yeah, because there's like, when it's just scattered on the Internet, there's, there's so much. So, yeah, if you had it like bookmarked in your app (P5, focus group 2, self-employed musician).

Similar to this study, Kelly et al. (2024) highlighted that using mHealth would be more accessible and facilitate better engagement with the programme. However, given the varied preferences expressed in this study, offering both a well-designed website and a complementary mobile app could allow users to choose the platform that best suits their needs (Kelly et al. 2024).

6.8.2.4 Theme 4: Design Features of Digital Health Interventions

Beyond their preferences for DHIs, the participants suggested several design features that would make DHIs more personalised and relevant to them, including well-being support features, health tracking, setting reminders, and feedback and monitoring.

6.8.2.4.1 Subtheme 1: Wellbeing Support Features

Two participants discussed how mental and emotional factors impact their physical symptoms and performance experiences:

Yeah, and also something that's been really crazy in my head recently has been this whole like the, the mental side of it. Because with the voice it's been like it actually can be partially psychological. Like the pain can be psychological and, and I guess like, I do lots of like, sort of meditations and things to try and help ... it's really becoming so prevalent how like psychological things, spiritual things are actually like linking to me (P4, focus group 2, student musician).

Similarly, another participant shared personal experiences of anxiety and stress affecting performance:

I was gonna add like the psychological thing of that definitely. I've had something recently where I, something happened at a gig that I was playing at and ever since then, sometimes I'll just choke up on stage (P5, focus group 2, self-employed musician).

These discussions indicate that musicians may be looking for more than physical rehabilitation; they are also in need of psychological support. A possible explanation for this is that mental health conditions are among the most prevalent issues affecting musicians (Kenny and Ackermann 2015; Perkins et al. 2017). A census of 5,867 professional musicians in the UK found that 30% reported having poor mental well-being, with musicians from marginalised communities being disproportionately impacted (Help Musicians and Musician' Union, 2023). Qualitative studies have also shown that musicians experience mental health conditions and performance anxiety that affect their well-being. For example, Roos et al. (2021) found that musicians struggle with mental health issues due to high expectations and a social environment within the musical community that discourages open communication about health

concerns. Despite this, access to mental health support has been limited due to increased pressure on healthcare systems and reduced availability of specialised services (Roy 2023).

In response to these challenges, three participants suggested incorporating wellbeing support features that could be incorporated into DHIs to address both physical and psychological aspects of musicians' health:

I think something like that can track your mood and track how you're feeling little affirmations and little stories and I think that would definitely be a big help cuz it just gets in your mind ... you're in the habit of ... receiving this kind of positivity and ... this drive to keep going (P4, focus group 2, student musician).

Motivational messages are widely implemented in DHIs for osteoarthritis and for promoting physical activity, with studies indicating significant improvements in outcomes such as adherence and self-management (Skrepnik et al. 2017; Nelligan et al. 2019). Grounded in the Social Cognitive Theory (Bandura 1998), these messages target self-efficacy by addressing personal factors (e.g., beliefs about capabilities), environmental cues (e.g., reminders to act), and behavioural strategies (e.g., problem-solving techniques). Similarly, qualitative studies indicate that mood-tracking applications promote self-monitoring and help people develop a greater understanding and awareness of their mood (Dubad et al. 2021). This increased awareness can help manage anxiety by identifying triggers and patterns in emotional states (Kauer et al. 2012; Schueller et al. 2021). However, most mood-tracking features ask users to enter their mood once per day and then develop feedback based on that (Schueller et al. 2021). Whereas in reality, people's moods fluctuate throughout the day and asking

them how they feel at one moment may not be relevant to showing patterns (Asscheman et al. 2021). Therefore, further research would be necessary to better support musicians in tracking their mood and also motivate them to use this feature regularly.

Another participant made a similar suggestion:

Like if there's a particular injury, someone's looking at these exercises for this injury and then they, there's an option just to hear about someone that recovered from it. Maybe it's someone notable, famous or even just like someone like us or something. I don't know how ... that could be really impactful (P5, focus group 2, self-employed musician).

Recovery stories, on the other hand, are the personal accounts of individuals who have experienced health challenges and either overcome them or made significant progress in their recovery (Sheens et al. 2016). According to the Transtheoretical Model of Change and the Social Cognitive Theory, when individuals hear about others who have successfully navigated behaviour changes, they identify with these stories, seeing parts of their own lives reflected in the narratives (Prochaska and Velicer 1997; Bandura 1998). This sense of connection can help people to realise that change is possible and that others have overcome similar challenges (social modelling), which helps them to progress through stages of change (e.g., contemplation to action) (Prochaska and Velicer 1997).

Recovery stories are widely used in mental health interventions, and qualitative studies have suggested themes such as feeling inspired, realising one is not alone, believing in the possibility of recovery, and de-stigmatising mental health conditions

(Llewellyn-Beardsley et al. 2022). Therefore, they may encourage conversations about musicians' injuries, which could help to shift the culture from one of silence to one of openness and support (Nurser et al. 2018). However, further research would be needed to address ethical issues, as research suggests that recovery stories may cause stress if participants perceive their own struggles to be greater than those portrayed in the stories (Nurser et al. 2018). There are also additional ethical issues, such as stories being shared beyond their intended scope, which could be problematic for musicians, given the culture of privacy and competition (Kaiser et al. 2020; Yeo et al. 2022).

6.8.2.4.2 Subtheme 2: Health tracking

Building on the need for psychological support, participants also valued features that could help monitor their health. Four participants discussed incorporating health tracking features in DHIs. One participant highlighted the value of reflective practice through guided prompts by sharing their experience with a previous DHI that incorporated health tracking features:

An app that I used to use ... It actually makes you think on your own like, ask 2 questions ... and it tracks it for you, which I found quite helpful, because sometimes all we need is to just reflect on our own what we did (P5, focus group 2, self-employed musician)

Another participant elaborated on how passive tracking technologies had helped them develop greater awareness of their health behaviours:

I've got an Apple Watch myself, and it's been quite interesting. Tracking my sleep, for example. That's just one thing that I like have never really counted if

I didn't have it. And if an app can tell you to do certain things, or say, 'Oh, maybe try this for this pain,' and it not just be so violin related, or whatever instrument you play ... you start thinking about your body not just related to your instrument, because I think musicians tend to think that the relationship with the instrument is almost too close in some ways ... But to kind of also do the things that you need to do outside of playing to be healthy (P9, focus group 4, student musician).

Musicians often develop a strong connection between their bodies and their instruments, leading to a complex relationship with their physical selves, where the body is viewed as an integral part of musical expression and technical skill (Kim 2020). Although musicians are becoming more aware of the importance of overall wellbeing and performance longevity (Shoebridge and Osborne 2025), recent research suggests that health tracking can uncover valuable health insights often missed in demanding routines. The use of smartwatches and other wearable technologies in healthcare has shown promising results for monitoring and predicting health outcomes (Köhler et al. 2024). Similarly, Merolli et al. (2022) found that the top three technologies used by people with MSDs were activity trackers (26.2%), logging/tracking health information on mobile apps or websites (11.7%), and entering information on a computer (12; 7.8%). Although implementation challenges remain as McGraw and Mandl (2021) cite privacy concerns and technical literacy as adoption barriers, while Piwek et al. (2016) note practical constraints including inadequate long-term behaviour change and variability in accuracy. Nevertheless, the findings suggest the importance and the need for broader health awareness among musicians.

6.8.2.4.3 Subtheme 3: Setting reminders

Another design feature that was suggested is setting reminders. Three participants discussed the potential benefits of receiving reminders to take breaks, as this is something they struggled to plan for in their routines. As one participant indicated:

We see one hour of practice time as just that — one hour to practise. It's not in our nature to split that time into smaller parts. So, if the app could handle things like giving reminders for me, I think it would be more tempting to use (P3, focus group 2, self-employed musician).

One participant suggested guidance on how to use breaks effectively:

I also think you know, if maybe what you could do in a break might be quite interesting, because I think often ... if I'm not in a very focused mood, and I take a break, I will probably break for longer than I need to and do something that is not very helpful, and more distracting than restful ... you know, instead of going on your phone, making like reminders to go on a walk or do an exercise (P9, focus group 4, student musician).

On the other hand, one participant expressed concerns about the potential negative impact of reminders:

Sometimes you know you miss a day or whatever and I feel I'm almost stressed with the process (receiving reminders) then if it was just you ... I know personally you get to the point you missed too many days and it's too much guilt (P7, focus group 3, student musician).

According to the Self-Regulation Theory, reminders can serve as prompts that help individuals to translate their intentions into actions, especially in environments where routine behaviours are challenging to maintain (Baumeister et al. 2007). In the context of the BCW, reminders promote the “Opportunity” component by providing environmental cues that support the desired behaviour change (Michie et al. 2011). Studies suggest that consistent exposure to well-designed reminders and actionable steps can reinforce behaviours over time (Lally et al. 2011).

However, the effectiveness of this approach depends on various factors, such as individual motivation, the relevance of the cues, and the stability of the environment (Pirolli et al. 2017). Previous qualitative studies that explored users’ perceptions of reminder systems in engaging them in exercises reported that they left them feeling overwhelmed, annoyed, and guilty (Damgaard and Gravert 2018; Grasaas et al. 2019). In these studies, the lack of personalisation in reminders, being daily, generic, and unchangeable might have contributed to negative user experiences and decreased engagement with the intervention (Grasaas et al. 2019). Similarly, musicians often have busy and unpredictable schedules, influenced by performance demands and creative processes (Arima et al. 2001). As one participant suggested, rigid reminder systems may not accommodate the variability in their routines, leading to frustration and disengagement (Grasaas et al. 2019). This suggests that there is a need for mechanisms within the design to allow users to personalise the frequency, timing, and content of reminders (Smyth and Heron 2016). This could promote their sense of control and reduce negative feelings associated with external pressures (Michie et al. 2013).

6.8.2.4.4 Subtheme 4: Feedback and Monitoring

Similar to reminders, four participants suggested incorporating feedback on their progress as a form of motivation:

I think you've followed the schedule that you're supposed to do and then at the end it shows a result of some data like saying it helps your body relieving in some way (P4, focus group 2, student musician).

Two participants suggested incorporating gamification elements such as progress trackers and mini games to provide feedback on performance:

Yeah, I think reminders or how those motivational apps work, they have a progress tracker or mini-games that is sort of fun. It gives you a drive to work on it and you know to keep going (P9, focus group 4, student musician).

Another participant proposed a financial reward system where users earn points through healthy activities and redeem them for tangible rewards like discounts:

So, I think it'll be quite satisfying to see it. You could maybe do like a reward system and I don't mean that in like I just mean I know I have this app where it's like it's basically to get you to do more active stuff, so if you, if, if you go for a walk or if you ride a bike, it adds up the minutes. It tracks it and then you get a certain amount of points; you get like 10% off a local shop (P7, focus group 3, student musician).

Incorporating feedback and monitoring features aligns with Bandura's concept of self-efficacy, where individuals' belief in their capabilities is reinforced through perceived

achievements (Bandura 1997). This is also consistent with the BCW model's emphasis on feedback on behaviour as a means to promote awareness of current habits and reinforce desired behaviours by providing recognition or rewards for progress (Michie et al. 2013). As some participants suggested, existing DHIs for MSDs, such as the NHS's getUBetter and Kaia Health, have included visual representations of progress, such as progress boards, graphs, and charts; however, they do not offer financial incentives (Kelders et al. 2012; Jain et al. 2021; Berry et al. 2022).

Behaviour economics suggests that financial incentives can bridge the intention-behaviour gap, which is a common issue in musicians' health research, as evidenced by high dropout rates in related studies (Chapter 2, Sections 2.6.3 and 2.6.4) (Baadjou et al. 2018). For example, Baadjou et al. (2018) conducted an RCT with a 69% dropout rate, where no incentives or persuasive tools were provided to promote motivation. In contrast, another RCT that included financial incentives to promote physical activity levels in older adults found significant benefits in physical activity (Brickwood et al. 2020).

Nonetheless, concerns exist regarding the extent and duration of financial rewards offered to participants (Boucher et al. 2021). Some researchers advocate for increasing incentives over time (Vlaev et al. 2019), while others suggest an escalating schedule until behaviours change occurs (Stitzer et al. 2010). However, it remains unclear whether behaviour change is maintained after incentives are removed (Paloyo et al. 2015). Research using activity trackers indicates that while incentives initially help to increase physical activity, these effects are not sustained once incentives are withdrawn (Brickwood et al. 2020).

According to recent research, 80% of musicians experience PRMSDs at least once in their careers, and these disorders can impact professional longevity and overall well-being (Rousseau et al. 2021); therefore, long-term self-management of PRMSDs is essential. Sustained behaviour change is often associated with intrinsic motivation, which arises from personal interest and internal satisfaction (Deci and Ryan 2008). This includes promoting positive beliefs and attitudes toward self-management, along with developing personally relevant goals and action plans (Michie et al. 2013). These features enable musicians to experience a sense of control over their own health management (autonomy), feel connected and supported by others (relatedness), and achieve mastery and effectiveness in managing their conditions (competence) (Deci and Ryan 2008).

6.8.2.5 Theme 5: Facilitators to using Digital Health Interventions

While the previous theme focused on specific design elements within DHIs, participants also identified broader facilitating factors that would encourage adoption and sustained use of these technologies. These facilitators are peer support and content organisation and delivery.

6.8.2.5.1 Subtheme 1: Peer Support

One participant suggested the need for an informal support network where musicians can connect, share experiences, and discuss their health challenges openly:

I don't know if apps are capable of like bringing people together, because I think a support network is really important, you know like Reddit, even if we're not talking to professionals but even like just talking to your peers, you know. And then sometimes we're like too worried to bring it (PRMSDs) out because we

don't know how it's gonna be perceived by other people and be like, oh, you're so weird (P10, focus group 4, self-employed classical musician / music teacher).

The participants' worries about being perceived as weird or facing judgment were also reported in another qualitative study exploring the lived experiences of musicians with PRMSDs (Guptill 2011). This stigma is reported to lead to feelings of isolation and disconnection from their musical peers and community, and to act as a barrier to seeking support and adhering to health prevention programmes, as discussed in Chapter 2, Section 2.5.3 (Guptill 2011; Rickert et al. 2014; Perkins et al. 2017). The participant suggested that support from other musicians with similar injuries could help to mitigate these feelings of isolation.

Consistent with this finding, three recent qualitative studies found that support from peers, managers, and conservatoire staff helped normalise discussions about injury prevention and health management and provided psychological benefits, such as increased self-efficacy and reduced anxiety related to health issues (Baadjou et al. 2021; Roos et al. 2021; Matei and Ginsborg 2022). Furthermore, Roos et al. (2021) found that group exercises and activities were more motivating for the professional musicians participating than individual implementation. These findings can be understood through Bandura's Social Learning Theory, which posits that individuals learn new behaviours by observing and imitating others, and that health information grounded in personal experiences is more engaging and less likely to be dismissed by end-users (Bandura 1977; Hinyard and Kreuter 2007).

However, in the context of peer support in DHIs, there may be a risk of health misinformation, cyberbullying, and conflicts between participants (Thomas et al. 2023), especially within the context of open and minimally moderated online platforms like Reddit. These concerns could potentially hinder progress and undermine the effectiveness of the intervention (Thomas et al. 2023). A previous study included healthcare professionals and research teams to monitor and moderate health information on social platforms (Taylor et al. 2006). However, online moderation is demanding, time consuming, and is considered the most significant intervention cost because of training requirements and supervision (Taylor et al. 2006). Further research would be needed to determine how social support platforms can be implemented in a cost-effective manner.

6.8.2.5.2 Subtheme 2: Content Organisation and Delivery

Beyond peer support, participants also emphasised the importance of having access to structured advice and different multimedia content. One participant suggested a catalogue of different conditions and methods of management:

I think having something like a catalogue maybe of, you know, like for example, if I have a flare up in my back and it's like you're saying it's really bad; have kind of like something for that stage and then you can continue having something that is for managing, I guess like the whole thing. But little, tiny, you know, exercises or something to help you on your journey I think would be, would be really helpful (P9, focus group 4, student musician).

Moreover, three participants discussed including different visual aids like videos and GIFs for their brevity, ease of use and retention of information:

I think definitely having the option to have a video, you know, like in, at some, at one point in like the app or the website, but also having like a GIF or something, you know, just like have the actual motion that is just quick, easy, accessible because a GIF is so quick (P3, focus group 2, self-employed musician).

I think having it on a phone with a video demonstration (referring to exercises) would be good because I've been to this physiotherapist before. They sometimes just draw you a diagram and then you just have to remember what they actually told you. Sometimes, the exercise you might be doing is just completely different after two weeks or maybe the pain comes back after a month or a year. You just don't remember what they told you (P6, focus group 3, student musician).

Taken together, the results indicate a preference for concise and accessible visual resources that deliver information without requiring extensive time investment, as reported in previous studies (Berry 2019; Blake et al. 2022; Kelly et al. 2024). It is important to address these preferences because the Technology Acceptance Model indicates that perceived usefulness and ease of use both directly and indirectly influences users' intentions to adopt new technology (Scherer et al. 2019). Direct influence occurs when individuals find an intervention easy to use, and thus develop a positive attitude toward it and are more likely to use it (Marangunić and Granić 2015). Indirect influence occurs when technology is perceived as easy to use and not time-consuming, thus making it appear more useful, increasing the likelihood of adoption (Marangunić and Granić 2015). However, the perceptions of usefulness can evolve over time and with technological advancements; therefore, the insights gathered from

this study may only be considered preliminary and require further exploration in future research (Taak et al. 2020). Despite identifying numerous facilitators, participants also discussed several barriers that might impede the adoption of DHIs for musicians, as discussed in the next theme.

6.8.2.6 Theme 6: Barriers to using Digital Health Interventions

The participants discussed three barriers to using DHIs: lack of trust, cost, and lack of physical contact.

6.8.2.6.1 Subtheme 1: Lack of Trust

All participants shared a common scepticism towards DHIs:

I think with an app, anyone can make an app really and I would be concerned whether it's ... I want to know where the information will come from. I would want to know whether it is sourced by medical professionals. I would want assurance (P5, focus group 2, self-employed musician).

Similarly, another participant discussed the risk associated with using DHIs:

Let's say I'm just someone who knows absolutely nothing, and I found this app on the app store. I would really question the reliability of it. I mean, I cannot afford to go online and use an app that might worsen things. I need to play and sometimes we're playing for six or seven hours a day. So, I need something that I can truly trust. I can't afford to experiment. It's too risky (P3, focus group 2, self-employed musician).

The participants' lack of trust in DHIs and online information may be relevant, given that previous systematic reviews that explored the quality of online information for MSDs on non-commercial websites, such as healthcare organisations' and universities' websites, found that they were inaccurate and inconsistent with recent evidence (Ferreira et al. 2019). Although systematic reviews that investigated the effect of DHIs on MSD and pain self-management did not report adverse effects, studies tended to focus on the benefits, rather than the negative impacts of these technologies, which makes it difficult to assess whether DHIs have had any adverse effects (Stevens et al. 2019; Hewitt et al. 2020).

To address these concerns, the participants suggested endorsements from trusted sources, such as music teachers and universities, to increase their trust in DHIs. One participant noted, "Probably I would just use it if my teacher recommended. I'd definitely check at least" (P4, focus group 2, student musician); while another added: "If the university recommended it as well, I say that would be really helpful" (P6, focus group 3, student musician).

It should be noted that the trusted source in this study contrasts with the typical reliance on endorsements from healthcare professionals such as GPs, and physiotherapists (O'Connor et al. 2016). This could be because of the lack of trust and poor experience with healthcare professionals (as discussed in Section 6.6.3.3), or their preference for a self-directed approach (Section 6.8.2.1.1), as one participant noted:

I think that ... if you had to ... be recommended it by a healthcare professional that it might be a bit counterintuitive because like, if I were to use it, I want to

use it to see if I should go to a healthcare professional (P8, focus group 3, student musician).

6.8.2.6.2 Subtheme 2: Lack of Physical Contact

Another barrier is the lack of physical contact, which was raised by two participants. One said:

My concern is it (DHIs) lacks that physical touch ... Sometimes, just the Alexander teacher can place a hand on your shoulder can make all the difference in how you feel (P9, focus group 4, student musician).

Both healthcare professionals and patients in previous studies also expressed challenges related to the limited non-verbal communication and impersonal nature of DHIs (Bennell et al. 2021; Kelly et al. 2024). They found it difficult to convey certain information and emotions effectively, leading to concerns about the quality of communication and treatment in DHIs (Malliaras et al. 2021; Barton et al. 2022). Conversely, DHIs may prompt the adoption of more active strategies such as exercise and education, which aligns with recent evidence and guidelines for managing MSDs (Malliaras et al. 2022; Bennell et al. 2021). This shift can empower individuals to take control of their health and well-being, leading to increased self-efficacy and independence in managing their conditions (Malliaras et al. 2022). This is consistent with best practice evidence for MSD self-management (NICE 2019).

6.8.2.6.3 Subtheme 3: Cost

Finally, cost emerged as a barrier, which was expected given the predominance of freelance work and the impact of the pandemic, as discussed in previous sections.

One participant highlighted a clear preference for free resources: “How much it would cost would be the only thing, yeah, if it's free ... I wouldn't see how you couldn't use it” (P3, focus group 2, self-employed musician). Meanwhile, another expressed reluctance towards ongoing financial commitments: “Yeah, like a yearly plan for those apps tends to put me off, but if it's a one-time purchase app then I find it more appealing” (P6, focus group 3, student musician).

Previous studies exploring the use of commercial health applications in the US found that nearly half of app users stopped using some health apps because of high data use and subscription costs (Krebs and Duncan 2015). Also, a survey study exploring the use of digital health apps in Chinese users found that one of the main barriers to using technology was cost, with 83% of patients stating that they would not be willing to pay to use health apps (Sun et al. 2020). According to the Technology Acceptance Model, cost is considered an external variable that can influence perceived usefulness and perceived ease of use (Scherer et al. 2019). The model suggests that even if a technology is easy to use and aligns well with user needs, the perceived financial burden associated with it can deter potential users (Scherer et al. 2019). Therefore, cost is a crucial barrier that needs to be addressed.

6.9 Thematic Cross-Overs

As outlined in the thematic analysis and in Figure 6.1, there are several crossovers between the themes and subthemes. Most notably, financial constraints emerge as a barrier across multiple themes, in Theme 1 (Barriers to PRMSDs self-management, Section 6.8.2.1) and in Theme 6 (Barriers and solutions to using DHIs, Section 6.8.2.6). Trust issues also cross several themes, appearing in Theme 2 (subtheme 1: Shared Understanding from Healthcare Professionals, Section 6.8.2.2.1), in Theme 3

(subtheme 3: Attitudes towards DHIs, Section 6.8.2.3.1) and in Theme 6 (subtheme 1: Lack of Trust, Section 6.8.2.6.1). This suggests that trust and credibility are important to musicians, whether dealing with healthcare professionals or DHIs. Furthermore, the importance of personalisation was discussed in Theme 2, as emphasis on instrument-specific and postural advice (Sections 6.8.2.2.2 and 6.8.2.2.3, respectively), and in Theme 4 (Section 6.8.2.4), within the discussion of design features for DHIs.

6.10 Strengths and Limitations

The use of the focus group method is a strength of this study, as it enables the sharing of views and thoughts based on the group's experiences; this generates new ideas, particularly when discussing a novel topic. All the participants were musicians with a broad range of experiences, from self-employed musicians to music teachers and student musicians. This is a strength, as it enriches the discussion through the diverse perspectives these participants bring. However, there are several limitations to consider. The study's small sample size of only ten participants, mostly in their twenties, might have influenced the outcomes. Younger people are generally more familiar with technology and may have more favourable views of DHIs. The small number of participants in each focus group might have further constrained the diversity of perspectives and limited opportunities for dynamic discussion. The online format might also have excluded individuals with limited digital literacy or poor access to technology. Therefore, the findings should be approached with caution, as they may not be representative of the wider population of musicians.

Furthermore, as with any qualitative research, there is a potential for researcher bias, particularly as the researcher is not a musician, and while this might have helped to prevent insider bias (Hicks 2010), it might also have limited the researcher's

understanding of the challenges musicians face. Nonetheless, several measures were undertaken to mitigate potential bias. The researcher included all opposing opinions, especially regarding DHIs. This ensured that the analysis remained grounded in the data and reflected participants' experiences and perspectives, as well as presented a balanced discussion, aligning with Braun and Clarke's (2021b) recommendations. In addition, the researcher maintained a reflexive diary throughout the data collection and analysis process and engaged in regular discussions with the project's supervisors to reflect on personal biases and influences that could affect the research.

6.11 Summary and Future Recommendations

This study explored musicians' opinions and views towards developing a DHI to support PRMSD self-management. Four focus groups were conducted to identify musicians' challenges, attitudes toward DHIs, intervention components, and concerns about design features, as well as the facilitators and barriers to DHIs for PRMSD self-management. The discussions in this focus group revolved around exploring strategies to help musicians maintain their ability to play. Musicians often begin their training at a young age, facing long hours of practice influenced by music teachers who might not adequately address the risks of PRMSDs or stress the importance of proper technique and injury prevention. Such early habits can lead to lifelong health issues, as suggested by musicians who recounted enduring pain from extensive practice sessions and inadequate early training. As professionals, musicians deal with demanding schedules and financial instability that exacerbates health risks, especially when touring, which disrupts sleep patterns and dietary habits. Access to healthcare is limited by cost, time, and insufficient healthcare knowledge about musicians' specific

needs. These contextual factors may shape their health needs and attitudes toward potential interventions.

Musicians suggested the need for personalised health education, such as instrument-related advice, posture recommendations and body awareness techniques to facilitate PRMSD self-management. They also expressed interest in DHIs while maintaining important concerns about their implementation. The key components discussed were wellbeing support features, health tracking, personalised reminders, and feedback systems. However, each proposed feature presents both opportunities and challenges, from recovery stories potentially causing stress to reminders becoming annoying and feedback systems potentially failing to promote long-term engagement. These dual effects highlight the importance of thoughtful design in DHIs to maximise their benefits while minimising the potential drawbacks.

Finally, several barriers and facilitators related to DHIs for PRMSD self-management were discussed. Facilitators included peer support, structured advice, and engaging multimedia content; while barriers centred on cost, distrust in technology, and absence of physical interaction. Professional endorsements and cost-effective development emerged as potential solutions to these challenges. Further research should include a more diverse age range of musicians, including mid-career and established professionals, to broaden the findings. In addition, as the results represent different views and perspectives, which at times are contradictory, further research is needed to better understand how these varying perspectives might influence the design and implementation of DHIs for PRMSD self-management.

Chapter 7: Phase 3 – Interview Study

Healthcare Professionals' Opinions and Views towards Developing a Digital Health Intervention to support Self-Management of Playing-Related Musculoskeletal Disorders in Musicians.

7.1 Introduction

In Chapters 5 and 6, the sequential explanatory study (Part 2) explored the key components, facilitators, barriers and concerns pertaining to the development of a DHI for PRMSD self-management from the perspectives of musicians with PRMSDs. While this helps to gain an understanding of the essential needs of musicians, further exploration is required to consider the perspectives of other relevant partners. Following the MRC framework, consideration of the insights and concerns of relevant partners, such as professionals who have prior experience in managing PRMSDs, is important to ensure a holistic and evidence-based approach to managing PRMSDs (O'Cathain et al. 2019; Skivington et al. 2021).

While no previous study has explored healthcare professionals' opinions on PRMSD management specifically, Matei and Phillips (2023) conducted interdisciplinary workshops with experts to identify systemic gaps in health education for conservatoire students in the UK. Their findings highlighted the critical role of integrating healthcare professionals' insights into institutional health strategies, as well as the need to address cultural barriers (e.g., no pain, no gain mindsets) and systemic issues (e.g., lack of teacher training) that perpetuate PRMSDs. However, the study mainly focused on conservatoire student musicians and the discussions covered general performance-related health topics (physical, psychological, and hearing loss) rather than focusing specifically on PRMSDs in instrumental musicians.

Furthermore, their research was focused on curriculum design and did not extend to behaviour change interventions or the development of practical interventions like DHIs. Finally, the majority of healthcare professionals in Matei and Phillip's (2023) study were psychologists, leaving gaps in perspectives from practitioners directly involved in PRMSD management, such as physiotherapists or occupational therapists. Therefore, this chapter presents Phase 3 of the thesis, which explores the opinions and views of healthcare professionals who are experienced in managing PRMSDs in musicians, including physiotherapists, occupational therapists, and Alexander Technique teachers, towards developing a DHI for PRMSD self-management in musicians.

7.2 Research Question, Aim and Objectives

7.2.1 Research Question

The research question for the interview study was as follows: **What are healthcare professionals' opinions and views towards developing a DHI for PRMSD self-management in musicians?**

7.2.2 Aim

The aim of this study was to explore healthcare professionals' opinions and views towards developing a DHI for PRMSD self-management in musicians.

7.2.3 Objectives

The objectives were to explore the views and opinions of healthcare professionals on the:

- Causes and self-management of PRMSDs in musicians.

- Key components, potential facilitators, concerns and solutions to developing DHIs for PRMSD self-management in musicians.

7.3 Study Design and Methods

As discussed in Chapter 6 (Section 6.3), both focus groups and interviews can be used to collect qualitative data at this stage (Skivington et al. 2021). However, focus groups are less suitable for heterogeneous groups of participants (Braun and Clarke 2013). The participants were healthcare professionals from different disciplines and were geographically dispersed both within and outside the UK. Silverman (2015) highlighted the importance of considering time and resource constraints when deciding between interviews and focus groups. Coordinating focus group discussions would have been logistically challenging and time-consuming: therefore, individual interviews were considered the most suitable method for this study.

There are three main approaches to conducting qualitative interviews: structured, semi-structured, and unstructured (Edwards and Holland 2013). The choice of approach depends on the research topic, participants' characteristics, and the researcher's skills (Edwards and Holland 2013; Lichtman 2013). Structured interviews, such as qualitative surveys, are widely used in positivist epistemological approaches (Edwards and Holland 2013). Their primary aim is to obtain objectively comparable information from a large number of participants, with data often subjected to statistical analysis (Edwards and Holland 2013). These interviews follow a predefined set of questions administered to all participants in the same manner and order, leaving little flexibility for the interviewer (Edwards and Holland 2013). While this ensures consistency, it limits the depth of exploration into participants' views and opinions,

which may lead to a superficial understanding of the research topic (Lichtman 2013; Leeming 2018). Given the niche focus and the exploratory aims of this study, structured interviews were considered inappropriate (DiCicco-Bloom and Crabtree 2006).

Unstructured interviews, by contrast, are open-ended and flexible, as they allow the interviewer to follow the participant's lead and explore emerging topics during the conversation (Edwards and Holland 2013). This can lead to variations in the topics covered and the depth of exploration achieved with each participant, potentially compromising the consistency of data collection across interviews (Brinkmann and Kvale 2015; Bryman 2016). Bryman (2016) cautioned that unstructured interviews are not suitable for studies requiring some degree of comparability across participants. This is because participants may provide information on different aspects of the research topic, making it challenging to identify common themes or patterns across the sample (Bryman 2016). Given these considerations, unstructured interviews were not considered appropriate for the present study.

Semi-structured interviews were chosen for this study, as they provide a balance between the need for comparability and the flexibility to explore participants' perspectives in depth (Patton 2002). Semi-structured interviews include a framework of predetermined questions while allowing the interviewer to probe more deeply into responses and adapt the conversation to topics that arise naturally (Patton 2002). This approach aligns well with the exploratory nature of the study, which aimed to gather detailed insights on a topic that had not been explored before (Bryman 2016).

The open-ended nature of the questions in semi-structured interviews enables participants to share their views without being constrained by predefined response options (Silverman 2015). Further, the flexibility of semi-structured interviews, such as reordering questions based on participants' responses, facilitates a more natural and engaging conversation (Bryman 2016). This adaptability helps to build rapport with participants by demonstrating active listening and genuine interest in their perspectives (Silverman 2015). The interviews for the present study were conducted online using Zoom technology because of the practical advantages discussed in Chapter 6 (Section 6.3).

7.3.1 Size and Number of Interviews

Interviews were conducted until an inductive thematic saturation point was achieved, which is the point where no new themes are discovered in the data (Saunders et al. 2018), as discussed in Chapter 6 (Section 6.3.2). As an outline, twelve interviews were considered appropriate, since previous studies indicated that the majority of studies reached saturation at an average of 12 to 13 interviews (Guest et al. 2006; Hennink and Kaiser 2022). This number was considered appropriate regardless of the type of saturation goal (codes, categories, or themes) or whether the sample was heterogeneous or homogenous (Hennink and Kaiser 2022). In this study, no new themes were identified by the tenth interview; however, two more interviews were conducted for further confirmation.

7.3.2 Sampling Method

Purposive convenience sampling was used to select participants for this study (Etikan et al. 2016). Within the framework of purposive sampling, various methods can be used to recruit participants, including typical, unique, maximum variation,

convenience, and snowball sampling (Holloway and Wheeler 2010; Merriam and Tisdell 2015). Participants were recruited through professional contacts via BAPAM (convenience sampling) and recommendations from participants who had already taken part in the study (snowball sampling). This enabled the researcher to include participants who had the necessary knowledge and experience to address the topic being investigated (Holloway and Wheeler 2010; Merriam and Tisdell 2015).

Although purposive sampling has drawbacks because it limits the generalisability of the data due to the potential bias of participant self-selection (Merriam and Tisdell 2015), it can be used when variations in the sample do not detract from the study's topic and when the primary aim is to gain in-depth understanding from participants with specific expertise rather than to achieve generalisable data (Patton 2002; Holloway and Wheeler 2010). The target group was similar in terms of professional experience in managing PRMSDs, and variations such as discipline or workplace were considered relevant to enriching the findings rather than detracting from the study's objectives. Furthermore, steps were taken to mitigate selection bias and ensure rigour, such as involving multiple researchers, documenting the selection process, triangulation to validate findings, and clearly defining the selection criteria, as discussed in Chapter 6, Section 6.7 (Guba and Lincoln 1994).

7.3.3 Eligibility Criteria

Given that this study aimed to gather the opinions of healthcare professionals about DHIs for PRMSD self-management, it was considered important to choose those who were most likely have sufficient clinical experience of PRMSDs. Eligible participants were clinically active healthcare professionals with at least two years' experience in treating musicians with PRMSDs. Healthcare professionals had to be currently

working within music-specific professional institutions (e.g., orchestras) or educational institutions (e.g., conservatoires). However, previous DHI experience was not required due to the novelty of the topic.

Participants were excluded if they were not registered with a UK or an internationally recognised professional body. This is because registration signifies adherence to ethical codes and professional conduct, which in turn ensures the credibility of the data collected (Health and Care Professionals' Council 2024). Participants were also excluded if they were unable to understand, read or write in English and if they had no access to email and/or Zoom online technology.

7.3.4 Recruitment

Participants were recruited through an online advertisement distributed by BAPAM (Appendix 19). The advertisement was disseminated as part of a newsletter to all BAPAM members and was promoted on BAPAM's X accounts throughout the study period, from July 2023 to December 2023. The advertisement directed potential participants to a brief description of the study's aims and objectives, a link to the Participant Information Sheet (Appendix 20), and an online form to leave their contact information if they were interested in the study or had any questions. Subsequently, the researcher contacted each participant via email to explain the research, address any questions, and confirm their eligibility (Appendix 21). Once this process was completed and participants had confirmed their interest in the study, they were asked to sign and return an e-consent form via email (Appendix 22). The interviews were scheduled according to the availability of the participants.

Potential participants who were identified based on recommendations from individuals already included in the study (i.e., snowball sampling) were contacted via email (Appendix 21). The email elaborated on the purpose of the study and extended an invitation to participate. The same eligibility and consent processes were followed. Participants who expressed their interest in the study were asked to sign and return an e-consent form via email (Appendix 22) and a convenient time and date was set for the interview.

7.3.5 Topic Guide

The topic guide was developed based on the findings of the survey and focus group discussions with the musicians, as well as discussions with the projects' supervisors. It comprised three main parts: the first part included introductory questions to establish participants' demographics, such as professional background, years of experience treating musicians, and views on the causes of PRMSDs in musicians. The second and third parts included questions on the management of PRMSDs. Four main topic areas were explored in detail: self-management advice they give to musicians with PRMSDs, whether they personalised treatment to individual musicians and how this was managed, advice on load and rest for playing music, and general well-being. The decision to explore these topics was based on the survey and focus group findings.

The questions then discussed the participants' views on using DHIs to facilitate these practices. The final part of the topic guide asked about their concerns regarding the use of DHIs and explored potential solutions. Prompts such as "Why do you think so?", "Could you explain more about it?" and "Can you tell me more?" were used throughout the interviews to further explore participants' responses, as required. Table 7.1 presents the interview topic guide.

Figure 7.1: Interview Topic Guide for Interviews with Healthcare Professionals

Section 1: Introductory questions	1) How long have you been treating musicians? 2) What percentage of your workload is related to treating musicians? 3) Have you used any form of digital health technology for management of musicians' musculoskeletal disorders? 4) In your experience, what are the common causes of musculoskeletal disorders in musicians?
Section 2a: Self-management of playing-related musculoskeletal disorders	5) Could you tell me more about the self-management advice you give to musicians? 6) Is your approach different when seeing a musician as opposed to an athlete or anyone from the general public?
Section 2b: Personalising treatment	In the survey and focus groups, musicians mentioned that they wanted tailored treatment plans based on the type of instrument they play. 7) Could you tell me more about how you make your musician client/patient management specific to their needs and capabilities? 8) What kinds of exercises do you find beneficial for management of musculoskeletal disorders? 9) What kinds of exercises do you find beneficial for prevention of musculoskeletal conditions? 10) How do you think digital health interventions can help in providing tailored treatments?
Section 2c: Advice on load and rest	In the survey and focus groups, musicians wanted to know more about how to manage their pain without suggesting stopping playing (which is not an option for a lot of people). 11) Is this something you came across in your practice, and if so, how do you manage it? 12) How do you think that digital health interventions can assist with this?
Section 2d: Role of general wellbeing	In the survey and focus groups, musicians suggested that monitoring factors such as mood, and mental health could be useful in improving their overall wellbeing. 13) What factors do you think are important for monitoring? 14) How do you think digital health interventions can assist with this?
Section 3: Facilitators, barriers and solutions to using digital health interventions	15) What do you think would be the facilitators and barriers to using digital health interventions? 16) What do you think could help to overcome these barriers?

7.3.6 Pilot Study

A pilot study was conducted with one physiotherapist who met the inclusion criteria. The participant had a master's degree in performance arts medicine and two years of clinical experience treating musicians with PRMSDs. The pilot study aimed to assess the clarity of the questions and determine whether any modifications were required. One question in Section 2b required modification, as the participant indicated that it was unclear. The original question was "What types of exercises do you find beneficial for musicians in managing and preventing PRMSDs?". Following discussions with the project's supervisors, it was noted that this question did not align with the general theme of personalising treatment to musicians. As a result, the question was divided into two questions: "What kinds of exercises do you find beneficial for PRMSD management?" and "What kinds of exercises do you find beneficial for PRMSD prevention?". As no further changes were required and the data collected were relevant to the research aim, the pilot interview data were included in the final analysis.

7.3.7 Data Collection and Processing

The researcher conducted the interviews in a quiet room to avoid any disruption and ensure clearance for the audio-recording. The researcher logged on 30 minutes before the scheduled time to check for and resolve any potential technical difficulties (Santhosh et al. 2021). Participants were required to wait to be admitted to the video call by the researcher, and once the participant had joined, the call was locked to prevent disruption. Initially, the researcher thanked the participant for their time and then provided a brief verbal overview of the aim of the entire project, the different study phases (i.e., survey and focus group studies), the results of these phases, and the aims and objectives of the interview study. A PowerPoint presentation (Appendix 23)

was used to facilitate this presentation. Following this, the participants were briefed on the interview ground rules, including confidentiality, the absence of right or wrong answers, and the right to terminate the interview at any time (Appendix 23). Verbal permission for audio recording was requested in addition to the written consent that had previously been obtained.

The topic guide was used to guide the conversation; however, the order of questions was adjusted based on responses to ensure that the interviews were more conversational and less rigid. This approach aligns with the recommendation of Irvine (2018), as it builds trust and rapport with the participants. The researcher gave sufficient time for each participant to answer the questions while also probing where necessary to clarify participants' responses. The researcher took notes during the interviews to facilitate conversation flow and address any additional questions or clarifications. These were addressed at the end of the interview and after exploring all topics within the interview guide, as suggested by Irvine (2018). At the end of the interview, the researcher asked the participants if they had anything else they would like to add or if they had any questions. Once the participants' queries had been addressed, the researcher thanked the participants for their time and contribution to the research.

The audio recording and transcription functions of Zoom technology were used to generate recordings and transcripts. The files were then downloaded onto the researcher's Cardiff University OneDrive account, which is accessible only with a username and password known to the researcher to ensure privacy and confidentiality (McMullin 2023). All recorded information and transcripts were then permanently deleted from Zoom Cloud. Automatic transcripts generated by Zoom were transferred

to a Microsoft Word document, cross-checked against the audio recording multiple times, and anonymised. Once the transcripts had been completed, they were emailed to participants for member checking. Only four participants responded, all of whom indicated that no further changes or clarification were required.

7.4 Ethical Considerations

7.4.1 Data Collection

Written informed consent was obtained from all participants prior to the interviews (Appendix 22). They were informed that all discussions would be audio recorded. Participants were asked to initial each box of the statements in the consent form to confirm that they had read and understood the information given and consented to taking part in the study. Prior to the recording, participants were informed that they were free to withdraw from the interview at any time without giving any reason and that if they chose to do so, their recording would be destroyed. They were also informed that their decision to withdraw from the interview would not affect their legal or medical rights.

7.4.2 Risk Assessment

It was not anticipated that there would be risks associated with participating in this study. However, participants were informed that they could refuse to discuss any topics that made them uncomfortable or that they simply did not want to discuss. Further, participants were directed to resources or services in the Participant Information Sheet (Appendix 20) and at the beginning of interview in case they were negatively affected in any way.

7.5 Data Analysis

As outlined in Chapter 6 (Section 6.6), RTA was undertaken using Braun and Clarke's (2021b) six step approach, which involves: 1) Familiarisation; 2) Data coding; 3) Generating initial themes; 4) Developing and reviewing themes; 5) Refining, defining and naming themes; and 6) Writing up. Both deductive (starting with a theory and testing it with data) and inductive (starting with observations and developing a theory) analysis was used (Braun and Clarke 2021b). A predominantly inductive approach was adopted, meaning that data were open-coded and respondent/data-based meanings were emphasised (Braun and Clarke 2021b; Byrne 2022). A degree of deductive analysis was employed to ensure that the open coding produced themes meaningful and relevant to the research questions (Braun and Clarke 2021b; Byrne 2022).

The data analysis and the groupings of codes and themes were facilitated by regular discussions with the supervision team. The researcher also kept a reflective diary throughout the data collection process and analysis, detailing thoughts before and after the interviews and discussions with supervisors, as well as during the data analysis. Extracts of the reflexive diary are provided in Appendix 24.

7.5.1 Phase 1 – Familiarisation

Transcripts were generated automatically using the transcription technology provided by Zoom. To ensure accuracy, the researcher cross-checked the generated transcripts against the corresponding audio recordings, taking notes of the laughs, emphasis, and pauses. Participants' names were replaced with pseudonyms to ensure anonymity. Any discrepancies or errors identified were corrected by listening to the audio

recordings and making the necessary adjustments. Each audio recording was carefully listened to three to five times to ensure familiarity with the data. Annotations and initial codes were then made physically around the transcript to capture relevant information. To facilitate the management of themes and codes, a Microsoft Word document featuring a table format that included the transcript and annotations/initial codes as two separate columns was created. An example of an interview transcript and initial codes is provided in Appendix 26.

7.5.2 Phase 2 – Data Coding

Each transcript was coded using a Word document to generate initial code ideas that addressed the research aims and objectives (Appendix 26). The data were coded semantically, which means that the aim was to present the data as communicated by the participants (Braun and Clarke 2021b; Byrne 2022). Another PhD student (AA) from the School of Healthcare Sciences, who had previous experience in qualitative research, assisted in coding one transcript and then compared their codes with those developed by the researcher. Analysis of the remaining transcripts was performed by the researcher alone, in conjunction with discussions with the project supervision team. All codes identified from each transcript were transferred to a Word Document with the participants' numbers to prevent any data loss or error.

7.5.3 Phase 3 – Generating Initial Themes

Once the entire dataset had been coded, the relevant segments corresponding to each code label were compiled for further analysis to generate shared meanings or themes based on their relevance to the research aims and objectives (Appendix 25) (Braun and Clarke 2021b). This was a cyclical process in which the researcher revised the transcripts and renamed the codes, if necessary, to obtain a more accurate

description. In addition, codes were merged or split when referring to similar or different themes. For example, the initial codes related to pain education and changing playing habits were merged into one theme related to intervention components.

7.5.4 Phase 4 – Developing and Reviewing Themes

The aim of this phase was to assess the fit of the provisional candidate themes to the data (Braun and Clarke 2021b). This included checking the coded texts for each theme and evaluating whether the coded data reflected the theme (Braun and Clarke 2021b). All themes and subthemes were then transferred onto a thematic map and discussed with the supervisors to refine and check the themes. Following the discussion, two original themes – ergonomic advice to musicians and opinions on instrument-related advice – were consolidated into a single theme, exploring all participants' opinions on providing personalised advice to musicians. Another change was that the elements of self-management and use of DHIs were initially considered as two separate themes; however, as the participants had varying opinions on using DHIs for each self-management element, it was considered best to discuss the element followed by its potential application in a DHI. Several subthemes were also refined during this process; for instance, "Mental Practice" was added as a distinct subtheme under Perspectives on wellbeing (Appendix 27). Similarly, "Balancing Load and Capacity" (Appendix 27) was refined to the more specific "Load Management" label.

7.5.5 Phase 5 – Refining, Defining and Naming Themes

Following a review of the final themes, the scope of each theme was clarified and refined and a descriptive and interpretative commentary of each theme was used for this task (Braun and Clarke 2021b). This phase involved selecting participant quotes that best illustrated the findings from the analysis, as well as naming the themes to clearly define their core meaning.

7.5.6 Phase 6 – Writing Up

This constituted the final phase of the analytic process of RTA where the findings were presented, incorporating quotations that capture the identified themes and subthemes (Braun and Clarke 2021b). Due to the iterative nature of RTA, this phase overlapped with phases 4 and 5, as the narrative analysis often revealed new connections between themes, requiring further review (Braun and Clarke 2021b).

7.6 Rigour and Quality

Adherence to standards of rigor is important in qualitative studies (Yadav 2022). Guba and Lincoln (1994) asserted that research must meet four criteria: credibility, transferability, dependability, and confirmability, as discussed in Chapter 6 (Section 6.7). To ensure credibility, member checking and data triangulation were conducted (Kornbluh 2015). Participants were asked to review their transcripts to ensure that their statements accurately reflected the intended meaning (Shenton 2004; Cypress 2017). However, there is conflict over whether member checks could enhance the accuracy of the research, as outlined in Chapter 6, Section 6.7.1 (Thomas 2017). Therefore, data triangulation across the three phases was included by discussing the results of the survey, focus groups, and interviews, as outlined in Chapter 8 (Section 8.3).

To establish dependability, one transcript was independently coded by another PhD student (AA), and discussions were held with supervisors throughout the data collection and data analysis stages to ensure rigor and accuracy. To ensure the transferability of the research, the data collection methods, analysis, and results are outlined in detail in this chapter. Confirmability was ensured by maintaining a reflexive diary to acknowledge the researcher's positions and thoughts after each interview and during data analysis (Appendix 24), as well as by documenting changes made to the topic guide between the pilot phase and data collection phase.

7.7 Results and Discussion

7.7.1 Participants

Twelve online interviews were conducted with ten females and two males. The sample included five physiotherapists, six Alexander Technique teachers, and one occupational therapist. The participants' clinical experience in treating musicians varied, ranging from a minimum of two years to a maximum of 36 years. The mean years of experience was 19.5 years, with a SD of 11.35 years. All the participants had experience of using Zoom technology. Two physiotherapists also used a mobile exercise application called Physitrack (<https://www.physitrack.com/en-gb>), and four Alexander Technique teachers used an Alexander Technique mHealth app called Think Up (<https://www.thinkup.nl/en/app/>). A summary of the participants' characteristics is provided in Table 7.2.

Table 7.1: Interview Participants

Participant	Location	Profession	Experience with musicians	% Workload with musicians	Practice	Experience with technology
P1	London	PT	2 years	1%	Private practice	Zoom Physitrack
P2	London	ATT	35 years	90%	RCM	Zoom Think Up app
P3	Manchester	PT	5 years	20-25%	Private practice	Zoom
P4	London	PT	10 years	80%	BAPAM clinic The Royal Ballet	Zoom Physitrack
P5	London	ATT	20 years	20%	Private practice	Zoom
P6	London	PT	36 years	80%	BAPAM clinic Guildhall school	Zoom
P7	London	OT	31 years	70-80%	RAM Private practice	Zoom
P8	Amsterdam	ATT	21 years	80%	Conservatorium van Amsterdam	Zoom Think Up app
P9	Birmingham	ATT	32 years	90%	RBC	Zoom Think Up app
P10	London	ATT	22 years	25%	RADA	Zoom Think Up app
P11	Cardiff	ATT	28 years	80%	RWCMD	Zoom
P12	Cardiff	PT	12 years	5%	Private practice RWCMD	Zoom

Key: DHIs: digital health intervention; PRMSD: playing-related musculoskeletal disorders; ATT: Alexander Technique teacher; OT: Occupational Therapist; PT: Physiotherapist; BAPAM: British Association of Performing Arts Medicine; RAM: The Royal Academy of Music; RBC: Royal Birmingham Conservatoire; RADA: Royal Academy of Dramatic Art; RWCMD: Royal Welsh College of Music and Drama

7.7.2 Themes

The overarching theme of the analysis was “Opinions and views of healthcare professionals on developing a DHI for PRMSD self-management in musicians”. As outlined in Figure 7.1, five main themes were developed:

Theme 1: Physical and psychological challenges facing musicians

Theme 2: Intervention components

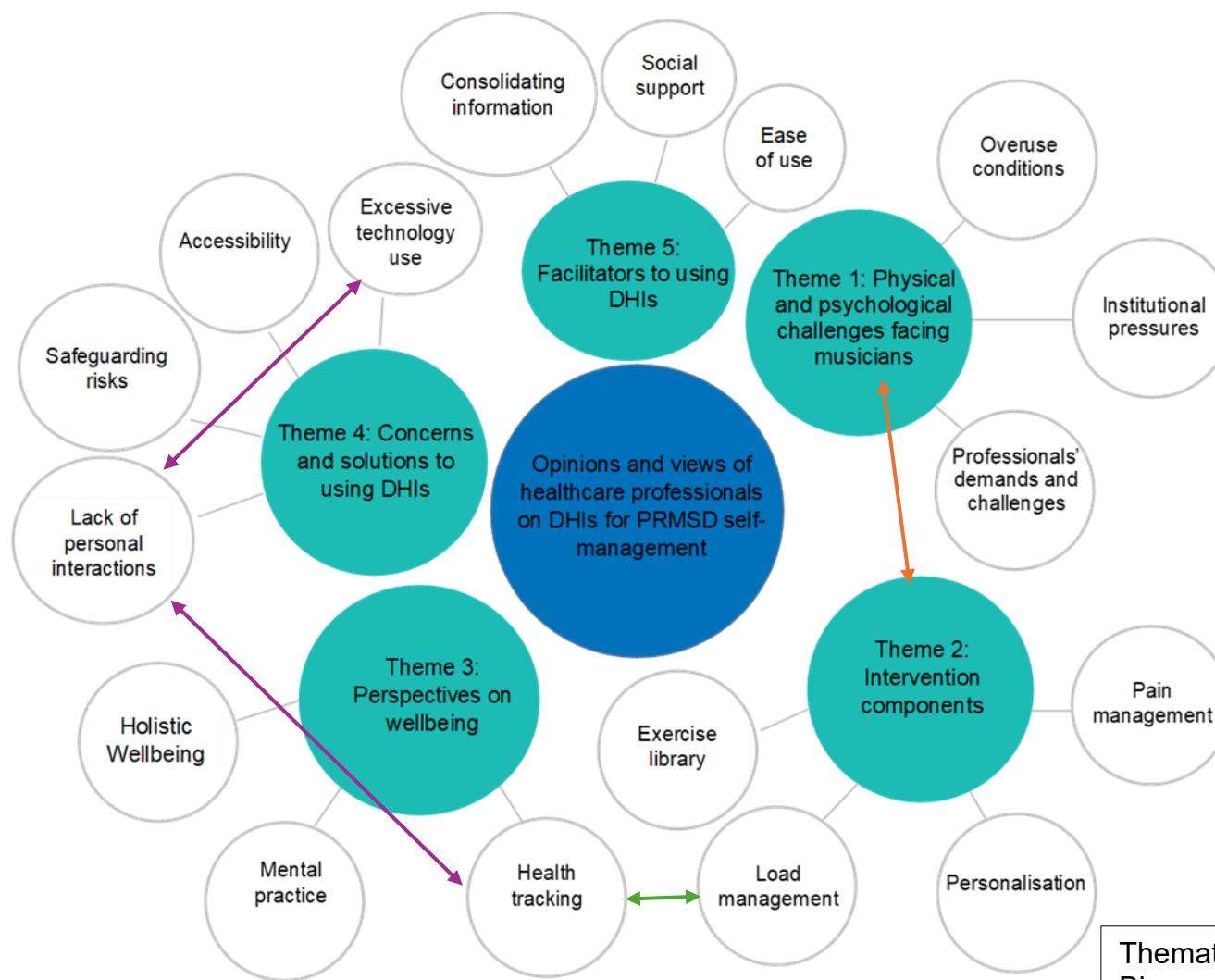
Theme 3: Perspectives on wellbeing

Theme 4: Concerns and solutions to using DHIs

Theme 5: Facilitators to using DHIs

These themes were developed from 15 subthemes and 40 codes and subcodes from the qualitative data (Appendix 25). The following section presents these themes in detail, supported by illustrative extracts from the qualitative data. The extracts are shown in blue, with some modifications, such as the deletion of excessive information, which is replaced by “...”. This approach was implemented to enhance clarity and improve the presentation of information for the reader (Braun and Clarke 2021b).

Figure 7.2: Thematic Map of Interview Results



Key: PRMSDs: Playing-related musculoskeletal disorders; DHIs: Digital health interventions

Thematic cross-overs:	
Biopsychosocial integration	↔
Load management	↔
Technology paradox	↔

7.7.2.1 Theme 1: Physical and Psychological Challenges Facing Musicians

The participants described a range of physical and psychological challenges impacting both professional and student musicians' health, mainly overuse conditions, institutional pressures, financial precarity, and social isolation.

7.7.2.1.1 Subtheme 1: Overuse Conditions

There was consensus between the participants that musicians commonly face overuse injuries such as tendonitis and repetitive strain injuries in the shoulders, wrists and hands, and that sudden increases in playing time may be a contributing factor:

The majority are overuse injuries, so tendonitis and muscle tension mainly in the upper limb, shoulders, wrists, hands. But the main trigger is a sudden increase in playing time. So, they've just set up a sort of cumulative pattern of overuse (P4, Physiotherapist).

Generally the ones that I see often have a change in their activity of their training and then they lead to having pain ... I have ... seen guitarists with a repetitive strain of forearm, drummer repetitive strain of shoulder, harpists repetitive strain (P1, Physiotherapist)

There's a trend of when they suddenly practice a new repertoire when they start school, and they have a change in the training load and then as a result they get pain (P11, Alexander Technique teacher).

These findings align with previous research on the impact of sudden increases in playing time (Buckley and Manchester 2006; Kok et al. 2018). Studies show that PRMSDs can increase dramatically from 28% to 80% after one week of intensive

rehearsals for classical musicians (9 hours daily) (Kok et al. 2018), while non-classical amateur musicians playing fewer hours (3.7 hours daily) experienced a smaller increase (19% to 44%) (Buckley and Manchester 2006). This contributes to the hypothesis that there is a gradual association between the amount of increase in playing burden and the resulting PRMSDs (Kok et al. 2018). Matei and Philips (2023) emphasised that music students should be taught about the negative consequences of excessive practicing and encouraged to gradually build their playing capacity over time, rather than an intensive short-term effort. However, Kok et al. (2018) found that the incidence of PRMSDs also correlated with anxiety, sleep deprivation, increased alcohol consumption and lack of warm-up exercises, suggesting that other factors may contribute to PRMSDs.

7.7.2.1.2 Subtheme 2: Institutional Pressures

Participants highlighted how educational settings may contribute to the multifactorial nature of PRMSDs through scheduling demands, cultural attitudes that devalue physical fitness, and an emphasis on practice volume over physical wellbeing:

There are other things like coming back into term time without spending a couple of weeks getting the body back into musical mode. That's not great. You have a holiday and then day one you come back in for whatever reason, there's a six-hour orchestra rehearsal. That's purely bad time management of the school, not the problem of the student (P6, Physiotherapist).

The conservatoires are deeply at fault. Along with these music schools, the secondary school ... where sport is treated with derision, and you know and felt to be not important. Fitness is not important and even seen as a risk that would

affect their technique and the concept of looking after themselves is not there, and the emphasis is on practise more. The only way you'll get better is to practise more (P7, Occupational Therapist).

These observations align with established research on conservatoire cultures (Perkins et al. 2017; Araújo et al. 2020) documenting how music institutions prioritise technical excellence over physical wellbeing. The abrupt scheduling described is related to Williamon and Thompson (2006) concept of performance loading – intensive demands without adequate physical preparation – which linked directly to increased injury risk in music students. Music students also receive far less injury prevention education compared to their counterparts in dance and sports (Rickert et al. 2015; Matei et al. 2018). One participant summed up this concern:

They don't think about their health enough, they don't think about working in the gym to get themselves strong. They don't think about those aerobics to get their heart, lungs, really fit. They don't think about eating at the right time of the day. They don't think about what they need nutritionally. They don't think about actually watering their body and keeping hydrated. They don't think about all the things that elite sports people do. And these are elite musicians (P2, Alexander Technique teacher).

The similarities between sportspeople and musicians include commencing training at a young age (Elbaum 1986; Quarrier 1993), practicing or performing daily, being highly competitive (Dick et al. 2013), requiring a high level of skill and physical capacity (e.g., endurance, coordination) (Quarrier 1993), practicing for many hours (Kreutz et al. 2009), playing through pain and being at high risk of career-threatening MSDs (Dick et al. 2013). Despite these similarities, sportspeople receive more training regarding

MSDs than musicians (Clark and Lisboa 2013), are aware of their MSD risk (Laberge and Ledoux 2011), and have access to specialised medical and healthcare support (Bennett and Grant 2004). The lack of adequate support in educational settings not only contributes to early physical and psychological challenges but also lays the basis for more complex issues as musicians transition into professional careers.

7.7.2.1.3 Subtheme 3: Professional Demands and Challenges

The participants discussed musicians' low locus of control, the pervasive culture of silence around musicians' injuries, and the psychological challenges musicians face. One participant noted the limited control musicians have under intense performance schedules:

Conductors can really put a lot of stress on musicians, you know they have to stand still and play for certain number of hours without taking any breaks ... I would say ... being under a huge amount of pressure and the music industry is tricky. It is difficult to get them to stop and notice their pain (P2, Alexander Technique teacher).

While there is limited research on the musician–conductor relationship and its impact on musicians' health, Miles (2020) and Moura and Serra (2021) reported that conductors' leadership style can influence anxiety. Leech-Wilkinson (2020) indicated in their qualitative study with musicians that the traditional hierarchical structure in orchestras can create power dynamics that affect musicians' wellbeing and creative fulfilment. As revealed in the interview data, conductors often maintain authority over interpretation and performance decisions due to time constraints, with musicians describing situations where conductors must simply dictate rather than consult (Leech-

Wilkinson 2020). This can leave musicians feeling restricted in their artistic expression and may contribute to psychological stress among orchestra musicians (Leech-Wilkinson 2020).

However, the main issue raised by the participants was musicians' limited control over their working conditions. Research on low locus of control suggests that when individuals feel powerless in high-demand settings, they become more prone to stress-related health problems and are less likely to engage in proactive self-care, which is essential in demanding professions (Gray-Stanley et al. 2010). Davies and Mangion (2002) found in a cross-sectional study that stress predicts both frequent pain over the previous year and chronic pain throughout a musician's career. Their multivariate analysis ($b=0.20$) also showed that musicians experiencing high stress levels and poor management of their work environment, including insufficient time for warm-up exercises before performances and inadequate breaks during long playing sessions, reported more severe pain.

This persistent lack of control and stressful environment appears to drive musicians toward unhealthy coping strategies, including substance use:

I'd say the major problem that I see is the lack of confidence and anxiety and the temptation of drugs, alcohol.... all of the this is completely different in the musician population to anyone else (P7, Occupational Therapist).

Research on psychological challenges in musicians supports the participants' observations about anxiety and lack of confidence (Chapter 2, Section 2.5.3). Music students experience significantly higher rates of performance anxiety than non-music university students, with 21-40% reporting severe or debilitating anxiety before

performances (Baxter 2020; Herman and Clark 2023). Furthermore, Ramatally (2021) reported in a mixed methods study a moderate positive correlation ($r = 0.39$) between imposter syndrome scores and the musicality levels of participants. The interview participants reported that feelings of self-doubt and low self-confidence often led to experiences of imposter syndrome, with many indicating that these feelings were accompanied by self-criticism, an extreme fear of failure, and a tendency to pass up opportunities due to doubts about their abilities. Although the study is limited by a small sample size (30 survey participants and three interview participants), the results align with previous research indicating that low self-confidence and imposter syndrome are prevalent among musicians (Sims 2017).

In response to these stressors, alcohol consumption may be a coping strategy. Help Musicians UK (2014) found that 45% of survey respondents reported alcohol-related problems, but as this study was a non-peer-reviewed survey, there was no information about its methodology, such as how questions were formulated, how data were collected, or how alcohol-related problems were defined. Therefore, it is difficult to evaluate the quality of the research. Butkovic and Dopudj's (2017) study of classical musicians, which found 21% expressing concerns about alcohol intake, also faces criticism for its failure to differentiate between recreational use and drinking in response to occupational stressors like performance anxiety. Whilst Kok et al. (2018) suggested that alcohol consumption might influence PRMSDs in amateur musicians, their cross-sectional design and poor measurement of alcohol use (lacking detailed dose–response analysis) probably contributed to their non-significant results. Therefore, the overall evidence regarding alcohol consumption is not strong; however, the high stress levels and psychological pressures in the music profession may drive musicians toward substance use as a coping mechanism (Kenny 2011).

7.7.2.2 Theme 2: Intervention Components

The multiple physical and psychological factors identified suggest the need for a comprehensive treatment approach. All the participants emphasised the importance of a biopsychosocial approach to pain management, personalisation of treatment, exercises, and effective load management; however, there were differences in how these components could be integrated into DHIs.

7.7.2.2.1 Subtheme 1: Pain Education

All participants emphasised the importance of taking a comprehensive approach to pain management, rather than considering only the physical demands of musical performance. This may include understanding the body and its movement, and how these may be affected by music playing:

I literally go through the skeleton, I go through the joints. I teach them about the six types of different joints so that they understand the hinge joints, a pivot joint, a sliding joint ... I talk about the soft tissue, so I don't go into great detail because there are so many, but certainly ligament, tendons, capsules, muscles, skin and how playing music may affect all this (P7, Occupational Therapist).

The same participant indicated that videos could facilitate this: “I think something like an interactive video would really help showcase this” (P7, Occupational Therapist).

However, several studies suggest that focusing on the anatomy and pathophysiology of pain without highlighting the potential for improvement through appropriate interventions can lead to fear and activity avoidance (Darlow et al. 2019; Richter et al. 2020). Individuals may misinterpret, or overly focus on, certain aspects of their condition, resulting in increased worry and avoidance of activities that could be

beneficial for their health and well-being (Darlow et al. 2019). Furthermore, information-focused videos are less effective in changing beliefs or promoting positive outcomes regarding pain (Moseley 2005; Egerton et al. 2022). Egerton et al. (2022) compared two videos for managing knee pain. The control video included information on anatomy, pathophysiology of knee osteoarthritis, and medical management. In contrast, the experimental video focused on promoting physical activity and overcoming barriers to healthy behaviours and was shown to be more effective in improving pain self-efficacy (Egerton et al. 2022).

Pain self-efficacy is defined as people's belief in their capability to function effectively despite experiencing pain, which is unlikely to be affected by information alone (Nicholas 2007). According to the intention–behaviour gap, individuals may have the knowledge and intention to change their behaviour, but struggle to translate this into action (Rhodes and de Bruijn 2013). A possible explanation is that individuals may face barriers, ranging from internal factors, such as lack of self-regulation or motivation, to external factors, such as environmental constraints or social influences (Michie et al. 2011; Rhodes and de Bruijn 2013). Therefore, interventions need to go beyond providing information and address barriers, habits, self-efficacy, and environmental factors that influence behaviour (Michie et al. 2011). This is consistent with what health experts have stressed in Matei and Philips' (2023) study exploring health education in conservatories.

One participant proposed the idea of using artificial intelligence to personalise pain education based on an individual's history:

So I would like an AI to kind of go right, what is your history and pain, and you go, what do you mean? What's your understanding of health? And then let's

educate you on that, because I think if people could educate themselves about why they could be going through pain and they understand that they are the expert in their own body (P12, Physiotherapist).

However, while several studies have shown that AI language models can provide easily accessible responses (Peng et al. 2022; Campbell et al. 2024), there are varying opinions on the level of personalisation offered by such models, and user satisfaction with these models remains limited (Kowatsch et al. 2018). Some programmes may have a restricted number of text characters, provide overly general information, or fail to differentiate between different types of pain, which may lead to misunderstanding or misinformation about pain management. This, in turn, could affect treatment decisions and outcomes (Hauser-Ulrich et al. 2020). Furthermore, it is important to note that studies that compared different pain education tools indicated that healthcare professionals are often the most effective and trusted source of pain education for people with musculoskeletal pain (Thompson et al. 2022). This might be because when individuals discuss their symptoms with healthcare professionals, they not only receive information, but also empathy and support, which can reduce pain-related anxiety and fear (Thompson et al. 2022). Therefore, it is unlikely that an AI-language model would be able to provide accurate and personalised pain education without additional supervision from healthcare professionals. The involvement of healthcare professionals in DHIs is often considered the most expensive aspect of implementation because of training needs, the time needed, and the resources required to interact with patients to monitor progress, as well as additional costs for compliance measures and patient data security and privacy (Cremers et al. 2021). Therefore, it is unlikely that an AI-based pain education model would be a feasible approach.

7.7.2.2.2 Subtheme 2: Personalisation

While understanding pain is important, addressing pain involves personalising treatments to individual musicians. All participants indicated that they would observe how musicians carry, transport and use their instruments and provide specific ergonomic advice accordingly, as one participant explained:

I'll definitely 100% watch the video of how they play because I don't play that instrument. I can kind of, from a physical lens, we know how the body works. We can advise around how the body works and how it might be helpful to do things differently and hold a different side to make it really tailored (P1, Physiotherapist).

However, all participants avoided overly specific instrument-related exercises, as they believed this approach could be too restrictive and might overlook individual differences:

So, I think, going into instruments and saying in a violinist, there'll probably be similarities as to why they got into it, how they got into it, the repetition, the skill set, their motor cortex, you know, if you scanned their brains, they'd probably be similar to the next violinist. But pain mechanisms, understanding their body, they'll all be a bit different. So, I think that it's dangerous (P11, Alexander Technique teacher).

Similarly, another participant added that the main focus when deciding upon the exercises prescription approach would be the patient and not the instrument they play:

I would always consider the needs of the person and not the type of instrument, so I treat them like a professional sports person, conditioning exercise if that's what they need, then yes, but if they don't need that, and endurance isn't a problem, but sensitisation and pain are a problem, then we focus a bit more on that, but I don't use any instrument-specific exercises (P6, Physiotherapist).

This contrasts with the findings from the survey (Chapter 5, Section 5.8.4, Table 5.10) and the focus group study (Chapter 5, Section 6.7.1), and with some suggestions in the wider literature, that musicians should be rehabilitated according to the instruments they play (Horvath 2003; Stanhope et al. 2022a; Matei and Phillips 2023). A possible explanation is that focusing on instrument-specific exercises could mean dealing with all musicians in the same way without considering each individual's specific physicality, playing style, psychological and mental wellbeing which can all affect health and wellbeing (Chapter 2) (Chan and Ackermann 2014). The participants' opinions reflect concepts from the biopsychosocial model, which indicates that the physical aspect of the condition may be necessary for its development, but it is not the only aspect that affects health (Engel 1977). In applying the biopsychosocial model to PRMSDs in musicians, biological factors include the physical demands of playing an instrument, such as posture, repetitive motions, and technical complexity, which can lead to musculoskeletal strain. Psychological factors encompass mental health aspects like stress, anxiety, motivation and individual pain perception, all of which can increase pain sensitivity (Engel 1977).

In dance medicine, dancers face similar physical demands and psychological pressures to musicians. Harrison et al. (2022) emphasised the need for interventions that include physical conditioning, psychological support, and consideration of the

social environment. Moreover, Koutedakis and Jamurtas (2004) demonstrated that dancers participating in programmes that combined physical training with psychological support showed significant improvements in both physical health and performance outcomes compared to those who received only physical training. Notably, neither study suggested utilising dance-specific exercise routines, despite including different types of dancers. Given this evidence from dance medicine, alongside the scarcity of holistic interventions for musicians, as discussed in Chapter 2 (Sections 2.6.4 and 2.6.5), and the lack of evidence for instrument-related exercises (Chapter 6, Section 6.7.1), adopting a holistic management approach appears to be more appropriate than focusing on instrument-related advice.

7.7.2.2.3 Subtheme 3: Load Management

Load management can also be considered a form of personalisation, as it involves assisting musicians to balance their individual workload with their physical capacity, as one participant suggested:

They need to continue playing as much as they are able to without interfering in the healing process or making things worse, because like if they don't play, they'll get so stressed about career, money and all that. So, I talk about kind of developing a strategy where they can work out what their current benchmark is in terms of how much they can comfortably play without exacerbating symptoms. Whether that's an hour or whether it's 5 minutes. And then we start to discuss how we can potentially build from that point, you know, gradually increasing, physical load with this kind of monitoring the response to the increase in the dose. I also ask them how they are feeling and all that because it is not only the physical aspect of playing (P4, Physiotherapist).

However, the body's capacity to tolerate load is influenced by numerous factors including age, comorbidities, previous injuries, and well-being factors such as sleep and stress levels (Impellizzeri et al. 2020). Given that these factors are diverse and personal, it is challenging to create a one-size-fits-all approach to load management and therefore, the process needs to be done under the guidance of an HCP, as one participant indicated:

One thing that musicians struggle with is that kind of structured process. It's a difficult process, it needs really to be done under the guidance of a Physio (P4, Physiotherapist).

Two participants proposed the use of mHealth to enable musicians to log their playing time and monitor symptoms like pain, fatigue, and perceived exertion. This could facilitate a gradual and controlled increase in playing capacity, as one participant suggested:

So, I think some kind of app diary where they can record their playing time and track their symptoms, their pain levels, or their fatigue levels, or their perceived exertion, or something like that, and then they can keep tracking their progress (P3, Physiotherapist).

Another participant also discussed a similar self-monitoring approach with an emphasis on the potential of data analytics to detect patterns and help users make informed adjustments to practice routines:

It could be an app or a timer that records details like 'I played today for 20 minutes, and I felt ... if I took breaks, like three breaks during a three-hour session, and I still felt a certain way', and the musician can record their pain

levels. The following week, whether it has increased or decreased, you would have this spreadsheet or log of your rehearsal progress to change or modify your practice (P12, Physiotherapist).

Digital self-monitoring tools can help individuals to understand their physical and mental wellbeing (Gaertner et al. 2004). However, a qualitative study of professional dancers (Harrison et al. 2022) shows that implementation is not straightforward. Using a wellness mobile app to track practice time, soreness location, and soreness intensity improved dancers' awareness of their training load, leading to more honest self-appraisals and a better balance between professional demands and health. However, some dancers found the daily recording of wellness scores to be a source of stress, especially when they had to acknowledge persistent discomfort or fatigue whilst still maintaining high performance levels (Harrison et al. 2022). The dancers reported avoidance as a coping mechanism by being dishonest about their scores or ignoring them (Harrison et al. 2022). This is also consistent with previous research that indicated that scoring symptoms daily could promote hyper-vigilance and psychological stress, with the potential to impact chronic pain conditions (Rollman et al. 2009). This is important to consider, as mental health issues are among the most prevalent conditions in musicians, as discussed in Chapters 2 and 6.

Another issue is that there is variability in users' satisfaction with these tools. Previous qualitative studies indicated that digital diaries were considered easier to use than traditional paper diaries and improved users' understanding of their loading capacity and its impact on their functions (Marceau et al. 2007; Jibb et al. 2020). However, other studies showed mixed results, with some suggesting lower user satisfaction with digital diaries (Gaertner et al. 2004; Morren et al. 2009). The different results may be because

some studies required individuals to complete multiple daily diaries, which can be inconvenient and burdensome (Morren et al. 2009). In turn, individuals missed questions and rushed through or skipped their diaries, which could have negatively affected the study outcomes (Morren et al. 2009). In contrast, in the studies that showed positive satisfaction with digital diaries, data were recorded once a day, and each time a participant logged on, they received a message from the study manager, generating the impression that someone cared about the information documented. Therefore, the design of these tools would need to be carefully considered to balance usability with convenience and ensure that users remain engaged and motivated.

7.7.2.2.4 Subtheme 4: Exercise Libraries

If workload can be balanced, incorporating physical exercises may further support musicians' musculoskeletal health. All the physiotherapists discussed the importance of strengthening, stretching and breathing exercises to prevent and manage PRMSDs:

Light load strengthening exercises something that they can do it every day ... so things like using shoulders just like having a theraband with them ... I think breath is really important and I might be very biased but when you're playing instrument if you are holding your breath your body gets tense, everything's different, so it's not gonna help with musculoskeletal conditions (P1, Physiotherapist).

As the above participant indicated, cardiovascular exercises have been recommended for musicians because it improves individual's stamina and improves breathing patterns (Khalsa et al. 2009). Previous research by Lee et al. (2013, 2019) on flautists and cellists found that combining yoga, deep breathing, and physical strengthening

exercises significantly improved physical strength, flexibility, and pain/discomfort in the neck, shoulders, and wrists, while also reducing muscle tension and enhancing mental wellbeing (Lee et al. 2019). Although the absence of a control group limits the ability to attribute changes solely to the intervention, validated measures like motion capture, submaximal strength tests, and the Physical-Musical Efficacy Survey were used to assess physical and performance-related outcomes (Lee et al. 2019). A systematic review and meta-analysis by Jiang et al. (2024) further supports the use of breathing exercises to reduce pain, assist with lumbar disabilities, and improve pulmonary function when paired with conditioning exercises. Therefore, combining breathing exercises with strengthening may similarly improve physical health, reduce muscle tension, and enhance musical performance.

However, the effectiveness of exercises depends on their consistent and appropriate implementation. Two participants suggested incorporating exercise videos with appropriate visual and auditory cues:

Maybe an app that can record the musician doing their exercise themselves and using that video of themselves as a practice or even an audio track of that recording ... like the internal external cues, and then the patient can just play the recording and then carry out the exercise as their own home training (P4, Physiotherapist).

Dynamic visualisations, such as exercise videos and digital tools, could be highly supportive in learning complex movement processes such as physical exercises. Previous studies have shown that personalised video exercise improved physical function and confidence in exercise performance and may have reduced care consumption, although the evidence was low due to bias arising from lack of blinding

(Davergne et al. 2023). Compared to written information, videos have significant advantages when providing motion and trajectory information (Mayer and Moreno 2002), making them a popular exercise instructional tool. This can be understood through the Social Cognitive Theory, which suggests that knowledge acquisition happens through observational learning and imitation (Bandura 1998).

7.7.2.3 Theme 3: Perspectives on Holistic Well-Being

Building on the intervention components discussed in the first theme, this theme explores the broader aspects of holistic well-being that influence musicians' health, and how these factors could be integrated into a DHI. The theme is divided into three subthemes: the role of mental practices in promoting physical and mental well-being in musicians, well-being factors, and the use of health tracking technology in supporting musicians' overall health.

7.7.2.3.1 Subtheme 1: Mental Practices

Mental practice is a cognitive technique used to enhance performance and skill acquisition without physical execution (Tramontana 2011). One participant suggested that it could be used to support musicians to maintain their playing skills without aggravating their physical health:

Depending on the severity of the pain, we'll either stop them completely and give them a break away ... if they have actually torn some fibres, which sometimes does happen, and they've got any sort of swelling or if they've got any really deep pain, they will stop. They will just stop. Maybe for a week – they don't like it, but we'll stop ... But I'm very much into mental practice and therefore I say, you can still practice, it's just not going to be doing it physically,

and it works because they can practice but without harming themselves (P6, Physiotherapist).

To date, it is unclear how mental practice works, but Frank et al. (2014) and Jackson et al. (2003) suggested that during mental practice, individuals create a mental representation of the movement in their mind, which activates the same neural pathways that would be involved in physically executing the task. Furthermore, Jackson et al. (2003) reported that the cerebellum was more activated at the beginning than in the late phase of motor learning. This increased activation may be because, as individuals progress in their skill acquisition, neural processes become more efficient; thus, the cerebellum's activity may decrease (Jackson et al. 2003; Doyon et al. 2003). Both changes are consistent with those observed for physical practice of the same motor task, which means that mental practice could help maintain performance skills during periods of reduced physical activity (Lotze and Halsband 2006).

Mental practice has been widely examined within sports psychology. A systematic review and meta-analysis of 36 studies found that while it is more effective than no practice, it is less effective than physical practice alone (Lindsay et al. 2023). Most of these studies involved novice athletes, who probably require physical training for foundational skills (Afrouzeh et al. 2013). In contrast, research on elite athletes demonstrates that mental practice can preserve or restore performance when physical practice is limited, such as during injury recovery (Guillot et al. 2013; Marshall and Gibson 2017; Lindsay et al. 2023). An RCT on elite athletes recovering from anterior cruciate ligament injuries found that those who engaged in mental imagery reported higher confidence and lower anxiety about returning to play (Lee 2020), with validated outcome measures supporting these reliable findings (Dupuis et al. 2023). These

benefits may extend to musicians, helping them to remain connected to their music and maintain performance skills during breaks from physical playing (Stanhope and Weinstein 2021).

7.7.2.3.2 Subtheme 2: Holistic Wellbeing

Whilst mind-body practices such as mental practice can help to maintain performance skills, it is also important to consider other factors that influence musicians' general well-being, such as nutrition, exercise and sleep, as discussed by all participants:

They need to be just sort of looking after themselves. They need to be eating and drinking sensibly. They need to be exercising. They need to be sleeping enough. They need to be, you know, doing all that sort of basic stuff, otherwise it's a battle (P10, Alexander Technique teacher).

Another participant elaborated:

Sleep and mood are something that I always ask and check in, because how you sleep affects your pain, and how we feel affects our pain. You know, physical and psychological aspects are inseparable within a person. So, if someone has a physical condition, they might be psychologically impacted in terms of fear, anxiety and worry. All of that will impact how you hold yourself, how you breathe, your pain levels, and how your brain, from a neural science point of view, whether your amygdala is hyper-activated or not, or even linked to your vagus tone (P1, Physiotherapist).

However, two participants expressed caution in giving advice on sleep given, the complexities of musicians' schedule and commitments:

I'm always incredibly careful, because if you start saying things like you really must make sure you get to bed earlier, they will say but I play gigs in the evening and then it's expected that I stay and have a beer ... And I think you lose them, you know I think, unless you demonstrate your understanding of the musician's lifestyle (P7, Occupational Therapist).

The participants' concerns about advising musicians to adhere to conventional sleep patterns which may not align with the reality of their professional obligations are relevant. Musicians have a higher prevalence of insomnia symptoms than the general public and other performing artists (Vaag et al. 2016a). This might be because musicians often have to balance daytime and evening work, as many are employed and freelancers, which could disrupt their sleep patterns (Vaag et al. 2016a). Constant travelling, touring, and late-night performance may further exacerbate this issue, as the focus group participants discussed in Chapter 6 (Vaag et al. 2016a). Previous research has also shown a link between irregular work hours, shift work, insomnia, and other sleep difficulties in musicians (Eldevik et al. 2013; Ursin et al. 2009). In addition, two qualitative studies found that as financial insecurity is a constant issue in this profession, socialising professionally, usually at night and after performance is important which could also affect sleep quality (Dobson 2011; Vaag et al. 2014). In this context, generalised recommendations (e.g., insisting on a traditional 8-hour sleep period) may not be feasible or effective which may explain why some participants did not think providing sleep recommendations would be appropriate.

Similar challenges have been observed in studies on sleep disorders among shift workers who share similar work patterns with musicians (Åkerstedt and Wright 2009). Research on shift workers has revealed a general lack of awareness about effective

sleep hygiene practices, which extend beyond the conventional advice of eight hours of sleep per night (Shriane et al. 2023). These practices include maintaining a consistent sleep schedule, avoiding daytime naps, and creating a conducive sleep environment which affect sleep quality (Shriane et al. 2023). This lack of knowledge may hinder opportunities for improvement, as behaviour change is based on knowledge, motivation, and the capacity to act (Michie et al. 2011). Although no studies have specifically explored sleep knowledge or practices among musicians, it is likely that there is limited awareness in this area given the high prevalence rates of insomnia (Vaag et al. 2016a) and that sleep was discussed in the focus group discussions within touring difficulties but not necessarily a health need or an issue that needs to be addressed (Chapter 6, Section 6.8.2.2). This suggests that in contrast to the participant's opinion, appropriate education is important to improve musicians' knowledge about sleep hygiene and its impact on overall well-being. However, it is also important to ensure that the advice is practical and relevant to musicians' schedules and challenges.

7.7.2.3.3 Subtheme 3: Health Tracking of Wellbeing Factors

Health tracking technology could assist musicians in managing well-being factors such as sleep and mood, as highlighted by four participants:

They (the Royal Ballet) use that kind of tracking and they've been really effective. How well the sleeping? ... What is your mood today? And track ... how much they're drinking, and all that kind of thing and they give them like tips, you know you need more water (P4, Physiotherapist).

Previous quantitative studies have indicated that tracking technology provides objective data and feedback that can help dancers to make informed decisions about their health and performance, which in turn helps them to adjust their routines and behaviours (Keay et al. 2021). Although no long-term benefits have been reported, qualitative studies have also indicated that health tracking promotes health awareness, allows users to set specific health goals, and tracks their progress over time, which are all positive steps towards behaviour change and health autonomy (Azodo et al. 2020). Despite these potential benefits, two participants expressed apprehension about reliance on external devices for self-monitoring, as it may lead to anxiety and affect an individual's ability to self-regulate and manage their health:

So, it's like they might just go into, 'Oh, God, you know I still haven't been able to eat well and sleep well. Oh, God, I'm a terrible human being', and I just made them feel more stressed (P12, Physiotherapist).

I think runners and everyone else are too fixed on these watches, which means, then you don't self-monitor, you're externally monitored, which becomes a problem because you take away that device, you start you, you lost, you panic

it. Your anxiety goes up. You haven't monitored to sleep. We need our bodies to self-regulate like they've done for centuries. While ... we're almost taking that capability away from ourselves, which I think I'm more scared about (P11, Alexander Technique teacher).

While the participants raised valid concerns, existing evidence provides a different perspective. One empirical study suggested that individuals with low conscientiousness or openness to experience were at greater risk of experiencing negative affect, such as anxiety or frustration, when using wearable trackers (Ryan et al. 2019). However, when prevented from wearing their devices, the pattern reversed, with most participants reporting stronger negative than positive affect, regardless of their level of conscientiousness (Ryan et al. 2019). This suggests that users may rely on their wearable devices for positive reinforcement or a sense of control over their health behaviours, contradicting the participants' views.

Moreover, Rose et al. (2019) indicated that musicians who have undergone formal music education tend to exhibit higher levels of conscientiousness than those who have not. This may be because formal music education is competitive and often involves structured goals and achievement standards (Rose et al. 2019; Bandi et al. 2023). Vaag et al. (2018) found that musicians scored significantly higher on openness to new experiences than the general workforce, after controlling for age, gender, marital status, and education through multivariable linear regression analysis. This may be related to the creative aspect of their profession (Vaag et al. 2018), which could imply that even if wearable trackers would cause anxiety and distress (Ryan et al. 2019), musicians might be better equipped to manage it. Therefore, while the participants raised valid concerns about the impact of health tracking, existing

evidence does not strongly support the idea that these tools reduce self-regulation or negatively affect psychological well-being.

7.7.2.4 Theme 4: Concerns and Solutions Regarding the Use of Digital Health Interventions

Building on the concerns of using health tracking devices, this theme explores additional challenges related to DHIs, including accessibility, lack of personal interactions, excessive reliance on technology, and safeguarding risks.

7.7.2.4.1 Subtheme 1: Accessibility

The participants' discussions' explored accessibility issues in different groups including neurodiverse individuals, and therefore, the need for inclusivity in technology design:

What particularly suits, you know, certain neurodivergent people because it really shows up in the music industry. Yeah, I think just taking into account, is this technology accessible to a diverse population as possible, in terms of, you know, language or images, accessibility of using it (P8, Alexander Technique teacher).

A recent survey study by the Association for Electronic Music (2022) found that 38% of musicians reported a clinical diagnosis of a neurodiverse condition. Although only electronic musicians were included in this study, which may limit the generalisability of the results, Dohn et al. (2015) found that musicians with perfect pitch exhibited a significantly higher degree of autism traits than musicians without perfect pitch and non-musicians. However, it is important to note that the total Autism-Spectrum Quotient scores of musicians were well below the clinical threshold for autism (Dohn

et al. 2015). This indicates that while there may be a higher incidence of certain traits associated with neurodiversity in musicians, this does not necessarily mean that it could cause accessibility issues (Dohn et al. 2015). However, given that 15-20% of the UK population is neurodivergent, ensuring cognitive and sensory accessibility remains an important consideration in the design of DHIs (Public Health Wales n.d). McKnight (2010) highlighted five key areas of digital design in neurodivergent individuals: providing structure, clear information, minimising distractions, encouraging praise, and rewards. Implementing these design features would ensure that DHIs are usable and beneficial for all users (McKnight 2010).

7.7.2.4.2 Subtheme 2: Excessive Technology Use

Another concern is the impact of excessive technology on the mental health of young musicians. One participant expressed this concern:

I mean the barrier is that there's just so many hours of it, kids are on computers, they're on mobiles, and it's just more of the same and ... and it's affecting their mental health (P3, Alexander Technique teacher).

Although a significant amount of research has been conducted on the association between screen time and mental health in recent years, the results have been mixed (Heffer et al. 2019). Positive associations between screen time and mental health problems, including depressive symptoms and suicidal ideation, have been reported (Twenge et al. 2018). However, these associations were based on cross-sectional data and have been subject to criticism based on other methodological concerns, such as issues with their measures of screen time (Heffer et al. 2019). For example, the outcome measure used by Twenge et al. (2018) was too general, as they did not ask

participants how many hours or minutes they spent on social media, but only how often they used it (e.g., “Almost every day”). Since the p-value was not provided, the statistical significance of this correlation cannot be confirmed, and the small magnitude suggests that the association was minimal. As Field (2013) explains, correlation coefficients range from -1 to $+1$, with values close to zero indicating little to no linear relationship.

Longitudinal studies may provide more robust data because they can examine correlations over time (Hicks 2010). A narrative synthesis of longitudinal studies found that the magnitude of the relationship between screen time and mental health conditions was also small to very small in size ($R = 0.10$) (Tang et al. 2021). Therefore, in contrast to the participants’ views, there is insufficient evidence to suggest that increased screen time through DHIs adversely affects mental health. Instead, DHIs may offer a beneficial form of screen time when used appropriately (Tang et al. 2021).

7.7.2.4.3 Subtheme 3: Lack of Personal Interactions

Another concern raised was the lack of personal interactions associated with DHIs. Although during the COVID-19 pandemic, all the Alexander Technique teachers in this study delivered online lessons using Zoom technology, with some also encouraging their patients to use Think Up, an Alexander Technique mHealth app, five teachers indicated that these digital tools were effective for students who had previously participated in face-to-face sessions:

But it [Zoom classes] was particularly effective with those who'd had hands-on work from me, because I think then they were able to remember ... The students that hadn't had any hands on, it was really limited. Yeah, it's less likely

that they will get there without help to begin with (P9, Alexander Technique teacher).

The Alexander Technique uses hands-on guidance to help improve self-awareness and posture, which may be why teachers were concerned about the lack of physical touch (Alexander 1932). Nonetheless, the Alexander Technique, in principle, is based on self-observation to prevent and reduce the problems caused by unhealthy habits (Alexander 1932). Therefore, while in-person guided instructions may initially aid in promoting understanding; the success of these methods relies on the individual's ability to remember and apply these principles, which is related to self-management (Pendenza 2023). This is corroborated by the findings of Tarr (2011), who suggested that excessive guidance from instructors could lead to dependency on the instructor and hinder students' independent learning skills. Consequently, one teacher highlighted that online delivery may have helped promoting self-awareness and understanding by requiring students to rely on their own cognitive processes:

It was interesting because during COVID, I had to start teaching online: it's the only way I could do it. And to start with, I thought, this is going to be ridiculous. How can I do this work online? And I realised that actually, it was having a useful impact, and the really big reason was that I couldn't make them feel better by putting my hands on them and being there, they had to do the thinking (P5, Alexander Technique teacher).

Nevertheless, it is important to note that the lack of personal interactions may have implications beyond specific treatment approaches. As two physiotherapists highlighted that while DHIs can be beneficial for managing certain symptoms and

behaviours, therapeutic conversations would still be needed to provide psychological support:

I think the technology might help about mechanical and the certain behaviour but the psychological aspect I'm not really sure how you can deliver that through an app that therapeutic conversation that therapeutic chats (P1, Physiotherapist).

Both patients and clinicians argue that DHIs cannot substitute for the trust, empathy and mutual understanding fostered by in person interactions, which are key components of Bordin's (1979) therapeutic alliance theory that underpins treatment adherence and outcomes. This limitation is particularly relevant for musicians with PRMSDs, who report feeling abandoned after initial treatment due to poor follow-up communication (Guptill 2011; Pecun et al. 2017). While DHIs such as eHealth diaries initially show high engagement (Sloots et al. 2021), adherence typically decreases without ongoing support. This pattern mirrors the low compliance (under 50%) observed in face-to-face PRMSD interventions where feedback and monitoring are lacking (Stanhope et al. 2022a)

The evidence from existing systematic reviews indicates that supported self-management approaches can help to overcome the limitations associated with DHIs by providing regular follow-ups, personalised feedback, and promotion of peer support networks (Babatunde et al. 2023). This could take the form of blended care models which combine digital interventions with in-person sessions (Andersson and Titov 2014). However, the overall effectiveness of supported-self-management methods compared to other management models is still under investigation and there is no evidence that it is associated with improved health outcomes (Babatunde et al. 2023).

Nonetheless, there is evidence of increased patient satisfaction and improved engagement following supported self-management interventions, which are compelling reasons to continue exploring and refining these approaches (Healey et al. 2023).

7.7.2.4.4 Subtheme 4: Safeguarding Risks

Building on the concerns regarding the lack of personal interactions, four participants expressed concerns about the risks associated with the absence of direct supervision and personal engagement. One participant explained that safeguarding may be required for musicians with injuries:

Safeguarding, safety netting is going to be a key issue, making sure that you know you're not sending off someone off with kind of going to do some exercises that could injure them, or that they don't understand. So that I think that's a key factor, how do we safeguard them to use this technology safely, you know, and effectively ... if musicians that are injured or in pain are using this. If it's healthy musicians who've got no injuries, then I think obviously there's less of a need. But certainly, if you're dealing with musicians in pain. I think some kind of monitoring would be a good idea (P4, Physiotherapist).

Another participant discussed the importance of professional oversight in DHIs due to the varied health needs of users:

I think technology is great, but I think it needs to be managed by a professional. I'm going to say that if you've got this out there, ... You're not going to have one nice programme. You're probably going to have about half a dozen programmes. And that would be the problem whether they are chronic, acute

whether they are student musician or professional musicians (P6, Physiotherapist).

Contrary to these concerns, previous systematic reviews have not identified adverse effects from using DHIs for the self-management of MSDs or chronic pain (Moman et al. 2019; Proper and van Oostrom 2019; Hewitt et al. 2020; Mesa-Castrillon et al. 2024). However, studies tend to focus on the benefits, rather than the negative impacts, of these technologies, making it difficult to assess whether there are any adverse effects (Stevens et al. 2019). It is also possible that musicians may suffer from additional risks, since in a systematic review, Stanhope et al. (2022a) found that 18% of participants experienced a negative impact on their instrument playing performance after exercises. This negative impact could be attributed to various factors, such as discomfort or pain caused by the exercises and changes in pressure sensations in the fingers, affecting instrument handling (Andersen et al. 2017). While this may seem modest, even minor performance setbacks can jeopardise a musician's ability to practice, perform, or earn an income (Andersen et al. 2017). Therefore, it is essential to involve healthcare professionals in the development and oversight of DHIs, both to ensure safe, effective use and to provide the ongoing support for long-term self-management and adherence.

7.7.2.5 Theme 5: Facilitators to using Digital Health Interventions

Similar to the results outlined in Chapter 6, one participant in this study also emphasised that ease of use and consolidating information into relevant chapters could mitigate some of the concerns previously discussed.

It's got to be easy, easily accessible to all ages ... I quite like my idea of chapters like a book and every chapter opens with maybe holistic approach to health care (P3, Physiotherapist).

Furthermore, two participants suggested including a social network of both musicians and healthcare professionals to help reduce isolation and improve musicians' overall wellbeing:

Maybe even having support groups or some events that the app whether online or offline based on your area or whatever way you can. You know, go for these talks or meet each other.... or just a social event or make friends. Make musician friends around you, that kind of a thing. So, it's not only working on their health but also their social well-being.... because they are lonely (P3, Physiotherapist).

Social support is considered a key factor in determining musical success, achievement and overall wellbeing (Orejudo et al. 2021; Barbeau et al. 2024). Matei and Ginsborg (2022), in their qualitative evaluation of a health education programme, found that students specifically requested more interaction with peers who could provide support. Building on this concept, Matei and Philips (2023) emphasised several key benefits of social support: the value of informal discussion sessions, enhanced communication and solidarity among students and destigmatising health issues while maintaining appropriate privacy. This is similar to the suggestions in Chapter 6 (Section 6.8.2.5.1) that having a supportive network can help musicians to self-manage PRMSDs.

7.8 Thematic Crossovers

As outlined in Figure 7.1, several crossovers exist between the themes and subthemes. The biopsychosocial approach is evident in both Theme 1 (Physical and Psychological Challenges Facing Musicians, Section 7.7.2.1) and Theme 2 (Intervention Components, Section 7.7.2.2), as the multiple factors identified in Theme 1 are addressed by the intervention strategies described in Theme 2. For example, discussions of injuries from overload and sudden injuries (Theme 1, Subtheme 1, Section 7.7.2.1.1) relate directly to the importance of load management (Theme 2, Subtheme 3, Section 7.7.2.2.3) and the use of health tracking to manage practice time (Theme 3, Subtheme 3, Section 7.7.2.3.2). Additionally, there is a cross-over between Theme 3, Subtheme 3 (Health Tracking of Wellbeing Factors, Section 7.7.2.3.2) and Theme 4, Subthemes 2 and 3 (Excessive Technology Use, Section 7.7.2.4.2; Lack of Personal Interactions, Section 7.7.2.4.3). Together, these subthemes highlight participants' concerns about the impact of DHIs on mental health, self-regulation, and engagement, whether through excessive screen time, reduced personal interactions, or reliance on health-tracking devices.

7.9 Strengths and Limitations

This was the first qualitative study to explore healthcare professionals' perspectives on the development of DHIs for PRMSD self-management in musicians. An important strength of this study was the involvement of a diverse group of healthcare professionals from different clinical backgrounds from the UK and the Netherlands. However, the study involved only twelve participants, which might be viewed as a limitation. In qualitative research, sample size is assessed not merely by the number of participants but by the depth and relevance of the information provided: a concept

known as information power (Malterud et al. 2016). Information power suggests that a small sample size is sufficient when the study aim is narrow, participants hold specific expertise, and the data is rich (Malterud et al. 2016), as implemented in this study. Nevertheless, the participants were recruited through convenience sampling, which could introduce selection bias, as only those interested in the study's topic chose to participate. Therefore, the results do not necessarily reflect the perspectives of all healthcare professionals working with musicians.

Furthermore, most of the healthcare professionals only had experience of using Zoom calls for online consultations; therefore, they could only describe their best guess or impression of how DHIs might be used. Although this is not surprising, due to the novelty of the topic, the participants' lack of knowledge and experience might have reduced the depth and richness of the data collected. There are also limitations with the data collection and analysis approaches. The online format might have impacted the richness of the collected data, despite the researcher facilitating the online group sessions as much as possible. Furthermore, as with any qualitative study, there is a risk of researcher bias, which might have affected how the interviews were conducted and the interpretation of the results. However, the interviews were semi-structured with predetermined questions, and although follow-up questions were used, the analyses ensured that all issues and concerns raised by the healthcare professionals were identified and discussed. Statements from one healthcare professional were considered to be as important as statements from the majority, as long as they were relevant to the research aims and objectives. The researcher also maintained a reflexive diary throughout the data collection and analysis process, and engaged in regular discussions with the project's supervisors to reflect on personal biases that could affect the research.

7.10 Summary and Future Recommendations

This study explored healthcare professionals' opinions and views on the development of DHIs for PRMSD self-management. Twelve healthcare professionals from diverse clinical backgrounds were recruited using convenience sampling to participate in an interview study. The interview data were analysed using reflexive thematic analysis and five themes were developed: Physical and psychological challenges facing musicians; Interview components; Perspectives of holistic wellbeing; Facilitators; and Concerns and solutions to using DHI. The main concept consistently discussed was the importance of implementing a biopsychosocial approach that addresses not only the physical symptoms but also the psychological and social factors influencing musicians' health. The participants discussed pain education, personalised treatments, education on load management, and breathing exercises, as well as strengthening and stretching exercises. The participants suggested several digital components that could be included in a DHI, including health tracking, exercise videos with external cues, and digital pain diaries. However, there were differences of opinion as to how to approach advising musicians on sleep and lifestyle modifications due to the demands of their profession. Whilst some participants advocated for educating musicians on well-being factors such as nutrition, exercise, and sleep, others were cautious about providing recommendations that might not align with the realities of a musician's schedule and commitments.

Furthermore, opinions varied regarding the use of health tracking technologies, with some participants seeing it as a practical solution by providing objective data and feedback. Others expressed concerns about the psychological impact of relying on external devices, fearing that it might lead to increased stress or reduce individuals'

ability to self-regulate their health. Factors such as accessibility issues, lack of personal interactions, excessive technology use, and safeguarding risks were also raised. The participants proposed solutions such as simplified programme structures, consideration of neurodivergent individuals' needs, building social networks, and professional monitoring to mitigate these challenges.

Whilst there are limitations due to the potential for selection bias from the sampling and recruitment method, this study has several implications for PRMSD self-management. The findings may encourage healthcare professionals to consider adopting a biopsychosocial approach when developing and implementing treatment programmes for musicians. Also, the proposed digital components could inform future health research for musicians. However, the findings indicate that DHIs may still require support from healthcare professionals in terms of screening and providing feedback on progress. Future research should evaluate the potential of this model and whether it would be a cost-effective approach. In addition, as there were varying opinions in the study, further research may be needed to reach consensus

Chapter 8: Summary Discussion

8.1 Introduction

The overall aim of this thesis was to explore DHIs for PRMSD self-management in musicians. In summary, the project consisted of three phases:

- Phase 1 – Scoping review: synthesis of the current evidence on DHIs for PRMSD self-management in musicians, including the key characteristics of current DHIs, encompassing content, mode of delivery and theoretical underpinning, effect on musicians' ability to continue to play, and any reported adverse effects, to inform future interventions.
- Phase 2 – Sequential explanatory study: to explore musicians' experiences, needs, and preferences regarding PRMSD self-management, and what barriers and facilitators influence their engagement with PRMSD self-management, as well as their opinions on key components, potential barriers, and solutions to using DHIs for PRMSD self-management.
- Phase 3 – Qualitative study: to explore the views and opinions of healthcare professionals about the key components, potential benefits, concerns, barriers, and facilitators to using DHIs for PRMSD self-management in musicians.

The aim of this chapter is to provide a summary of the results, synthesise the thesis findings in relation to the BCW framework (Chapter 3, Section 3.3.3), discuss the study's contributions to knowledge, identify its overall strengths and limitations, and provide recommendations for future research.

8.2 Overview of the Results

8.2.1 Scoping Review (Chapter 4)

The review included nine studies: five quasi-experimental research designs, two RCTs and two pilot RCTs. The studies utilised exercise videos, video conferencing, and websites; however, very few studies described DHIs in a manner that would be reproducible. For example, two studies included warm-up exercises without detailing exercise content (Porter 2021; Austen et al. 2024). Other health education programmes included a list of modules or content (e.g., injury prevention principles, mindful exercise) without specifying what principles were delivered to musicians (Ingle 2013). These limitations, coupled with the lack of a theoretical framework and limited involvement of musicians and healthcare professionals in the design and implementation phases, suggest that the current design and delivery of DHIs for PRMSDs may not meet the standards required for robust and effective interventions. To address these limitations, consultations with musicians and healthcare professionals were conducted in the subsequent phases of this study to explore the development of DHIs for PRMSD self-management in musicians.

8.2.2 Consultations with Musicians (Chapters 5 and 6)

A sequential mixed methods study was conducted, including an online cross-sectional survey and focus groups with musicians with current or previous PRMSDs. The research revealed several key themes regarding challenges, barriers and needs:

- Educational gaps in early training related to injury prevention and body awareness.
- Industry-specific challenges, including cultural norms, financial pressures, irregular schedules and lack of time.

- Healthcare access barriers, including difficulty with finding relevant information for musicians and affordability issues.

Regarding potential solutions, 75% of survey participants indicated that DHIs could assist in better managing PRMSDs. In focus groups, most musicians (9/10) expressed receptiveness toward web-based or mobile health interventions. They highlighted preferences for peer support networks, motivational elements, recovery stories, reminders, and progress tracking features to maintain engagement with self-management routines.

8.2.3 Consultations with Healthcare Professionals (Chapter 7)

Healthcare professionals highlighted several physical and psychological challenges musicians face:

- Overuse conditions often triggered by sudden increases in playing time.
- Institutional pressures that prioritise technical excellence over physical wellbeing.
- Psychological challenges including anxiety, perfectionism, and maladaptive coping.

They emphasised three core needs for effective PRMSD self-management in musicians:

- Development of skills for safe playing, particularly incremental increases in playing.
- Knowledge enhancement about PRMSDs and the biopsychosocial model of pain.

- Understanding the broader aspects of holistic well-being that influence musicians' health.

Healthcare professionals stressed that while DHIs may offer valuable support, professional guidance remains important for the effective implementation of DHIs for PRMSD self-management. To translate these findings into practical recommendations, the next section will explore how the findings fit within the constructs of the BCW.

8.3 Applying the Behaviour Change Wheel to Intervention Design

The first step in the BCW is to identify the problem (Michie et al. 2011). The current literature and consultations with musicians and healthcare professionals reveal several barriers to self-management of PRMSDs, including limited health education and prevention, limited time and money, social and stigma-related barriers, and motivation barriers. Similar barriers have been documented in the literature for MSD self-management. For example, a qualitative study by Cunningham et al. (2024) found that knowledge gaps and accessibility were persistent barriers across populations to engaging with self-management of osteoarthritis. Berry et al. (2021) noted insufficient personalised information and low self-efficacy as key obstacles, while Bennell et al. (2014) observed that inadequate patient education on exercise techniques and pain management directly undermined self-management outcomes in people with osteoarthritis.

Musicians face additional profession-specific challenges, including lack of time, which can hinder their ability to implement consistent self-management strategies, as reported in other studies (Bennell et al. 2014). But more importantly, a considerable

strain on musicians' well-being is their lack of control over their work schedules and job requirements (Chapter 6 and 7), as also reported in previous studies (Rickert et al. 2013). This study identified that in addition to these factors, low external locus of control greatly increases musicians' risk of overuse, as the need to follow conductors and work and practice schedules overrides the possibility of activity modification related to playing an instrument, similar to athletes, dancers and nurses (Chapter 7) (Dick et al. 2013; Rickert et al. 2013).

Furthermore, social and stigma-related barriers play a crucial role in PRMSD self-management (Chapter 6). The culture of over-practicing and the tendency to conceal injuries have previously been identified as barriers to health and health promotion (Chapter 6), as also reported in previous studies on both conservatoire music students (Perkins et al. 2017) and professional orchestral musicians (Rickert et al. 2013; Rickert et al. 2015). This influence of organisational culture on well-being and performance parallels findings in healthcare workers and athletes (Maitland et al. 2015; Mannion et al. 2019). While previous studies identified intention for change as a potential facilitator for musicians' wellbeing, orchestra administrative staff expressed discomfort in leading health promotion efforts, citing limited resources and a need for external proposals (Roos et al. 2021). In turn, this creates a cycle where organisational culture perpetuates accessibility barriers (Roos et al. 2021).

Finally, motivation barriers may also affect PRMSD self-management, although this was not clear in the consultations with musicians. It is, however, evident from previous research (Chapter 2) (Chan et al. 2013b; Chan et al. 2014; Baadjou et al. 2018) that musicians discontinue exercise because of lack of motivation or concerns that it will make their pain worse. In this project, musicians further pointed to their difficulties in

establishing self-management routines when tours or playing music and suggested that social support and gamification could help to promote their motivation (Chapter 6). End users' motivation, regardless of population, is considered critical for behaviour change and positive implementation outcomes in any type of health intervention (Michie et al. 2011; Roos et al. 2021; Michaelsen and Esch 2023).

Altogether, these barriers (limited health education and prevention, limited time and money, social and stigma-related and lack of motivation) informed the behavioural analysis to determine the necessary changes to achieve the target behaviour, as detailed in Tables 8.1 and 8.2, below.

Table 8.1: Behavioural Analysis of the Project, guided by the Capability, Opportunity, Motivation-Behaviour model (adapted from Michie et al. 2011)

Target behaviour: To help musicians adopt self-management practices for playing-related musculoskeletal disorders		
COM-B components	What needs to happen for the target behaviour to occur?	Is there a need to change?
Physical capability	Musicians need to have the physical ability to engage in self-management practices that will help their PRMSDs.	Yes, there is a need to ensure that musicians understand and can safely and effectively implement these practices (Chapter 2, Section 2.6.1).
	Musicians need to understand PRMSDs from a biopsychosocial perspective, including how physical, psychological, and social factors influence their condition.	Yes, there is a need to improve understanding of the biopsychosocial nature of PRMSDs and its implications for self-management (Chapter 7, Section 7.7.2.2.1).
Psychological capability		
Physical opportunity	Musicians need easy and cost-effective access to resources for self-management practices.	Yes, change is needed to provide easy access to self-management resources (Chapter 2, Section 2.7; Chapter 5, Section 5.4.5; Chapter 6, Section 6.8.2.2.5).
Social opportunity	Musicians need support from healthcare professionals, teachers, and peers.	Yes, there is a need to create a supportive environment where musicians can seek advice, share experiences, and receive encouragement from individuals who understand their challenges (Chapter 6, Section 6.8.2.2.1).
Reflective motivation	Lack of motivation may be relevant in this population, as musicians discontinue exercise because of the lack of motivation or concerns that it will make their pain worse (Chapter 2, Section 2.6).	Yes, there is a need to connect self-management practices to musicians' career aspirations, set relevant goals, and provide feedback to help them stay motivated to continue their routines (Chapter 2, Section 2.7; Chapter 6, Chapter 5, Section 5.5.5; Sections 6.8.2.4.3, 6.8.2.4.2).

Automatic motivation	Musicians should establish regular habits for self-management, such as consistent exercise routines and breaks during practice.	Yes, there is a need to help musicians develop and maintain self-management habits through guidance on habit formation and time-management (e.g., appropriate reminders and feedback and monitoring functions) (Chapter 2, Sections 2.5.4, 2.6.4; Chapter 6, Section 6.8.2.4.2, 6.8.2.4.3).

Key: COM-B: Capability, Opportunity, Motivation – Behaviour; PRMSDs: Playing-related musculoskeletal disorders

Table 8.2: Integrating the Capability, Opportunity, Motivation – Behaviour Model and Intervention Functions (adapted from Michie et al. 2015)

COM-B Component	Problems to overcome	For behaviour change to occur, musicians would need to:	Intervention functions: What needs to be done to change behaviour?	BCTs with examples from Chapters 6 and 7
Capability / Psychological	Lack of knowledge about the biopsychosocial links between stress, pain, and lifestyle factors (sleep, nutrition).	Develop understanding and practical skills to: - Recognise the relationship between stress, pain, and general lifestyle factors, such as sleep hygiene, nutrition, and overall well-being/ career,	Education and Training – Provide learning resources that: - Explain the biopsychosocial aspects of PRMSDs and the impact of lifestyle factors on pain and injuries and how better management of these factors can improve recovery and enhance career longevity.	- BCT 5.1: Information about health consequences (e.g., online learning modules with interactive content).
Capability / Physical	Musicians often lack structured methods to balance playing demands with physical capacity, leading to unmonitored workloads and injury risk.	Develop skills to: - Establish a baseline playing capacity benchmark. - Monitor symptoms, fatigue, and perceived exertion during/after practice. - Implement controlled, incremental increases in playing time. - Apply mental practice techniques to supplement physical rehearsal.	Education and Training - Guidance on establishing baseline playing capacity. - Monitoring physical responses. - Guidance on mental practice strategies.	- BCT 4.1: Instruction on how to perform a behaviour (e.g., gradual return to playing/building playing capacity). - BCT 2.3: Self-monitoring of behaviour (e.g., logging of playing duration, pain levels, perceived exertion). - BCT 2.2: Feedback on behaviour.
Opportunity / Social	Musicians face stigma around PRMSDs and isolation in their health journey, with limited access to both peer support and specialised healthcare guidance. This can lead to reluctance in discussing injuries and seeking help,	- Connect with peers who have similar experiences. - Engage with healthcare professionals who understand musicians' specific needs.	Enablement – Provide peer support groups and communication channels to promote sharing of experiences, provide emotional support, and offer advice on managing PRMSDs.	- BCT 3.2: Social support (Practical) (e.g., communication channels with healthcare professionals). - BCT 3.3: Social support (Emotional) (e.g., moderated community forums for peer

	potentially worsening their condition.			support and experience sharing).
Opportunity / Physical	Musicians face barriers in accessing specialised healthcare due to high costs, touring schedules, and limited availability of practitioners who understand musicians' specific needs.	Access to reliable, cost-effective self-management resources.	Persuasion and Environmental Restructuring – Create accessible digital resources. Provide endorsement from trusted sources (music institutions, teachers).	- BCT 9.1: Credible source (Organisational / professional endorsement). - BCT 12.1: Restructuring the physical environment (e.g., advice on workplace modification / instrument ergonomics to better manage PRMSDs).
Motivation / Reflection	Musicians experience lack of motivation to maintain exercise and self-management routines, with some discontinuing these activities.	Develop positive beliefs and attitudes towards self-management, and set personal goals aligned with career aspirations to promote commitment.	Modelling and Persuasion – Build understanding and confidence through: - Evidence of benefits through peer experiences. - Regular progress monitoring.	- BCT 1.3: Goal setting (outcome) (e.g., return to full capacity for a tour) - BCT 2.2: Feedback on behaviour. - BCT 2.7: Feedback on outcomes of a behaviour (e.g., improved playing capacity). - BCT 10.10: Reward outcome (e.g., motivational messages). - BCT 6.1: Demonstration of the behaviour (e.g., recovery stories).
Motivation / Automatic	Musicians struggle to establish consistent routines for self-management due to irregular schedules.	Establish consistent routines for self-management, including regular breaks and exercises, to prevent PRMSDs.	Persuasion – Demonstrate effective routines for self-management and provide prompts and cues to support habit formation.	- BCT 7.1: Prompts and cues (e.g., regular reminders).

As outlined in Table 8.1 and Chapter 3, the target behaviour of the intervention is to help musicians to adopt PRMSD self-management practices. Based on the behavioural analysis in Table 8.1, six key intervention functions were considered appropriate to achieve the target behaviour: education (increasing knowledge or understanding), training (imparting skills), persuasion (using communication to provoke positive or negative feelings or stimulate action), enablement (removing barriers and providing resources to support behaviour change), modelling (providing an example for people to aspire to or emulate), and environmental restructuring (changing the physical or social context) (Michie et al. 2013) (Table 8.2).

Although the BCW outlines three other intervention functions – incentivisation (creating an expectation of a reward), coercion (creating an expectation of punishment), and restriction (using rules to reduce the opportunity for the target behaviour) – these intervention functions place more emphasis on external influences and less on personal agency (Michie et al. 2013), which is a key for promoting self-efficacy (Bandura 1998). The decision to exclude these three functions aligns with previous studies that developed digital behaviour change interventions for MSD self-management (Pearson et al. 2016; Berry et al. 2021) and for promoting physical activity (Berry 2019; Nelligan et al. 2019).

The selection of specific BCTs was directly informed by the consultations with both musicians and healthcare professionals conducted for this research, ensuring that the intervention design responded to real-world needs and challenges. Healthcare professionals emphasised education and skill training as critical to addressing biopsychosocial pain factors, building capacity for gradual return to playing, and promoting mental practice as an alternative when injured (Chapter 7). They suggested

that musicians need clear information and instructions about what not to do, demonstrations of how to gradually build up capacity for practice/return to playing after an injury, and the ability to self-monitor both health outcomes and behaviours, comparing these against expected standards (Chapter 7). These priorities map directly to BCT 5.1: Information about health consequences; BCT 4.1: Instruction on how to perform a behaviour; and BCT 2.3: Self-monitoring of behaviour. These BCTs are most frequently used for increasing knowledge and understanding (Cline et al. 2025) and have been implemented in DHIs for self-management of osteoarthritis (Berry 2019) and for promoting physical activity (Lorig et al. 2006; Nelligan et al. 2019).

Both musicians and healthcare professionals highlighted that to improve knowledge and skills, the provided information must be easy to understand and personalised for each musician, with suggestions for incorporating interactive modules and self-monitoring tools for general health and wellbeing (Chapter 6 and 7). These suggestions align with approaches in other DHIs designed to support self-management of MSDs, particularly self-monitoring tools (Orji et al. 2018). Self-monitoring is the most widely employed strategy in interventions aimed at promoting health and wellness (Orji et al. 2018). However, findings specifically from within a digital health setting have highlighted that a weaknesses of self-monitoring strategies is that they require high levels of user engagement and can be viewed as tedious and boring (Orji et al. 2018). Another two acceptability studies suggested that self-monitoring tools can be too work-like, childish, or an intrusive burden requiring time and effort (Pearson et al. 2016; Berry 2019). Therefore, further exploration of self-monitoring tools might be necessary prior to implementation for musicians.

Following the capability component, the enablement function could address both physical and social opportunities for PRMSD self-management. For physical opportunities, providing credible sources (BCT 8.1) was considered essential (Chapter 6), similar to previous research (Pearson et al. 2016; Berry 2019). Information needs to come from trusted and approved sources to ensure musicians' confidence in the intervention and their chosen activities (Chapter 6). This may include endorsements from institutions and organisations, as suggested in Chapter 6, or testimonials by people with whom users could identify (e.g., music teachers) (Pearson et al. 2016). Both methods have been reported to be influential in encouraging people to visit a website and convincing them to engage with it and implement online advice (Sillence et al. 2007; Currie et al. 2015).

In terms of social opportunity, both musicians and healthcare professionals emphasised the importance of professional and peer support (Chapters 6 and 7). Musicians were particularly keen to have support through online communities (i.e., forums) where they could share experiences to learn from and support other musicians with PRMSDs, although a few participants thought such communities would need to be moderated to prevent inaccurate and inappropriate postings (Chapter 6). Meanwhile, healthcare professionals emphasised the importance of professional oversight (Chapters 7). The BCTs selected for this are BCT 3.1: Social support (Practical); and BCT 3.3: Social support (Emotional).

Both of these BCTs have been consistently identified as appropriate for enactment of a behaviour (Morrison et al. 2012; Pearson et al. 2016; Perkins et al. 2017; Blake et al. 2022; Huang and Yu 2022; Cline et al. 2025). Huang and Yu (2022) found that social support reduced stigma and increased help-seeking behaviour for performance

anxiety in musicians. Similarly, Perkins et al. (2017) showed that combining professional therapy with peer support reduced anxiety and increased self-efficacy in musicians with performance anxiety. Blake et al. (2022) and Chiauuzzi et al. (2010) further emphasised the importance of social support networks for people with low back pain and WMSDs, respectively. These findings strengthen the BCT mapping as well as the suggestions for intervention design in this study (Table 8.2).

Another form of providing support is through motivation and encouragement (Chapter 6). Persuasion and modelling intervention functions are often associated with promoting motivation (Michie et al. 2011; Cline et al. 2025). The main emphasis in this study is that motivational approaches for PRMSDs must align with musicians' career aspirations rather than focusing on functional or clinical health outcomes (such as increased physical activity or reducing pain), as in previous studies on behaviour change DHIs for MSDs (Berry 2019; Möllenkamp et al. 2019; Nelligan et al. 2019). This finding aligns with earlier research indicating that musicians typically demonstrate greater motivation toward activities that improve their musical abilities rather than those focused on injury prevention or general health maintenance (Williamon 2004; Spahn et al. 2004). In addition to findings from work-based interventions and return to work interventions, which similarly emphasise occupation-specific motivations (Wegrzynek et al. 2020).

The BCTs selected to enhance motivation are BCT 1.3: Goal setting (outcome); BCT 2.2: Feedback on behaviour; BCT 2.7: Feedback on outcomes of a behaviour; BCT 10.10: Reward outcome; and BCT 7.1 Prompts and cues (Michie et al. 2013; Cline et al. 2025). These BCTs were selected because they provide users with an opportunity for reflective motivation by offering them goals and feedback on progression and

regression to keep them motivated (Michie et al. 2013). BCT 6.1: Demonstration of the behaviour was also incorporated because it is the single most frequently used BCT for modelling of behaviour (Michie et al. 2013; Cline et al. 2025).

The participants suggested several digital features to promote motivation, including reminders to take breaks during rehearsals, visual feedback on progress, motivational messages, and recovery stories of musicians who successfully managed PRMSDs (Chapter 6). The Join2Move programme (Bossen et al. 2013), the Arthritis Self-Management Programme (Barlow et al. 2009) and an SMS-based intervention for knee osteoarthritis (Nelligan et al. 2019) included similar tools to enhance motivation. Furthermore, in workplace pain self-management, Blake et al. (2022) effectively used podcasts and videos featuring personal stories about managing pain and accessing support in the workplace, as part of a web-based intervention.

Overall, this study's mapping process shares commonalities with previous research, although there are several key differences. Previous studies have identified 25 BCTs (out of 93) for MSDs (Berry et al. 2021) and 20 BCTs for osteoarthritis (Nelligan et al. 2019), while this study only outlined 13 BCTs (Table 8.2). However, this number of BCTs is comparable to a previous review in which the highest BCTs being reported in a single study was 13 (Keogh et al. 2015). All the studies included in the review reported instructions on how to perform the behaviour, demonstration of the behaviour, and behavioural practice in their interventions (Keogh et al. 2015). Another 80% of the studies reported credible sources, goal setting and graded tasks in their interventions. Many of these BCTs were also mapped in this study (Table 8.2), which may suggest that the results are comparable to those from previous studies (Keogh et al. 2015). However, as this study is at an early stage, it is possible that the number of BCTs may

expand as the intervention develops and is refined through future iterations. This may be necessary, as metaanalyses of digital health behaviour interventions by Webb et al. (2010) and Eisele et al. (2019) found that interventions that incorporated more BCTs tended to have larger effect sizes.

8.4 Knowledge Contribution

To the best of the author's knowledge, this thesis represents the first systematic exploration of DHIs for PRMSD self-management that follows the rigorous development process according to the MRC framework for complex interventions. The BCW model was used to systematically identify and address the factors influencing musicians' abilities to self-manage PRMSDs. These frameworks were also employed throughout the interpretation and coding of qualitative findings and in the integration of insights across all phases of the discussion. To date, no studies have applied the BCW model specifically to musicians; nor have they developed a theoretically informed intervention for self-management of PRMSDs in this population. Previous studies that applied theoretical models, such as the Knowledge-to-Action framework and the Integrated Change model (Baadjou et al. 2018; Roos et al. 2024), lacked sufficient detail regarding framework implementation or detail regarding how findings informed the development of their interventions (Chapters 2 and 4). In contrast, this thesis provides a detailed account of the systematic application of these models, allowing other researchers to understand the findings, rationale, and methodological process undertaken, and thus enabling replication and adaptation of the model.

Furthermore, a key strength and contribution of this study is its use of a co-production methodology by actively involving musicians and healthcare professionals from different backgrounds who work with musicians. This approach enhances the

relevance and impact of research findings whilst also helping to reduce research waste, as the study considers the needs, challenges and the preferences of its end-users (Hawkins et al. 2017). While a recent systematic review found no conclusive evidence that early end-user involvement improves health outcomes (Grindell et al. 2022), findings from this research suggest that co-design approaches are crucial for identifying profession-specific challenges and needs (Chapter 6) that generic interventions might overlook, especially in niche contexts such as music.

Furthermore, the study demonstrates the importance of addressing psychosocial risk factors alongside physical symptoms. This aligns with the biopsychosocial approach to pain management (Gatchel et al. 2007), which has been shown to improve outcomes in MSDs (Kamper et al. 2015). The findings contribute to understanding occupational health in high-skill professions where additional unpaid hours are often required to maintain competitiveness and job security. This knowledge is particularly relevant to the performing arts sector and other high-skill professions where work-related ill health can significantly impact both individual careers and broader industry sustainability (Mizera-Pęczek et al. 2024). Therefore, the suggestions from healthcare professionals for addressing both physical and psychological well-being could inform clinical practice beyond musicians, extending to other performing artists and similar high-demand professional groups.

This study is also the first to explore the development of DHIs for PRMSD self-management in musicians as a practical solution that accommodates musicians' working conditions and health needs. The study explored the factors that could hinder or facilitate end-users' engagement with DHIs: this is a strength because it enhances the knowledge of which approaches are likely to have the greatest impact on user

engagement and outcomes, and for whom (Svendson et al. 2020). This approach is consistent with the MRC framework, which recommends that interventions should be underpinned by a comprehensive understanding of the actual conditions and needs of the target population (Skivington et al. 2021).

8.5 Strengths and Limitations of the Thesis

For each of the three phases of the thesis, the strengths and limitations have been presented following the presentation of the data (see Sections 4.5, 5.7, 6.9, 7.8). Therefore, this section will present an overview of the strengths and limitations of the thesis, rather than the specifics of each research approach. The current thesis adopted a mixed methods approach to inform the development of a DHI for PRMSD self-management in musicians. This is in line with the MRC guidelines for complex intervention development.

Importantly, this thesis demonstrates the significant value of collaborative research that brings together musicians with current or previous PRMSDs and healthcare professionals experienced in performing arts medicine. This approach grounds the research firmly in the lived experiences and clinical expertise of those most directly involved with these conditions, once again in line with the MRC framework (Skivington et al. 2021). Although the small sample sizes, particularly in the qualitative studies, may limit the generalisability of the results of this study, the goal of qualitative research is often transferability rather than generalisability (Braun and Clarke 2021b; Byrne 2022).

Moreover, the BCW is a valuable tool to use in designing complex interventions and tailoring their content and format to the target population and local context, in line with

the MRC framework (Skivington et al. 2021). Following the BCW process prompted a rigorous analysis of the problem and exploration of how it could potentially be addressed within the music industry. However, it is important to acknowledge that theoretical grounding alone does not guarantee superiority over interventions developed through other approaches (Moore and Evans 2017). Furthermore, the interpretation of data and the selection of intervention functions and BCTs can be influenced by researcher bias and is open to interpretation (Murphy et al. 2023). Therefore, future iterations should test the applicability of this framework with larger and more diverse sample sizes.

8.6 Recommendations for Future Research

The findings of this thesis may serve as a roadmap for co-designing research, engaging both musicians and healthcare professionals, to inform the development of a DHI for PRMSD self-management. This thesis demonstrates that this collaboration can yield insights into end-users' practical and contextual needs, and that DHIs have the potential to work as an alternative means of supporting musicians who may not have the financial means or time to consult a healthcare professional or engage in traditional rehabilitation. However, the findings highlighted the multi-factorial nature of the responses, with many different opinions emerging from participants. These diverse perspectives may be difficult to capture within a single intervention. Therefore, in the next stages of the research, reaching consensus through co-production workshops involving both musicians and healthcare professionals should be undertaken to refine and select the techniques that best support the intended self-management behaviours. This should be followed by the development of a prototype intervention, a feasibility study to assess its usability and initial benefit, and if successful, a full RCT. According

to the MRC framework (Skivington et al. 2021), modification or refinement should be considered within each stage of the development and evaluation of a complex intervention. Therefore, involvement with relevant partners should continue throughout the development and implementation process to ensure that the intervention remains aligned with users' needs and preferences while maintaining its theoretical foundation.

Furthermore, this work lends itself to early engagement and collaboration with the digital health industry sector to develop effective DHIs. Such partnerships could facilitate rapid prototype development using the latest technology and design methods, navigate the complex health technology approval landscape, and create high levels of functionality to ensure effective scaling and implementation. By bringing together academic research with industry expertise, DHIs for musicians and other performing artists could be developed more efficiently, incorporating innovative approaches while maintaining the evidence-based foundation established through this research.

Finally, as this study only focused on individual-level behaviour change and the technical aspects of DHI for PRMSD self-management, rather than broader aspects of the system within which the intervention would be placed, future research should examine how organisational and institutional factors may influence intervention adoption. This includes exploring how music schools, orchestras, and professional organisations might support the incorporation of self-management interventions into their existing structures, policies, and cultures. Future research should also investigate what resources and infrastructure are needed for successful implementation, and how professional norms might be shifted to prioritise musicians' health. Research across multiple disciplines indicates that without addressing fundamental systemic changes, interventions focused solely on enhancing individual knowledge and capabilities are

unlikely to produce lasting improvements in wellbeing outcomes (NIOSH 2016; Weale et al. 2022).

Chapter 9: Conclusion

Professional musicians are chronically exposed to continuous and repeated physical movements that leave them vulnerable to developing PRMSDs. With recent technological advancements, there have been attempts to use DHIs to support PRMSD self-management in musicians. However, the pre-investigation on the critical aspects of intervention development has not been undertaken in PRMSD self-management and evidence on the effectiveness of these existing technologies is inconclusive. The overall aim of the thesis was to explore DHIs for PRMSD self-management in musicians. This thesis adopted a mixed methods approach to explore musicians' health needs and preferences, as well as their views and opinions on developing a DHI to support PRMSD self-management.

Phase 1 involved a scoping review, which found that current DHIs for PRMSDs showed limited improvements in musculoskeletal symptoms, and that their development was not underpinned by a theoretical framework and only included orchestra and student musicians. Phases 2 and 3 explored musicians' health needs, key intervention functions and features required within the DHIs, as well as the barriers and facilitators to using DHIs for PRMSD self-management, from the perspectives of both musicians and healthcare professionals. The BCW model was applied to systematically map these findings and identify appropriate BCTs tailored to musicians' needs for PRMSD self-management.

The analysis yielded six key intervention functions (education, training, persuasion, enablement, modelling, and environmental restructuring) and 13 BCTs. Unlike previous DHIs for MSDs and osteoarthritis, this study emphasised career-aligned outcomes rather than general health outcomes, while addressing profession-specific challenges such as limited control over work schedules and practice demands. Key

BCTs included social support (both practical and emotional), credible information sources, and self-monitoring intervention functions.

Overall, this research provides a framework for developing DHIs that address musicians' unique needs for PRMSD self-management. However, further refinement is needed through:

1. Co-production workshops with a diverse group of musicians, healthcare professionals, and researchers to refine and select methods that best support the intended self-management behaviours.
2. Greater involvement from key industry partners, such as BAPAM and digital health companies, to support the development and testing of a DHI prototype.
3. Consideration of organisational and institutional factors that may influence DHI adoption, including how music schools, orchestras, and professional bodies could support the integration of self-management into their existing systems.

These steps would help to establish a solid foundation of knowledge and a comprehensive understanding of how DHIs may support PRMSD self-management in musicians to improve health outcomes and quality of life.

References

- Abréu-Ramos, A.M. and Micheo, W.F. 2007. Lifetime prevalence of upper-body musculoskeletal problems in a professional-level symphony orchestra: age, gender, and instrument-specific results. *Medical Problems of Performing Artists* 22(3), pp. 97-104. doi: 10.21091/mppa.2007.3022
- Abyarjoo, F., Nonnarit O., Sudarat T., Francisco O., and Armando B. 2015. PostureMonitor: real-time IMU wearable technology to foster poise and health. In *Design, user experience, and usability: Interactive experience design: proceedings of the 4th International Conference, DUXU. Los Angeles; USA, 2-7 August 2015*. doi: 10.1007/978-3-319-20889-3_50
- Ackermann, B., Adams, R. and Marshall, E. 2002. Strength or endurance training for undergraduate music majors at a university? *Medical Problems of Performing Artists* 17(1), pp. 33-41. doi: 10.21091/mppa.2002.1006
- Ackermann, B., Driscoll, T. and Kenny, D.T. 2012. Musculoskeletal pain and injury in professional orchestral musicians in Australia. *Medical Problems of Performing Artists* 27(4), pp. 181-187. doi: 10.21091/mppa.2012.4034
- Adam, G., Wang, K., Demaree, C.J., Jiang, J.S., Cheung, M., Bechara, C.F. and Lin, P.H. 2018. A prospective evaluation of duplex ultrasound for thoracic outlet syndrome in high-performance musicians playing bowed string instruments. *Diagnostics* 8(1), 11. doi: 10.3390/diagnostics8010011

Afrouzeh, M., Sohrabi, M., Torbati, H.R.T., Gorgin, F. and Mallett, C. 2013. Effect of PETTLEP imagery training on learning of new skills in novice volleyball players. *Life Science Journal* 10(1), pp. 231-238.

Agarwal, P. et al. 2019. Mobile app for improved self-management of type 2 diabetes: multicenter pragmatic randomized controlled trial. *JMIR mHealth and uHealth* 7(1), e10321. doi: 10.2196/10321

Age UK. 2023. *Age UK launches offline and overlooked digital campaign*. Available at: <https://www.ageuk.org.uk/latest-press/articles/2023/age-uk-analysis-reveals-that-almost-6-million-people-5800000-aged-65-are-either-unable-to-use-the-internet-safely-and-successfully-or-arent-online-at-all/>. [Accessed: 17 February 2025]

Age UK. 2024. *More than 1 in 3 over 65s (4.7 million) Lack the Basic Skills to Use the Internet Successfully*. Available at: <https://www.ageuk.org.uk/latest-press/articles/2024/more-than-1-in-3-over-65s-4.7-million-lack-the-basic-skills-to-use-the-internet-successfully/> [Accessed: 17 February 2025]

Ahlberg, J. et al. 2019. Oro-facial pain experience among symphony orchestra musicians in Finland is associated with reported stress, sleep bruxism and disrupted sleep—independent of the instrument group. *Journal of Oral Rehabilitation* 46(9), pp. 807-812. doi: 10.1111/joor.12818

Ajidahun, A.T., Myezwa, H., Mudzi, W. and Wood, W.A. 2019. Barriers and facilitators in implementing an exercise-based injury prevention program for string players. *Work* 64(4), pp. 713-720. doi: 10.3233/WOR-193033

Ajzen, I. 1985, *From intentions to actions: a theory of planned behaviour*. New York: Springer-Verlag.

Åkerstedt, T. and Wright Jr, K.P. 2009. Sleep loss and fatigue in shift work and shift work disorder. *Sleep Medicine Clinics* 4(2), 257. doi: 10.1016/j.jsmc.2009.03.001

Alciauskaite, L., Sinkariova, L., Zajanckauskaite-Staskeviciene, L., Misiuniene, J. and Petroliene, R. 2015. Does the transtheoretical model show health behaviour changes for patients with musculoskeletal disorders? *Procedia-Social and Behavioral Sciences* 205, pp. 429-436. doi: 10.1016/j.sbspro.2015.09.032

Alexander, F.M. 1932. The use of the self. *British Medical Journal* 2(3731), 77.

Allman-Farinelli, M. and Nour, M. 2021. Exploring the role of social support and social media for lifestyle interventions to prevent weight gain with young adults: focus group findings. *Journal of Human Nutrition and Dietetics* 34(1), pp. 178-187. doi: 10.1111/jhn.12774

Almutairi, R., Alsarraf, A., Alkandari, D., Albazali, A. and Ashkanani, H. 2024. Dissecting through the literature: a review of the critical appraisal process. *Cureus* 16(5), e59658. doi: 10.7759/cureus.59658

Altman, M., Huang, T.T. and Breland, J.Y. 2018. Design thinking in health care. *Preventing Chronic Disease* 15, e117. doi: 10.5888/pcd15.180128

Andersen, L.N., Mann, S., Juul-Kristensen, B. and Søgaaard, K. 2017. Comparing the impact of specific strength training vs general fitness training on professional symphony orchestra musicians: a feasibility study. *Medical Problems of Performing Artists* 32(2), pp. 94-100. doi: 10.21091/mppa.2017.2016

- Anderson, D.D., Chubinskaya, S., Guilak, F., Martin, J.A., Oegema, T.R., Olson, S.A. and Buckwalter, J.A. 2011. Post-traumatic osteoarthritis: improved understanding and opportunities for early intervention. *Journal of Orthopaedic Research* 29(6), pp. 802-809. doi: 10.1002/jor.21359
- Andersson, G. and Titov, N. 2014. Advantages and limitations of Internet-based interventions for common mental disorders. *World Psychiatry* 13(1), pp. 4-11. doi: 10.1002/wps.20083
- Araújo, L.S., Wasley, D., Redding, E., Atkins, L., Perkins, R., Ginsborg, J. and Williamon, A. 2020. Fit to perform: a profile of higher education music students' physical fitness. *Frontiers in Psychology* 11, 298. doi: 10.3389/fpsyg.2020.00298
- Arima, T., Svensson, P., Rasmussen, C., Nielsen, K.D., Drewes, A.M. and Arendt-Nielsen, L. 2001. The relationship between selective sleep deprivation, nocturnal jaw-muscle activity and pain in healthy men. *Journal of Oral Rehabilitation* 28(2), pp. 140-148. doi: 10.1046/j.1365-2842.2001.00687
- Armstrong, T.J. et al. 1993. A conceptual model for work-related neck and upper-limb musculoskeletal disorders. *Scandinavian Journal of Work, Environment & Health*, pp. 73-84. doi: 10.5271/sjweh.1494
- Aschentrup, L., Steimer, P.A., Dadaczynski, K., McCall, T., Fischer, F. and Wrona, K.J. 2024. Effectiveness of gamified digital interventions in mental health prevention and health promotion among adults: a scoping review. *BMC Public Health* 24(1), 69. doi: 10.1186/s12889-023-17517-3

Asscheman, J.S., Zanolie, K., Bexkens, A. and Bos, M.G. 2021. Mood variability among early adolescents in times of social constraints: a daily diary study during the COVID-19 pandemic. *Frontiers in Psychology* 12. doi: 10.3389/fpsyg.2021.722494

Association for Electronic Music 2023. *Neurodiversity survey and report*. Available at: <https://associationforelectronicmusic.org/2023/04/06/afem-2022-neurodiversity-survey-report/> [Accessed: 07 December 2024]

Atkins, L. et al. 2017. A guide to using the Theoretical Domains Framework of behaviour change to investigate implementation problems. *Implementation Science* 12, pp. 1-18. doi: 10.1186/s13012-017-0605-9

Austen, C. 2020. *'I'm not injured, this is just my life': an exploration of the experiences of conservatoire students with chronic playing-related musculoskeletal disorders*. PhD Thesis, Royal College of Music.

Austen, C., Redman, D. and Martini, M. 2024. Warm-up exercises reduce music conservatoire students' pain intensity when controlling for mood, sleep and physical activity: A pilot study. *British Journal of Pain* 18(1), pp. 57-69. doi: 10.1177/20494637231188306

Axon, D.R., Patel, M.J., Martin, J.R. and Slack, M.K. 2019. Use of multidomain management strategies by community dwelling adults with chronic pain: evidence from a systematic review. *Scandinavian Journal of Pain* 19(1), pp. 9-23. doi: 10.1515/sjpain-2018-0306

Ayres, L. 2007. Qualitative research proposals—part III: sampling and data collection. *Journal of Wound, Ostomy & Continence Nursing* 34(3), pp. 242-244. doi: 10.1097/01.WON.0000270816.99318.3b

Azodo, I., Williams, R., Sheikh, A. and Cresswell, K. 2020. Opportunities and challenges surrounding the use of data from wearable sensor devices in health care: qualitative interview study. *Journal of Medical Internet Research* 22(10), e19542. doi: 10.2196/19542

Baader, A.P., Kazennikov, O. and Wiesendanger, M. 2005. Coordination of bowing and fingering in violin playing. *Cognitive Brain Research* 23 (2), pp. 436-443. doi: 10.1016/j.cogbrainres.2004.11.008

Baadjou, V.A., Ackermann, B.J., Verbunt, J.A., van Eijsden-Besseling, M.D., de Bie, R.A. and Smeets, R.J. 2021. Implementation of health education interventions at Dutch music schools. *Health Promotion International* 36(2), pp. 334-348. doi: 10.1093/heapro/daaa050

Baadjou, V.A., Roussel, N.A., Verbunt, J.A.M.C.F., Smeets, R.J.E.M. and de Bie, R.A. 2016. Systematic review: risk factors for musculoskeletal disorders in musicians. *Occupational Medicine* 66(8), pp. 614-622. doi: 10.1093/occmed/kqw052

Baadjou, V.A.E., Verbunt, J.A.M.C.F., van Eijsden-Besseling, M.D.F., De Bie, R.A., Girard, O., Twisk, J.W.R. and Smeets, R.J.E.M. 2018. Preventing musculoskeletal complaints in music students: a randomized controlled trial. *Occupational Medicine* 68(7), pp. 469-477. doi: 10.1093/occmed/kqy105

Babatunde, O.O. et al. 2023. Interventions for supporting self-management in people with musculoskeletal pain, including focus on varying levels of health literacy: a systematic overview of reviews. *Health Open Research* 5, pp. 2. doi:

10.12688/healthopenres.13151.1

Babbie, E.R. 2020. *The practice of social research*. 5th ed. Boston: Cengage Learning.

Bahaadinbeigy, K., Yogesan, K. and Wootton, R. 2010. MEDLINE versus EMBASE and CINAHL for telemedicine searches. *Telemedicine Journal and e-Health* 16(8), pp. 916-919. doi: 10.1089/tmj.2010.0046

Bandi, S.A., Lukácsi, T., Kemény, V., Vida, D., Nagy, S.I., Vas, B. and Révész, G. 2023. The HEXACO personality profile of musicians. *Psychology of Music* 51(1), pp. 107-118. doi: 10.1177/03057356221087725

Bandura, A. 1977. Self-efficacy: toward a unifying theory of behavioral change. *Psychological Review* 84(2), pp.191-215. doi: 10.1037/0033-295X.84.2.191

Bandura, A. 1998. Exercise of agency in personal and social change. *Behavior and cognitive therapy today: selected proceedings of the XXVII Congress of the European Association for Behavioral and Cognitive Therapies, Venice, 1997*, pp. 1-29. doi: 10.1016/B978-008043437-7/50002-8

Barbe, M.F. and Barr, A.E. 2006. Inflammation and the pathophysiology of work-related musculoskeletal disorders. *Brain, Behavior, and Immunity* 20(5), pp. 423-429. doi: 10.1016/j.bbi.2006.03.001

Barbeau, A.K., Héroux, I., Ryan, G. and Thouin-Poppe, L.É. 2024. The effects of musical practice on the well-being, mental health and social support of student, amateur, and professional musicians in Canada during the COVID-19 pandemic. *Frontiers in Psychology* 15, 1386229. doi: 10.3389/fpsyg.2024.1386229

Barker, T.H. et al. 2023. The revised JBI critical appraisal tool for the assessment of risk of bias for randomized controlled trials. *JBI Evidence Synthesis* 21(3), pp. 494-506. doi: 10.11124/JBIES-22-00430

Barker, T.H. et al. 2024. The revised JBI critical appraisal tool for the assessment of risk of bias for quasi-experimental studies. *JBI Evidence Synthesis* 22(3), pp. 378-388. doi: 10.11124/JBIES-23-00268

Barlow, J., Turner, A., Swaby, L., Gilchrist, M., Wright, C. and Doherty, M. 2009. An 8-yr follow-up of arthritis self-management programme participants. *Rheumatology* 48(2), pp. 128-133. doi: 10.1093/rheumatology/ken429.

Barr, A.E. and Barbe, M.F. 2002. Pathophysiological tissue changes associated with repetitive movement: a review of the evidence. *Physical Therapy* 82(2), pp. 173-187. doi: 10.1093/ptj/82.2.173

Bartley, E.J. and Fillingim, R.B. 2013. Sex differences in pain: a brief review of clinical and experimental findings. *British Journal of Anaesthesia* 111(1), pp. 52-58. doi: 10.1093/bja/aet127

Barton, C.J., Ezzat, A.M., Merolli, M., Williams, C.M., Haines, T., Mehta, N. and Malliaras, P. 2022. "It's second best": a mixed-methods evaluation of the experiences and attitudes of people with musculoskeletal pain towards physiotherapist delivered

telehealth during the COVID-19 pandemic. *Musculoskeletal Science and Practice* 58, 102500. doi: 10.1016/j.msksp.2021.102500

Bartos, L.J., Funes, M.J., Ouellet, M., Posadas, M.P., Immink, M.A. and Krägeloh, C. 2022. A feasibility study of a program integrating mindfulness, yoga, positive psychology, and emotional intelligence in tertiary-level student musicians. *Mindfulness* 13(10), pp. 2507-2528. doi: 10.3389/fpsyg.2021.642992

Baumeister, R.F., Vohs, K.D., Nathan DeWall, C. and Zhang, L. 2007. How emotion shapes behavior: feedback, anticipation, and reflection, rather than direct causation. *Personality and Social Psychology Review* 11(2), pp. 167-203. doi: 10.1177/1088868307301033

Baxter, S. 2020. *Music performance anxiety in student orchestras: do music students suffer more than non-music students?* Available at: <https://musicscience.net/wp-content/uploads/2020/10/baxter.pdf> [Accessed: 26 March 2025]

Bellucci, G. and Seedhom, B.B. 2001. Mechanical behaviour of articular cartilage under tensile cyclic load. *Rheumatology* 40(12), pp. 1337-1345. doi: 10.1093/rheumatology/40.12.1337

Bennell, K. 2021. Digital health approaches for the lifestyle management of osteoarthritis. *Osteoarthritis and Cartilage* 29, S8. doi: 10.1016/j.joca.2021.02.020

Bennell, K.L. et al. 2021. Physiotherapists and patients report positive experiences overall with telehealth during the COVID-19 pandemic: a mixed-methods study. *Journal of Physiotherapy* 67(3), pp. 201-209. doi: 10.1016/j.jphys.2021.06.009

Bennell, K.L., Dobson, F. and Hinman, R.S. 2014. Exercise in osteoarthritis: moving from prescription to adherence. *Best Practice & Research: Clinical Rheumatology* 28(1), pp. 93-117. doi: 10.1016/j.berh.2014.01.009

Bennett, C.J. and Grant, M.J. 2004. Specialisation in physiotherapy: a mark of maturity. *Australian Journal of Physiotherapy* 50(1), pp. 3-5. doi: 10.1016/S0004-9514(14)60242-7

Bennett, D. and Hennekam, S. 2018. Self-authorship and creative industries workers' career decision-making. *Human Relations* 71(11), pp. 1454-1477. doi: 10.1177/0018726717747369

Bennett, G.G. and Glasgow, R.E. 2009. The delivery of public health interventions via the Internet: actualizing their potential. *Annual Review of Public Health* 30, pp. 273-292. doi: 10.1146/annurev.publhealth.031308.100235

Bernard, B. P. and Putz-Anderson, V. 1997. *Musculoskeletal disorders and workplace factors: a critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back*. Available at: <https://stacks.cdc.gov/view/cdc/21745> [Accessed: 25 August 2025].

Bernard, C., Courouve, L., Bouée, S., Adjémian, A., Chrétien, J.C. and Niedhammer, I. 2011. Biomechanical and psychosocial work exposures and musculoskeletal symptoms among vineyard workers. *Journal of Occupational Health* 53(5), pp. 297-311. doi: 10.1539/joh.10-0031-oa

Bernhard H.C. II. 2007. A comparison of burnout between undergraduate music and non-music majors. *Visions of Research in Music Education* 9(1), 3.

Berque, P., Gray, H. and McFadyen, A. 2016. Playing-related musculoskeletal problems among professional orchestra musicians in Scotland. *Medical Problems of Performing Artists* 31(2), pp. 78-86. doi: 10.21091/mppa.2016.2015

Berry, A., McClellan, C., Wanless, B. and Walsh, N. 2021. Evidencing the behaviour change model underpinning a personalised and tailored app for low back pain. *Physiotherapy* 113, 176. doi: 10.1016/j.physio.2021.10.184

Berry, A., McClellan, C., Wanless, B. and Walsh, N. 2022. A tailored app for the self-management of musculoskeletal conditions: evidencing a logic model of behavior change. *JMIR Formative Research* 6(3), e32669. doi: 10.2196/32669

Berry, A.E. 2019. *Physical activity and osteoarthritis: fostering autonomous motivation and self-efficacy via a digital intervention*. PhD thesis, University of the West of England.

Bert, F., Giacometti, M., Gualano, M.R. and Siliquini, R. 2014. Smartphones and health promotion: a review of the evidence. *Journal of Medical Systems* 38, pp. 1-11. doi: 10.1007/s10916-013-9995-7

Betancourt, J.R., Green, A.R. and Carrillo, J.E. 2002. *Cultural competence in health care: emerging frameworks and practical approaches*. Available at: <https://www.commonwealthfund.org/publications/fund-reports/2002/oct/cultural-competence-health-care-emerging-frameworks-and> [Accessed: 14 March 2025].

Bevan, S. 2015. Economic impact of musculoskeletal disorders (MSDs) on work in Europe. *Best Practice & Research Clinical Rheumatology* 29(3), pp. 356-373. doi: 10.1016/j.berh.2015.08.002

Bhuyan, S.S. et al. 2017. Privacy and security issues in mobile health: current research and future directions. *Health Policy and Technology* 6(2), pp. 188-191. doi: 10.1016/j.hlpt.2017.01.004

Birt, L., Scott, S., Cavers, D., Campbell, C. and Walter, F. 2016. Member checking: a tool to enhance trustworthiness or merely a nod to validation? *Qualitative Health Research* 26(13), pp. 1802-1811. doi: 10.1177/1049732316654870

Bishop, D. 2003. Warm up II: performance changes following active warm up and how to structure the warmup. *Sports Medicine* 33, pp. 483-498. doi: 10.2165/00007256-200333070-00002

Blake, H., Chaplin, W.J. and Gupta, A. 2024. The effectiveness of digital interventions for self-management of chronic pain in employment settings: a systematic review. *British Medical Bulletin* 151(1), pp. 36-48. doi: 10.1093/bmb/ldae007

Blake, H., Somerset, S. and Greaves, S. 2022. The Pain at Work toolkit for employees with chronic or persistent pain: a collaborative-participatory study. *Healthcare* 10(1), 56. doi: 10.3390/healthcare10010056

Bloor, M. and Wood, F. 2006. *Keywords in qualitative methods: A vocabulary of research concepts*. London: Sage Publications.

Bodenheimer, T., Lorig, K., Holman, H. and Grumbach, K. 2002. Patient self-management of chronic disease in primary care. *Journal of the American Medical Association* 288(19), pp. 2469-2475. doi: 10.1001/jama.288.19.2469

Boland, A., Cherry, M.G. and Dickson, R. 2017. *Doing a systematic review: a student's guide*. 2nd ed. Los Angeles: Sage Publications.

Bolling, C., van Rijn, R.M., Pasman, H.R., van Mechelen, W. and Stubbe, J.H. 2021. In your shoes: a qualitative study on the perspectives of professional dancers and staff regarding dance injury and its prevention. *Translational Sports Medicine* 4(3), pp. 386-394. doi: 10.1002/tsm2.226

Bordin, E.S. 1979. The generalizability of the psychoanalytic concept of the working alliance. *Psychotherapy: Theory, Research & Practice* 16(3), pp. 252-260. doi: 10.1037/h0085885

Borghouts, J. et al. 2021. Barriers to and facilitators of user engagement with digital mental health interventions: systematic review. *Journal of Medical Internet Research* 23(3), e24387. doi: 10.2196/24387

Bossen, D., Veenhof, C., Van Beek, K.E., Spreeuwenberg, P.M., Dekker, J. and De Bakker, D.H. 2013. Effectiveness of a web-based physical activity intervention in patients with knee and/or hip osteoarthritis: randomized controlled trial. *Journal of Medical Internet research* 15(11), e2662. doi: 10.2196/jmir.2662

Boucher, E.M., Ward, H.E., Mounts, A.C. and Parks, A.C. 2021. Engagement in digital mental health interventions: can monetary incentives help? *Frontiers in Psychology* 12, 746324. doi: 10.3389/fpsy

Bowling, A. 2014. *Research methods in health: investigating health and health services*. 4th ed. New York: McGraw-Hill education.

Bragge, P., Bialocerkowski, A. and McMeeken, J. 2006. A systematic review of prevalence and risk factors associated with playing-related musculoskeletal disorders in pianists. *Occupational Medicine* 56(1), pp. 28-38. doi: 10.1093/occmed/kqi177

Brandfonbrener, A.G. 2003. Musculoskeletal problems of instrumental musicians. *Hand Clinics* 19(2), pp. 231-239. doi: 10.1016/s0749-0712(02)00100-2

Braun, V. and Clarke, V. 2008. Using thematic analysis in psychology. *Qualitative Research in Psychology* 3(2), pp. 77-101. doi: 10.1191/1478088706qp063oa

Braun, V. and Clarke, V. 2019. To saturate or not to saturate? Questioning data saturation as a useful concept for thematic analysis and sample-size rationales. *Qualitative Research in Sport, Exercise and Health* 13(2), pp. 201-216. do: 10.1080/2159676X.2019.1704846

Braun, V. and Clarke, V. 2021a. Can I use TA? Should I use TA? Should I not use TA? Comparing reflexive thematic analysis and other pattern-based qualitative analytic approaches. *Counselling and Psychotherapy Research* 21(1), pp. 37-47. doi: 10.1002/capr.12360

Braun, V. and Clarke, V. 2021b. *Thematic analysis: a practical guide*. London: Sage Publications.

Brickwood, K.J., Williams, A.D., Watson, G. and O'Brien, J. 2020. Older adults' experiences of using a wearable activity tracker with health professional feedback over a 12-month randomised controlled trial. *Digital Health* 6, 2055207620921678. doi: 10.1177/2055207620921678

Brinkmann, S. and Kvale, S. 2015. *InterViews: learning the craft of qualitative research interviewing*. 3rd ed. California: Sage Publications

British Association for Performing Arts Medicine 2025. *Practitioner Search*. Available at: <https://www.bapam.org.uk/practitioner-search/> [Accessed 07 January 2025].

Brukner, P., Khan, K. and Bahr, R. 2012. *Clinical sports medicine*. 4th ed. Sydney: McGraw-Hill

Brumitt, J. and Cuddeford, T. 2015. Current concepts of muscle and tendon adaptation to strength and conditioning. *International Journal of Sports Physical Therapy* 10(6), pp. 748-759.

Bruyneel, A.-V., Stern, F., Schmid, A., Rieben, N. and James, C. E. 2024. Network analyses of physical and psychological factors of playing-related musculoskeletal disorders in student musicians: a cross-sectional study. *BMC Musculoskeletal Disorders* 25(1), 979. doi: 10.1186/s12891-024-08103-8

Bryan, M.L., Bryce, A.M. and Roberts, J. 2020. *Presenteeism in the UK: effects of physical and mental health on worker productivity*. Available at: <https://sheffield.ac.uk/media/12544/download> [Accessed: 25 August 2025].

Bryman, A. 2016. *Social research methods*. Oxford: Oxford University Press.

Buckley, T. and Manchester, R. 2006. Overuse injuries in non-classical recreational instrumentalists. *Medical Problems of Performing Artists* 21(2), pp. 80-87.
doi: 10.21091/mppa.2006.2015

Burns, K. E. Duffett, M., Kho, M. E., Meade, M. O., Adhikari, N. K., Sinuff, T. and Cook, D. J. 2008. A guide for the design and conduct of self-administered surveys of

clinicians. *Canadian Medical Association Journal* 179(3), pp. 245-252. doi: 10.1503/cmaj.080372.

Butkovic, A. and Rancic Dopudj, D. 2017. Personality traits and alcohol consumption of classical and heavy metal musicians. *Psychology of Music* 45(2), pp. 246-256. doi: 10.1177/0305735616659128

Byrne, D. 2022. A worked example of Braun and Clarke's approach to reflexive thematic analysis. *Quality & Quantity* 56(3), pp. 1391-1412. doi: 10.1007/s11135-021-01182-y

Caldron, P.H., Calabrese, L.H., Clough, J.D., Lederman, R.J., Williams, G. and Leatherman, J. 1986. A survey of musculoskeletal problems encountered in high-level musicians. *Medical Problems of Performing Artists* 1(4), pp.136-139.

Campbell, B. et al. 2007. International Society of Sports Nutrition position stand: protein and exercise. *Journal of the International Society of Sports Nutrition* 4, 8. doi: 10.1186/1550-2783-4-8

Campbell, B.D., Hedley, N. and Hertzmann, A. 2024. Art and artificial intelligence. *Computer Graphics and Applications* 44(2), pp. 10-11. doi: 10.1109/MCG.2024.3359128

Cargnin, Z.A., Schneider, D.G. and Rosa-Junior, J.N. 2023. Digital self-care in the management of spine musculoskeletal disorders: A systematic review and meta-analysis. *Revista Latino-Americana de Enfermagem* 31, e3908. doi: 10.1590/1518-8345.6423.3909

Cash, P., Wrobel, A., Maier, A. and Hansen, J.P. 2023. Understanding long-term behaviour change techniques: a mixed methods study. *Journal of Engineering Design* 34(5-6), pp. 383-410. doi: 10.1080/09544828.2023.2227933

Cerveró, C., Martín Ruiz, J., Ruiz Sanchis, L. and Ros Ros, C. 2018. Pain perception in clarinetists with playing-related pain after implementing a specific exercise program. *Medical Problems of Performing Artists* 33(4), pp. 238-242. doi: 10.21091/mppa.2018.4035

Chan, C. and Ackermann, B. 2014. Evidence-informed physical therapy management of performance-related musculoskeletal disorders in musicians. *Frontiers in Psychology* 5. doi: 10.3389/fpsyg.2014.00706

Chan, C., Driscoll, T. and Ackermann, B. 2012. Development of a specific exercise programme for professional orchestral musicians. *Injury Prevention* 19(4), pp. 257-263. doi: 10.1136/injuryprev-2012-040608

Chan, C., Driscoll, T. and Ackermann, B. 2013a. The usefulness of on-site physical therapy-led triage services for professional orchestral musicians—a national cohort study. *BMC Musculoskeletal Disorders* 14, pp. 1-9. doi: 10.1186/1471-2474-14-98

Chan, C., Driscoll, T. and Ackermann, B. 2013b. Exercise DVD effect on musculoskeletal disorders in professional orchestral musicians. *Occupational Medicine* 64(1), pp. 23-30. doi: 10.3389/fpsyg.2014.00706

Chan, C., Driscoll, T. and Ackermann, B.J. 2014. Effect of a musicians' exercise intervention on performance-related musculoskeletal disorders. *Medical Problems of Performing Artists* 29(4), pp.181-188. doi: 10.21091/mppa.2014.4038

Charmaz, K. 2008. Grounded theory as an emergent method. In: Hesse-Biber, S. and Leavy, P. eds. *Handbook of emergent methods*. New York: The Guilford Press, pp. 155-170.

Check, J. and Schutt, R.K. 2011. *Research methods in education*. Los Angeles: Sage Publications.

Chen, J., Mullins, C.D., Novak, P. and Thomas, S.B. 2016. Personalized strategies to activate and empower patients in health care and reduce health disparities. *Health Education & Behavior*, 43(1), pp. 25-34. doi: 10.1177/1090198115579415

Chen, M. et al. 2021. Efficacy of mobile health in patients with low back pain: systematic review and meta-analysis of randomized controlled trials. *JMIR mHealth and uHealth* 9(6), e26095. doi: 10.2196/26095

Chi, J.Y., Halaki, M. and Ackermann, B.J. 2020. Ergonomics in violin and piano playing: A systematic review. *Applied Ergonomics* 88, 103143. doi: 10.1016/j.apergo.2020.103143

Chiauzzi, E., Pujol, L.A., Wood, M., Bond, K., Black, R., Yiu, E. and Zacharoff, K. 2010. painACTION-back pain: a self-management website for people with chronic back pain. *Pain Medicine* 11(7), pp. 1044-1058. doi: 10.1111/j.1526-4637.2010.00879.x

Cieza, A., Causey, K., Kamenov, K., Hanson, S. W., Chatterji, S. and Vos, T. 2020. Global estimates of the need for rehabilitation based on the Global Burden of Disease study 2019: a systematic analysis for the Global Burden of Disease Study 2019. *The Lancet* 396(10267), pp. 2006-2017. doi: 10.1016/S0140-6736(20)32340-0

Cizek, E., Kelly, P., Kress, K. and Mattfeldt-Beman, M. 2016. Factors affecting healthful eating among touring popular musicians and singers. *Medical Problems of Performing Artists* 31(2), pp. 63-68. doi: 10.21091/mppa.2016.2013

Clark, T. and Lisboa, T. 2013. Training for sustained performance: moving toward long-term musician development. *Medical Problems of Performing Artists* 28(3), pp. 159-168. doi: 10.21091/mppa.2013.3031

Cline, A., Knowles, N., West, J., Homolova, L., Grey, C., Mugweni, E. and Gould, A. 2025. *Evaluating behaviour change interventions: 'Improving health and wellbeing: a guide to using behavioural science in policy and practice'*. Available at: <https://phwwhocc.co.uk/bsu/wp-content/uploads/sites/6/2023/03/PHW-BSU-Guide-1.pdf> [Accessed: 04 March 2025].

Clohesy, S., Kempton, C., Ryan, K., Grinbergs, P. and Elliott, M.T. 2024. Exploring older adults' perceptions of using digital health platforms for self-managing musculoskeletal health conditions: focus group study. *JMIR Aging* 7, e55693. doi: 10.2196/55693

Cohen, J. 1988. *Statistical power analysis for the behavioral sciences*. New York: Routledge.

Cohen, S. and Ginsborg, J. 2022. One year on: the impact of COVID-19 on the lives of freelance orchestral musicians in the United Kingdom. *Frontiers in Psychology* 13, 885606. doi: 10.3389/fpsyg.2022.885606

Complete Music Update 2020. *Self-employed who make up 72% of the music industry being let down by government as COVID-19 crisis grows, say trade bodies*.

Available at: <https://completemusicupdate.com/article/uk-music-industry-ramps-up-call-for-government-support-as-covid-19-crisis-continues-while-impala-launches-pan-european-industry-taskforce/> [Accessed: 09 January 2021].

Connolly, P. 2007. *Quantitative data analysis in education: a critical introduction using SPSS*. London: Routledge

Cooper, C. 2018. Global, regional, and national disability-adjusted life-years (DALY) for 359 diseases and injuries and health life expectancy (HALE) for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet* 392(10159), pp. 1859-1922. doi: 10.1016/S0140-6736(18)32335-3

Corbin, J.M. and Strauss, A. 1988. *Unending work and care: managing chronic illness at home*. San Francisco: Jossey-Bass Publications.

Craig, P., Dieppe, P., Macintyre, S., Michie, S., Nazareth, I. and Petticrew, M. 2008. Developing and evaluating complex interventions: the new Medical Research Council guidance. *British Medical Journal* 337, a1655. doi: 10.1136/bmj.a1655

Cramer, J.D., Johnson, J.T. and Nilsen, M.L. 2018. Pain in head and neck cancer survivors: prevalence, predictors, and quality-of-life impact. *Otolaryngology–Head and Neck Surgery* 159(5), pp. 853-858. doi: 10.1177/0194599818783964

Cranen, K., Groothuis-Oudshoorn, C.G., Vollenbroek-Hutten, M.M. and Ijzerman, M.J. 2017. Toward patient-centered telerehabilitation design: understanding chronic pain patients' preferences for web-based exercise telerehabilitation using a discrete

choice experiment. *Journal of Medical Internet Research* 19(1), e26. doi: 10.2196/jmir.5951

Crawford, J.O. et al. 2020. Musculoskeletal health in the workplace. *Best Practice Research Clinical Rheumatology* 34(5), 101558. doi: 10.1016/j.berh.2020.101558

Creech, A. et al. 2008. From music student to professional: the process of transition. *British Journal of Music Education* 25(3), pp. 315-331. doi: 10.1017/S0265051708008127

Cremers, H.P. et al. 2021. Successful implementation of eHealth interventions in healthcare: development of an eHealth implementation guideline. *Health Services Management Research* 34(4), pp. 269-278. doi: 10.1177/0951484821994421

Creswell, J. W. 2014. *Research design: qualitative, quantitative and mixed methods approaches*. 4th ed. California: Sage Publications.

Creswell, J.W. and Plano Clark, V.L. 2011. *Designing and conducting mixed methods research*. 2nd ed. California: Sage Publications.

Creswell, J.W. and Plano Clark, V.L. 2017. *Designing and conducting mixed methods research*. 3rd ed. California: Sage Publications.

Creswell, J.W., Fetters, M.D. and Ivankova, N.V. 2004. Designing a mixed methods study in primary care. *The Annals of Family Medicine* 2(1), pp. 7-12. doi: 10.1370/afm.104

Crnivec, U. 2004. Prevalence of playing-related musculoskeletal disorders in young Slovenian string players. *Medical Problems of Performing Artists* 19(2), pp. 57-62. doi: 10.21091/mppa.2004.3023

Cruder, C., Barbero, M., Koufaki, P., Soldini, E. and Gleeson, N. 2020. Prevalence and associated factors of playing-related musculoskeletal disorders among music students in Europe. Baseline findings from the Risk of Music Students (RISMUS) longitudinal multicentre study. *PLoS One* 15(12), e0242660. doi: 10.1371/journal.pone.0242660

Cruder, C., Barbero, M., Soldini, E. and Gleeson, N. 2021. Patterns of pain location in music students: a cluster analysis. *BMC Musculoskeletal Disorders* 22(1), 184. doi: 10.1186/s12891-021-04046-6

Cunningham, J. et al. 2024. Barriers and enablers to the management of osteoarthritis in primary care in Ireland from the perspective of healthcare professionals and individuals with osteoarthritis: a qualitative study using the Theoretical Domains Framework. *BMJ Open* 14(12), e087054. doi: 10.1136/bmjopen-2024-087054

Currie, M., Philip, L.J. and Roberts, A. 2015. Attitudes towards the use and acceptance of eHealth technologies: a case study of older adults living with chronic pain and implications for rural healthcare. *BMC Health Services Research* 15, pp. 1-12. doi: 10.1186/s12913-015-0825-0

Curry, L. and Nunez-Smith, M. 2015. *Mixed methods in health sciences research: a practical primer*. California: Sage Publications.

Cypress, B. S. 2017. Rigor or reliability and validity in qualitative research: perspectives, strategies, reconceptualization, and recommendations. *Dimensions of Critical Care Nursing* 36(4), pp. 253-263. doi: 10.1097/DCC.0000000000000253

Damgaard, M.T. and Gravert, C. 2018. The hidden costs of nudging: experimental evidence from reminders in fundraising. *Journal of Public Economics* 157, pp. 15-26. doi: 10.1016/j.jpubeco.2017.11.005

Darley, S., Coulson, T., Peek, N., Moschogianis, S., Van Der Veer, S.N., Wong, D.C. and Brown, B.C. 2022. Understanding how the design and implementation of online consultations affect primary care quality: systematic review of evidence with recommendations for designers, providers, and researchers. *Journal of Medical Internet Research* 24(10), e37436. doi: 10.2196/37436

Darlow, B. et al. 2019. The Fear Reduction Exercised Early (FREE) approach to management of low back pain in general practice: a pragmatic cluster-randomised controlled trial. *PLoS Medicine* 16(9), e1002897. doi: 10.1371/journal.pmed.1002897

Davergne, T., Meidinger, P., Dechartres, A. and Gossec, L. 2023. The effectiveness of digital apps providing personalized exercise videos: systematic review with meta-analysis. *Journal of Medical Internet Research* 25, e45207. doi: 10.2196/45207

Davern, M. 2013. Nonresponse rates are a problematic indicator of nonresponse bias in survey research. *Health Services Research* 48(3), pp. 905–912. doi: 10.1111/1475-6773.12070

Davies, J. 2020. Alexander Technique classes improve pain and performance factors in tertiary music students. *Journal of Bodywork and Movement Therapies* 24(1), pp. 1-7. doi: 10.1016/j.jbmt.2019.04.006

Davies, J. and Mangion, S. 2002. Predictors of pain and other musculoskeletal symptoms among professional instrumental musicians: elucidating specific effects. *Medical Problems of Performing Artists* 17(4), pp. 155-168.

Davies, K.A., Macfarlane, G.J., Nicholl, B.I., Dickens, C., Morriss, R., Ray, D. and McBeth, J. 2008. Restorative sleep predicts the resolution of chronic widespread pain: results from the EPIFUND study. *Rheumatology* 47(12), pp. 1809-1813. doi: 10.1093/rheumatology/ken389

Davis, R., Campbell, R., Hildon, Z., Hobbs, L. and Michie, S. 2015. Theories of behaviour and behaviour change across the social and behavioural sciences: a scoping review. *Health Psychology Review* 9(3), pp. 323-344. doi: 10.1080/17437199.2014.941722

De Bézenac, C. and Swindells, R. 2010. No pain, no gain? Motivation and self-regulation in music learning. *International Journal of Education & the Arts* 10.

De Kock, S., van der Merwe, L. and Wentink, C. 2023. Lived experiences of musicians with pain: an interpretative phenomenological analysis of performance-related pain of professional violinists. *International Journal of Qualitative Studies on Health and Well-being* 18(1), 2203624. doi: 10.1080/17482631.2023.2203624

De Vries, H. and Brug, J. 1999. Computer-tailored interventions motivating people to adopt health promoting behaviours: introduction to a new approach. *Patient Education and Counselling* 36(2), pp. 99-105. doi: 10.1016/s0738-3991(98)00127-x

Deakin, H. and Wakefield, K. 2014. Skype interviewing: reflections of two PhD researchers. *Qualitative Research* 14(5), pp. 603-616. doi: 10.1177/1468794113488126

Deci, E. L. and Ryan, R. M. 2008. Self-determination theory: a macrotheory of human motivation, development, and health. *Canadian Psychology/Psychologie canadienne* 49(3), pp. 182-185. doi: 10.1037/a0012801

Demerouti, E., Le Blanc, P.M., Bakker, A.B., Schaufeli, W.B. and Hox, J. 2009. Present but sick: a three-wave study on job demands, presenteeism and burnout. *Career Development International* 14(1), pp. 50-68. doi: 10.1108/13620430910933574

Denscombe, M. 2017. *The good research guide: for small-scale social research projects*. Maidenhead: McGraw-Hill Education.

Dicianno, B.E. et al. 2015. Perspectives on the evolution of mobile (mHealth) technologies and application to rehabilitation. *Physical Therapy* 95(3), pp. 397-405. doi: 10.2522/ptj.20130534

DiCicco-Bloom, B. and Crabtree, B.F. 2006. The qualitative research interview. *Medical Education* 40(4), pp. 314-321. doi: 10.1111/j.1365-2929.2006.02418.x

Dick, R.W., Berning, J.R., Dawson, W., Ginsburg, R.D., Miller, C. and Shybut, G.T.

2013. Athletes and the arts—the role of sports medicine in the performing

arts. *Current Sports Medicine Reports* 12(6), pp. 397-403. doi:

10.1249/JSR.0000000000000009

Dillman, D.A., Smyth, J.D. and Christian, L.M. 2014. *Internet, phone, mail, and*

mixed-mode surveys: The tailored design method. 4th ed. New Jersey: John Wiley &

Sons.

Dobson, M.C. 2011. Insecurity, professional sociability, and alcohol: Young freelance

musicians' perspectives on work and life in the music profession. *Psychology of*

Music 39(2), pp. 240-260.

Dohn, A., Garza-Villarreal, E.A., Chakravarty, M.M., Hansen, M., Lerch, J.P. and

Vuust, P. 2015. Gray-and white-matter anatomy of absolute pitch

possessors. *Cerebral Cortex* 25(5), pp. 1379-1388. doi: 10.1093/cercor/bht334

Donaghy, E. et al. 2019. Acceptability, benefits, and challenges of video consulting: a

qualitative study in primary care. *British Journal of General Practice* 69(686), pp.

e586-e594. doi: 10.3399/bjgp19X704141

Doyon, J., Penhune, V. and Ungerleider, L.G. 2003. Distinct contribution of the

cortico-striatal and cortico-cerebellar systems to motor skill learning.

Neuropsychologia 41(3), pp. 252-262. doi: 10.1016/S0028-3932(02)00158-6

Du, S. et al. 2017. Self-management program for chronic low back pain: a systematic

review and meta-analysis. *Patient Education and Counseling* 100(1), pp. 37-49. doi:

10.1016/j.pec.2016.07.029

Dubad, M., Elahi, F. and Marwaha, S. 2021. The clinical impacts of mobile mood-monitoring in young people with mental health problems: the MeMO study. *Frontiers in Psychiatry* 12, doi: 10.3389/fpsyt.2021.687270

Dupuis, F., Cherif, A., Batcho, C., Massé-Alarie, H. and Roy, J.S. 2023. The Tampa scale of kinesiophobia: a systematic review of its psychometric properties in people with musculoskeletal pain. *The Clinical Journal of Pain* 39(5), pp. 236-247.
doi: 10.1097/AJP.0000000000001104

Eaton, L.H., Langford, D.J., Meins, A.R., Rue, T., Tauben, D.J. and Doorenbos, A.Z. 2018. Use of self-management interventions for chronic pain management: a comparison between rural and nonrural residents. *Pain Management Nursing* 19(1), pp. 8-13. doi: 10.1016/j.pmn.2017.09.004

Edwards, R. and Holland, J. 2013. *What is qualitative interviewing?* London: Bloomsbury Academic.

Edwards, R.R., Almeida, D.M., Klick, B., Haythornthwaite, J.A. and Smith, M.T. 2008. Duration of sleep contributes to next-day pain report in the general population. *Pain* 137(1), pp. 202-207. doi: 10.1016/j.pain.2008.01.025

Egerton, T., Bennell, K.L., McManus, F., Lamb, K.E. and Hinman, R.S. 2022. Comparative effect of two educational videos on self-efficacy and kinesiophobia in people with knee osteoarthritis: an online randomised controlled trial. *Osteoarthritis and Cartilage* 30(10), pp. 1398-1410. doi: 10.1016/j.joca.2022.05.010

Eisele, A., Schagg, D., Kraemer, L.V., Bengel, J. and Goehner, W. 2019. Behaviour change techniques applied in interventions to enhance physical activity adherence in

patients with chronic musculoskeletal conditions: a systematic review and meta-analysis. *Patient Education and Counseling* 102(1), pp. 25-36. doi:

10.1016/j.pec.2018.09.018

Elbaum, L. 1986. Musculoskeletal problems of instrumental musicians. *Journal of Orthopaedic & Sports Physical Therapy* 8(6), pp. 285-287.

Eldevik, M.F., Flo, E., Moen, B.E., Pallesen, S. and Bjorvatn, B. 2013. Insomnia, excessive sleepiness, excessive fatigue, anxiety, depression and shift work disorder in nurses having less than 11 hours in-between shifts. *PloS One* 8(8). doi:

10.1371/journal.pone.0070882

Engel, G.L. 1977. The need for a new medical model: a challenge for biomedicine. *Science* 196(4286), pp. 129-136. doi: 10.1126/science.847460

Etikan, I., Musa, S.A. and Alkassim, R.S. 2016. Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics* 5(1), pp. 1-4. doi: 10.11648/j.ajtas.20160501.11

Evans, A., Rennie-Salonen, B., Wijsman, S. and Ackermann, B. 2024. A scoping review of occupational health education programs for music students and teachers. *Research Studies in Music Education* 46(3), pp. 493-515. doi:

10.1177/1321103X241235794

Falla, D.L., Jull, G.A. and Hodges, P.W. 2004. Patients with neck pain demonstrate reduced electromyographic activity of the deep cervical flexor muscles during performance of the craniocervical flexion test. *Spine* 29(19), pp. 2108-2114.

doi: 10.1097/01.brs.0000141170.89317.0e

Fatoye, F., Gebrye, T., Mbada, C. and Useh, U. 2023. Economic evaluations of digital health interventions for the management of musculoskeletal disorders: systematic review and meta-analysis. *Journal of Medical Internet Research* 25, e41113. doi: 10.2196/41113

Faul, F., Erdfelder, E., Lang, A.G. and Buchner, A. 2007. G* Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods* 39(2), pp. 175-191. doi: 10.3758/BF03193146

Fernholz, I. et al. 2019. Performance anxiety in professional musicians: a systematic review on prevalence, risk factors and clinical treatment effects. *Psychological Medicine* 49(14), pp. 2287-2306. doi: 10.1017/S0033291719001910

Ferreira, G., Traeger, A.C., Machado, G., O'Keeffe, M. and Maher, C.G. 2019. Credibility, accuracy, and comprehensiveness of internet-based information about low back pain: a systematic review. *Journal of Medical Internet Research* 21(5), e13357. doi: 10.2196/13357

Field, A. 2013. *Discovering statistics using IBM SPSS statistics*. 4th ed. London: Sage Publications.

Finlay, L. and Gough, B. 2008. *Reflexivity: a practical guide for researchers in health and social sciences*. New York: John Wiley & Sons.

Flick, U. 2018. *Doing qualitative data collection—charting the routes. The SAGE handbook of qualitative data collection*. London: Sage Publications

Fowler, F. 2018. *Survey research methods*. 5th ed. Los Angeles: Sage Publications

Frank, C., Land, W.M., Popp, C. and Schack, T. 2014. Mental representation and mental practice: experimental investigation on the functional links between motor memory and motor imagery. *PloS one* 9(4), e95175. doi: 10.1371/journal.pone.0095175

Fung Ying, L., Evens, G.I., Hashim, M.N. and Chiat, L.F. 2015. Tension release in piano playing: teaching Alexander Technique to undergraduate piano majors. *Procedia-Social and Behavioral Sciences* 174, pp. 2413-2417.

Gaertner, J., Elsner, F., Pollmann-Dahmen, K., Radbruch, L. and Sabatowski, R. 2004. Electronic pain diary: a randomized crossover study. *Journal of Pain and Symptom Management* 28(3), pp. 259-267. doi: 10.1016/j.jpainsymman.2003.12.017

Gallagher, S. and Heberger, J.R. 2013. Examining the interaction of force and repetition on musculoskeletal disorder risk: a systematic literature review. *Human Factors* 55(1), pp. 108-124. doi: 10.1177/0018720812449648

Gallagher, S., Marras, W.S., Litsky, A.S. and Burr, D. 2005. Torso flexion loads and the fatigue failure of human lumbosacral motion segments. *Spine* 30(20), pp. 2265-2273. doi: 10.1097/01.brs.0000182086.33984.b3

Gallagher, S., Marras, W.S., Litsky, A.S., Burr, D., Landoll, J. and Matkovic, V. 2007. A comparison of fatigue failure responses of old versus middle-aged lumbar motion segments in simulated flexed lifting. *Spine* 32(17), pp.1832-1839. doi: 10.1097/01.brs.0000259812.75138.c0

Garrett, S.M., Rose, S.B. and McKinlay, E.M. 2022. Young people talk about primary care and telehealth: a survey of 15- to 25-year-olds in the Wellington region of New

Zealand. *Health & Social Care in the Community* 30(6), pp. e6345-e6355. doi: 10.1111/hsc.14076

Gatchel, R. J., Peng, Y. B., Peters, M. L., Fuchs, P. N. and Turk, D. C. 2007. The biopsychosocial approach to chronic pain: scientific advances and future directions. *Psychological Bulletin* 133(4), pp. 581-624. doi: 10.1037/0033-2909.133.4.581

Gembris, H., Menze, J., Heye, A. and Bullerjahn, C. 2020. High-performing young musicians' playing-related pain. Results of a large-scale study. *Frontiers in Psychology* 11, 564736. doi: 10.3389/fpsyg.2020.564736

Geraghty, A. W. A. et al. 2024. Supporting self-management of low back pain with an internet intervention with and without telephone support in primary care (SupportBack 2): a randomised controlled trial of clinical and cost-effectiveness. *The Lancet Rheumatology* 6(7), pp. e424-e437. doi: 10.1016/S2665-9913(24)00086-9doi

Gill, T.K. et al. 2023. Global, regional, and national burden of other musculoskeletal disorders, 1990–2020, and projections to 2050: a systematic analysis of the Global Burden of Disease Study 2021. *The Lancet Rheumatology* 5(11), pp. e670-e682. doi: 10.1016/S2665-9913(23)00232-1

Glaser, B.G. 1978. *Theoretical sensitivity: advances in the methodology of grounded theory*. Los Angeles: Sociology Press

Gluud, L. L. 2006. Bias in clinical intervention research. *American Journal of Epidemiology* 163(6), pp. 493-501. doi: 10.1093/aje/kwj069

Gothe, N. P. et al. 2015. Physical activity levels and patterns in older adults: the influence of a DVD-based exercise program. *Journal of Behavioral Medicine* 38(1), pp. 91-97. doi: 10.1007/s10865-014-9581-6

Gómez-Rodríguez, R., Díaz-Pulido, B., Gutiérrez-Ortega, C., Sánchez-Sánchez, B. and Torres-Lacomba, M. 2020. Prevalence, disability and associated factors of playing-related musculoskeletal pain among musicians: a population-based cross-sectional descriptive study. *International Journal of Environmental Research and Public Health* 17(11), 3991. doi: 10.3390/ijerph17113991

GOV.UK. 2023. *Graduate labour market statistics, calendar year 2023*. Available at: <https://explore-education-statistics.service.gov.uk/find-statistics/graduate-labour-markets> [Accessed: 20 November 2024]

Graham, I. D., Logan, J., Harrison, M. B., Straus, S. E., Tetroe, J., Caswell, W. and Robinson, N. 2006. Lost in knowledge translation: time for a map? *Journal of Continuing Education in the Health Professions* 26(1), pp. 13-24. doi: 10.1002/chp.47

Grasaas, E., Fegran, L., Helseth, S., Stinson, J., Martinez, S., Lalloo, C. and Haraldstad, K. 2019. iCanCope With Pain: cultural adaptation and usability testing of a self-management app for adolescents with persistent pain in Norway. *JMIR Research Protocols* 8(6), e12940. doi: 10.2196/12940

Gray-Stanley, J.A., Muramatsu, N., Heller, T., Hughes, S., Johnson, T.P. and Ramirez-Valles, J. 2010. Work stress and depression among direct support professionals: the role of work support and locus of control. *Journal of Intellectual Disability Research* 54(8), pp. 749-761. doi: 10.1111/j.1365-2788.2010.01303.x

Green, B.N., Johnson, C.D. and Adams, A. 2006. Writing narrative literature reviews for peer-reviewed journals: secrets of the trade. *Journal of Chiropractic Medicine* 5(3), pp.101-117. doi: 10.1016/S0899-3467(07)60142-6

Greenhalgh, T., Hinton, L., Finlay, T., Macfarlane, A., Fahy, N., Clyde, B. and Chant, A. 2019. Frameworks for supporting patient and public involvement in research: systematic review and co-design pilot. *Health Expectations* 22(4), pp. 785-801. doi: 10.1111/hex.12888

Greenhalgh, T., Thorne, S. and Malterud, K. 2018. Time to challenge the spurious hierarchy of systematic over narrative reviews? *European Journal of Clinical Investigation* 48(6), e12931. doi: 10.1111/eci.12931

Griffiths, C., Dziedzic, K., Waterfield, J. and Sim, J. 2009. Effectiveness of specific neck stabilization exercises or a general neck exercise program for chronic neck disorders: a randomized controlled trial. *The Journal of Rheumatology* 36(2), pp. 390-397. doi: 10.3899/jrheum.080376

Grindell, C., Coates, E., Croot, L. and O’Cathain, A. 2022. The use of co-production, co-design and co-creation to mobilise knowledge in the management of health conditions: a systematic review. *BMC Health Services Research* 22(1), 877. doi: 10.1186/s12913-022-08079-y

Gross, S. and Musgrave, G. 2016. *Can music make you sick? A study into the incidence of musicians' mental health - part 1: pilot survey report*. Available at: <https://westminsterresearch.westminster.ac.uk/item/q33qy/can-music-make-you-sick-part-1-a-study-into-the-incidence-of-musicians-mental-health> [Accessed: 25 August 2025]

- Guba, E.G. and Lincoln, Y.S. 1994. *Competing paradigms in qualitative research. Handbook of qualitative research*. 2nd ed. California: Sage Publications
- Guest, G., Bunce, A. and Johnson, L. 2006. How many interviews are enough? An experiment with data saturation and variability. *Field Methods* 18(1), pp. 59-82. doi: 10.1177/1525822X05279903
- Guillot, A., Desliens, S., Rouyer, C. and Rogowski, I. 2013. Motor imagery and tennis serve performance: the external focus efficacy. *Journal of Sports Science Medicine* 12(2), pp. 332-338.
- Guptill, C.A. 2011. The lived experience of professional musicians with playing-related injuries: a phenomenological inquiry. *Medical Problems of Performing Artists* 26(2), pp. 84-95. doi: 10.21091/mppa.2011.2013
- Guptill, C.A. and Zaza, C. 2010. Injury prevention: what music teachers can do. *Music Educators Journal* 96(4), pp. 28-34. doi: 10.1177/0027432110370736
- Hannibal, K.E. and Bishop, M.D. 2014. Chronic stress, cortisol dysfunction, and pain: a psychoneuroendocrine rationale for stress management in pain rehabilitation. *Physical Therapy* 94(12), pp. 1816-1825. doi: 10.2522/ptj.20130597
- Hargittai, E. 2020. Potential biases in big data: omitted voices on social media. *New Media & Society* 22(8), pp. 1359-1377. doi: 10.1177/0894439318788322
- Harrison, C., Ruddock, S., O'Halloran, P., Mayes, S., Cook, J. and Ruddock-Hudson, M. 2022. Wellness monitoring for professional ballet dancers: a pilot study. *Journal of Dance Medicine & Science* 25(2), pp. 80-85. doi: 10.12678/1089-313X.061521b

Hartsell, H.D. and Tata, G.E. 1991. A retrospective survey of music-related musculoskeletal problems occurring in undergraduate music students. *Physiotherapy Canada* 43(1), pp. 13-18.

Hassan, E. 2006. Recall bias can be a threat to retrospective and prospective research designs. *The Internet Journal of Epidemiology* 3(2), pp. 339-412. doi: 10.5580/2732

Hauser-Ulrich, S., Künzli, H., Meier-Peterhans, D. and Kowatsch, T. 2020. A smartphone-based health care chatbot to promote self-management of chronic pain (SELMA): pilot randomized controlled trial. *JMIR mHealth and uHealth* 8(4), e15806. doi: 10.2196/15806

Hawkins, J. et al. 2017. Development of a framework for the co-production and prototyping of public health interventions. *BMC Public Health* 17, pp. 1-11. doi: 10.1186/s12889-017-4695-8

Hay-Gibson, N. 2009. Interviews via VoIP: benefits and disadvantages within a PhD study of SMEs. *Library and Information Research* 33(105), pp. 1756-1086.

Haynes, J. and Marshall, L. 2018. Reluctant entrepreneurs: musicians and entrepreneurship in the 'new' music industry. *The British Journal of Sociology* 69(2), pp. 459-482. doi: 10.1111/1468-4446.12286

Healey, E.L. et al. 2023. Supported self-management for all with musculoskeletal pain: an inclusive approach to intervention development: the EASIER study. *BMC Musculoskeletal Disorders* 24(1), 474. doi: 10.1186/s12891-023-06452-4

Health and Care Professions Council 2024. *Why your registration matters*. Available at: <https://www.hcpc-uk.org/registration/your-registration/why-your-registrationmatters/#:~:text=Service%20users%20are%20clear%20about,honest%20when%20things%20go%20wrong> [Accessed: 07 December 2024].

Health and Safety Executive 2021. *The impact of the coronavirus pandemic on the interpretation of health and safety statistics*. Available at: <https://www.hse.gov.uk/statistics/coronavirus/index.htm> [Accessed: 15 August 2021].

Health and Safety Executive 2023. *Work-related musculoskeletal disorders in Great Britain, 2022/23*. Available at: <https://www.firstmats.co.uk/blogs/buying-guides/executive-summary-of-hse-work-related-msds-statistics-2023> [Accessed 24 March 2025].

Heffer, T., Good, M., Daly, O., MacDonell, E. and Willoughby, T. 2019. The longitudinal association between social-media use and depressive symptoms among adolescents and young adults: an empirical reply to Twenge et al. (2018). *Clinical Psychological Science* 7(3), pp. 462-470. doi: 10.1177/2167702618812727

Help Musicians and Musicians' Union 2023. *Musicians' Census report, Help Musicians*. Available at: <https://www.musicianscensus.co.uk/> [Accessed: 23 October 2023)

Help Musicians UK 2014. *Health and wellbeing survey results*. Available at: from http://issuu.com/helpmusiciansuk/docs/help_musicians_uk_health_and_wellbeing?e=10405134/8971874 [Accessed: 24 March 2025]

- Hennink, M. and Kaiser, B.N. 2022. Sample sizes for saturation in qualitative research: a systematic review of empirical tests. *Social Science & Medicine* 292, 114523. doi: 10.1016/j.socscimed.2021.114523
- Hennink, M.M., Kaiser, B.N. and Marconi, V.C. 2017. Code saturation versus meaning saturation: how many interviews are enough? *Qualitative Health Research*, 27(4), pp. 591-608. doi: 10.1177/1049732316665344
- Herman, R. and Clark, T. 2023. It's not a virus! Reconceptualizing and de-pathologizing music performance anxiety. *Frontiers in Psychology* 14, 1194873. doi: 10.3389/fpsyg.2023.1194873
- Hewitt, S., Sephton, R. and Yeowell, G. 2020. The effectiveness of digital health interventions in the management of musculoskeletal conditions: systematic literature review. *Journal of Medical Internet Research* 22(6), 15617. doi: 10.2196/1561
- Hicks, C. 2010. *Research methods for clinical therapists: applied project design and analysis*. 5th ed. London: Churchill Livingstone.
- Higgins, J.P.T., Lasserson, T., Thomas, J., Flemyng, E. and Churchill, R. 2022 *Methodological Expectations of Cochrane Intervention Reviews (MECIR) standards for the conduct and reporting of new Cochrane Intervention Reviews, reporting of protocols and the planning, conduct and reporting of updates*. Available at: <https://community.cochrane.org/sites/default/files/uploads/MECIR%20PRINTED%20BOOKLET%20FINAL%20v1.01.pdf> [Accessed: 20 November 2024]

Hinyard, L.J. and Kreuter, M.W. 2007. Using narrative communication as a tool for health behavior change: a conceptual, theoretical, and empirical overview. *Health Education & Behavior* 34(5), pp. 777-792. doi: 10.1177/1090198106291963

Holden, M.A., Nicholls, E.E., Young, J., Hay, E.M. and Foster, N.E. 2012. Role of exercise for knee pain: what do older adults in the community think? *Arthritis Care & Research* 64(10), pp. 1554-1564. doi: 10.1002/acr.21700

Holloway, I. and Wheeler, S. 2010. Qualitative research in nursing and healthcare. 3rd ed. Chichester: Wiley-Blackwell.

Hornby, G. and Greaves, D. 2022. *Essential evidence-based teaching strategies: ensuring optimal academic achievement for students*. New York: Springer Nature.

Horvath, K.A. 2003. Muscle-ship: The overlooked foundational element of stringed instrument performance technique. *American String Teacher* 53(3), pp. 68-73.

Huang, G.D., Feuerstein, M. and Sauter, S.L. 2002. Occupational stress and work-related upper extremity disorders: concepts and models. *American Journal of Industrial Medicine* 41(5), pp. 298-314. doi: 10.1002/ajim.10045

Huang, W.L. and Yu, H. 2022. Social support in university music students' coping with performance anxiety: people, strategies and performance situations. *Music Education Research* 24(1), pp. 124-135. doi: 10.1080/14613808.2022.2028752

Hupe, M. 2019. EndNote X9. *Journal of Electronic Resources in Medical Libraries* 16(3-4), pp. 117-119.

Iglesias-Carrasco, C., de-la-Casa-Almeida, M., Suárez-Serrano, C., Benítez-Lugo, M. L. and Medrano-Sánchez, E. M. 2024. Efficacy of therapeutic exercise in reducing

pain in instrumental musicians: systematic review and meta-analysis. *Healthcare (Basel)* 12(13). doi: 10.3390/healthcare12131340

Impellizzeri, F.M., Menaspà, P., Coutts, A.J., Kalkhoven, J. and Menaspà, M.J. 2020. Training load and its role in injury prevention, part I: back to the future. *Journal of Athletic Training* 55(9), pp. 885-892. doi: 10.4085/1062-6050-500-19

Ingle, M. 2014. *Evaluation of a trial of an e-health promotion course aimed at Australian tertiary music students*. MSc Dissertation, University of Sydney.

International Association for the Study of Pain (IASP). 2019. *Terminology*. Available at: <https://www.iasp-pain.org/resources/terminology/?ItemNumber=2051&navItemNumber=576> [Accessed: 12 March 2025].

International Labour Office. 2017. *Improving employment and working conditions in health services: report for discussion at the tripartite meeting on improving employment and working conditions in health services*. Available at: <https://www.ilo.org/publications/improving-employment-and-working-conditions-health-services> [Accessed: 12 March 2025].

Ioannou, C.I. and Altenmüller, E. 2015. Approaches to and treatment strategies for playing-related pain problems among Czech instrumental music students: an epidemiological study. *Medical Problems of Performing Artists* 30(3), pp. 135-142. doi: 10.21091/mppa.2015.3027

Irvine, A.B. 2018. Duration, dominance and depth in telephone and face-to-face interviews: a comparative exploration. *International Journal of Qualitative Methods* 17(1), pp. 1-13. doi: 10.1177/1609406918758234

Irvine, A.B. et al. 2015. Mobile-Web app to self-manage low back pain: randomized controlled trial. *Journal of Medical Internet Research* 17(1), e3130. doi: 10.2196/jmir.3130

Jackson, P.L., Lafleur, M.F., Malouin, F., Richards, C.L. and Doyon, J. 2003. Functional cerebral reorganization following motor sequence learning through mental practice with motor imagery. *Neuroimage* 20(2), pp. 1171-1180. doi: 10.1016/S1053-8119(03)00369-0

Jaffe, D.H., Lee, L., Huynh, S. and Haskell, T.P. 2020. Health inequalities in the use of telehealth in the United States in the lens of COVID-19. *Population Health Management* 23(5), pp. 368-377. doi: 10.1089/pop.2020.0186

Jager, J., Putnick, D.L. and Bornstein, M.H. 2017. More than just convenient: the scientific merits of homogeneous convenience samples. *Monographs of the Society for Research in Child Development* 82(2), pp. 13-30. doi: 10.1111/mono.12296

Jain, D., Norman, K., Werner, Z., Makovoz, B., Baker, T. and Huber, S. 2021. Using postmarket surveillance to assess safety-related events in a digital rehabilitation app (Kaia App): observational study. *JMIR Human Factors* 8(4), e25453. doi: 10.2196/25453

Jesson, J., Lacey, F.M. and Matheson, L. 2011. *Doing your literature review: traditional and systematic techniques*. London: Sage Publications

Jiang, X., Sun, W., Chen, Q., Xu, Q., Chen, G. and Bi, H. 2024. Effects of breathing exercises on chronic low back pain: a systematic review and meta-analysis of randomized controlled trials. *Journal of Back and Musculoskeletal Rehabilitation* 37(1), pp. 13-23. doi: 10.3233/BMR-230054

Jibb, L.A. et al. 2020. Electronic data capture versus conventional data collection methods in clinical pain studies: systematic review and meta-analysis. *Journal of Medical Internet Research* 22(6), e16480. doi: 10.2196/16480

Joffe, H., and Yardley, L. 2004. *Content and thematic analysis. Research methods for clinical and health psychology*. London: Sage Publications

Joint Information Systems Committee (JISC) 2025. *Online surveys security*. Available at: <https://www.onlinesurveys.ac.uk/help-support/online-surveys-security/> [Accessed: 7 January 2025].

Jull, G., Kristjansson, E. and Dall'Alba, P. 2004. Impairment in the cervical flexors: a comparison of whiplash and insidious onset neck pain patients. *Manual Therapy* 9(2), pp. 89-94. doi: 10.1016/S1356-689X(03)00086-9

Kaiser, B.N., Varma, S., Carpenter-Song, E., Sareff, R., Rai, S. and Kohrt, B.A. 2020. Eliciting recovery narratives in global mental health: benefits and potential harms in service user participation. *Psychiatric Rehabilitation Journal* 43(2), pp.111-120. doi: 10.1037/prj0000384

Kaka, B., Ogwumike, O.O., Adeniyi, A.F., Maharaj, S.S., Ogunlade, S.O. and Bello, B. 2018. Effectiveness of neck stabilisation and dynamic exercises on pain intensity, depression and anxiety among patients with non-specific neck pain: a randomised

controlled trial. *Scandinavian Journal of Pain* 18(2), pp. 321-331. doi: 10.1515/sjpain-2017-0146

Kamper, S.J., Apeldoorn, A.T., Chiarotto, A., Smeets, R.J., Ostelo, R.W., Guzman, J. and van Tulder, M. 2015. Multidisciplinary biopsychosocial rehabilitation for chronic low back pain: Cochrane systematic review and meta-analysis. *British Medical Journal* 350. doi: 10.1136/bmj.h444

Kaneko, Y., Lianza, S. and Dawson, W.J. 2005. Pain as an incapacitating factor in symphony orchestra musicians in Sao Paulo, Brazil. *Medical Problems of Performing Artists* 20(4), pp. 168-174. doi: 10.21091/mppa.2005.4033

Kapp, J. M., LeMaster, J. W., Lyon, M. B., Zhang, B. and Hosokawa, M. C. 2009. Updating public health teaching methods in the era of social media. *Public Health Rep* 124(6), pp. 775-777. doi: 10.1177/003335490912400603

Karsh, B.T. 2006. Theories of work-related musculoskeletal disorders: implications for ergonomic interventions. *Theoretical Issues in Ergonomics Science* 7(1), pp. 71-88. doi: 10.1080/14639220512331335160

Kauer, S.D. et al. 2012. Self-monitoring using mobile phones in the early stages of adolescent depression: randomized controlled trial. *Journal of Medical Internet Research* 14(3), e1858. doi: 10.2196/jmir.1858

Kaufman-Cohen, Y. and Ratzon, N.Z. 2011. Correlation between risk factors and musculoskeletal disorders among classical musicians. *Occupational Medicine* 61(2), pp. 90-95. doi: 10.1093/occmed/kqq196

Kava, K. S., Larson, C. A., Stiller, C. H. and Maher, S. 2010. Trunk endurance exercise and the effect in instrumental performance: a preliminary study comparing Pilates exercise and a trunk and proximal upper extremity endurance exercise program. *Music Performance Research* 3, pp. 1-30.

Keay, N., Lanfear, M. and Francis, G. 2021. Clinical application of monitoring indicators of female dancer health, including application of artificial intelligence in female hormone networks. *medRxiv*, pp. 2021-09.
doi: 10.1101/2021.09.27.21264119

Kelders, S.M., Kok, R.N., Ossebaard, H.C. and Van Gemert-Pijnen, J.E. 2012. Persuasive system design does matter: a systematic review of adherence to web-based interventions. *Journal of Medical Internet Research* 14(6), e152.
doi: 10.2196/jmir.2104

Kelly, M., Fullen, B., Martin, D., McMahon, S. and McVeigh, J.G. 2022. eHealth interventions to support self-management in people with musculoskeletal disorders, “eHealth: It’s TIME”—a scoping review. *Physical Therapy* 102(4), pzab307. doi: 10.1093/ptj/pzab307

Kelly, M., Fullen, B.M., Martin, D., Bradley, C. and McVeigh, J.G. 2024. eHealth interventions to support self-management: perceptions and experiences of people with musculoskeletal disorders and physiotherapists-‘eHealth: it’s TIME’: A qualitative study. *Physiotherapy Theory and Practice* 40(5), pp. 1011-1021. doi: 10.1080/09593985.2022.2151334

Kenny, D. 2011. *The psychology of music performance anxiety*. Oxford: Oxford University Press

Kenny, D. and Ackermann, B. 2015. Performance-related musculoskeletal pain, depression and music performance anxiety in professional orchestral musicians: a population study. *Psychology of Music* 43(1), pp. 43-60. doi:

10.1177/0305735613493953

Kenny, D. T., Driscoll, T. R. and Ackermann, B. J. 2018. Incidence and severity of self-reported playing-related musculoskeletal disorders in professional orchestra musicians in Australia. *Medical Problems of Performing Artists* 33(1), pp. 25-30.

Kent, P., Laird, R. and Haines, T. 2015. The effect of changing movement and posture using motion-sensor biofeedback, versus guidelines-based care, on the clinical outcomes of people with sub-acute or chronic low back pain—a multicentre, cluster-randomised, placebo-controlled, pilot trial. *BMC Musculoskeletal Disorders* 16, pp. 1-19. doi: 10.1186/s12891-015-0591-5

Keogh, A., Tully, M.A., Matthews, J. and Hurley, D.A. 2015. A review of behaviour change theories and techniques used in group based self-management programmes for chronic low back pain and arthritis. *Manual Therapy* 20(6), pp. 727-735. doi:

10.1016/j.math.2015.03.014

Kerksick, C.M. et al. 2006. The effects of protein and amino acid supplementation on performance and training adaptations during ten weeks of resistance training. *The Journal of Strength & Conditioning Research* 20(3), pp. 643-653.

Kesmodel, U.S. 2018. Cross-sectional studies—what are they good for? *Acta Obstetricia et Gynecologica Scandinavica* 97(4), pp. 388-393. doi:

10.1111/aogs.13331

Khalsa, S. B., Shorter, S. M., Cope, S., Wyshak, G. and Sklar, E. 2009. Yoga ameliorates performance anxiety and mood disturbance in young professional musicians. *Applied Psychophysiology and Biofeedback* 34(4), pp. 279-289. doi: 10.1007/s10484-009-9103-4

Khan, M. and Maes, P. 2021. *Self-determined behavior change goals are dynamic, diverse, and intrinsically-motivated*. Available at: <https://ceur-ws.org/Vol-2885/paper6.pdf> [Accessed: 26 March 2025].

Khankeh, H., Ranjbar, M., Khorasani-Zavareh, D., Zargham-Boroujeni, A. and Johansson, E. 2015. Challenges in conducting qualitative research in health: a conceptual paper. *Iranian Journal of Nursing and Midwifery Research* 20(6), pp. 635-641. doi: 10.4103/1735-9066.170010

Kidd, P.S. and Parshall, M.B. 2000. Getting the focus and the group: enhancing analytical rigor in focus group research. *Qualitative Health Research* 10(3), pp. 293-308. doi: 10.1177/10497320012911845

Kim, J.H. 2020. From the body image to the body schema, from the proximal to the distal: embodied musical activity toward learning instrumental musical skills. *Frontiers in Psychology* 11, p.101. doi: 10.3389/fpsyg.2020.00101

Kim, K. and Cho, Y.K. 2015. Construction-specific spatial information reasoning in building information models. *Advanced Engineering Informatics* 29(4), pp. 1013-1027. doi: 10.1016/j.aei.2015.08.004

Kim, K. and Cho, Y.K. 2021. Automatic recognition of workers' motions in highway construction by using motion sensors and long short-term memory networks. *Journal*

of Construction Engineering and Management 147(3), 04020184. doi:
10.1061/(ASCE)CO.1943-7862.0002001

King, B., Koenig, J. and Berg, L. 2024. Popular musician occupational stress and psychological ill health: an exploratory factor analysis. *Medical Problems of Performing Artists* 39(2), pp. 72-81. doi: 10.21091/mppa.2024.2010

Klein, S. D., Bayard, C. and Wolf, U. 2014. The Alexander technique and musicians: a systematic review of controlled trials. *BMC Complementary and Alternative Medicine* 14(1), 414. doi: 10.1186/1472-6882-14-414

Knauder, H. and Koschmieder, C. 2019. Individualized student support in primary school teaching: a review of influencing factors using the Theory of Planned Behavior (TPB). *Teaching and Teacher Education* 77, pp. 66-76. doi:
10.1016/j.tate.2018.09.012

Köhler, C., Bartschke, A., Fürstenau, D., Schaaf, T. and Salgado-Baez, E. 2024. The value of smartwatches in the health care sector for monitoring, nudging, and predicting: viewpoint on 25 years of research. *Journal of Medical Internet Research* 26, e58936. doi: 10.2196/58936

Kok, L.M., Groenewegen, K.A., Huisstede, B.M., Nelissen, R.G. Rietveld, A.B.M. and Haitjema, S. 2018. The high prevalence of playing-related musculoskeletal disorders (PRMDs) and its associated factors in amateur musicians playing in student orchestras: a cross-sectional study. *PloS One* 13(2), e0191772. doi:
10.1371/journal.pone.0191772

Kok, L.M., Huisstede, B.M., Voorn, V.M., Schoones, J.W. and Nelissen, R.G. 2016.

The occurrence of musculoskeletal complaints among professional musicians: a systematic review. *International Archives of Occupational and Environmental Health* 89(3), pp. 373-396. doi: 10.1007/s00420-015-1090-6

Kok, L.M., Schrijvers, J., Fiocco, M., Van Royen, B. and Harlaar, J. 2019. Use of a shoulder rest for playing the violin revisited: an analysis of the effect of shoulder rest height on muscle activity, violin fixation force, and player comfort. *Medical Problems of Performing Artists* 34(1), pp. 39-46. doi: 10.21091/mppa.2019.1009

Konczak, J., Vander Velden, H. and Jaeger, L. 2009. Learning to play the violin: motor control by freezing, not freeing degrees of freedom. *Journal of Motor Behavior* 41(3), pp. 243-252. doi: 10.3200/JMBR.41.3.243-252

Kornbluh, M. 2015. Combatting challenges to establishing trustworthiness in qualitative research. *Qualitative Research in Psychology* 12(4), pp. 397-414. doi: 10.1080/14780887.2015.1021941

Koutedakis, Y. and Jamurtas, A. 2004. The dancer as a performing athlete: physiological considerations. *Sports Medicine* 34, pp. 651-661. doi: 10.2165/00007256-200434100-00003

Kowal, J., Wilson, K.G., Henderson, P.R. and McWilliams, L.A. 2014. Change in suicidal ideation after interdisciplinary treatment of chronic pain. *The Clinical Journal of Pain* 30(6), pp. 463-471. doi: 10.1097/AJP.0000000000000003

Kowatsch, T., Nißen, M., Rüegger, D., Stieger, M., Flückiger, C., Allemand, M. and Wangenheim, F. 2018. The impact of interpersonal closeness cues in text-based

healthcare chatbots on attachment bond and the desire to continue interacting: an experimental design. *Proceedings of the 26th European Conference on Information Systems (ECIS 2018), Portsmouth, UK, 23–28 June 2018*. doi: 10.5167/uzh-158352

Krebs, P. and Duncan, D.T. 2015. Health app use among US mobile phone owners: a national survey. *JMIR mHealth and uHealth* 3(4), e4924. doi: 10.2196/mhealth.4924

Kress, H.G. et al. 2015. A holistic approach to chronic pain management that involves all stakeholders: change is needed. *Current Medical Research and Opinion* 31(9), pp. 1743-1754. doi: 10.1185/03007995.2015.1072088

Kreutz, G., Ginsborg, J. and Williamon, A. 2009. Health-promoting behaviours in conservatoire students. *Psychology of Music* 37(1), pp. 47-60. doi: 10.1177/0305735607086047

Krolikowski, K.A., Bi, M., Baggott, C.M., Khorzad, R., Holl, J.L. and Kruser, J.M. 2022. Design thinking to improve healthcare delivery in the intensive care unit: promise, pitfalls, and lessons learned. *Journal of Critical Care* 69, 153999. doi: 10.1016/j.jcrc.2022.153999

Kroon, F.P., Carmona, L., Schoones, J.W. and Kloppenburg, M. 2018. Efficacy and safety of non-pharmacological, pharmacological and surgical treatment for hand osteoarthritis: a systematic literature review informing the 2018 update of the EULAR recommendations for the management of hand osteoarthritis. *RMD Open* 4(2), e000734. doi: 10.1136/rmdopen-2018-000734

Krueger, R.A. and Casey, M.A. 2015. *Focus group interviewing*. 4th ed. New Jersey: John Wiley & Sons

Kruse, C., Karem, P., Shifflett, K., Vegi, L., Ravi, K. and Brooks, M. 2018. Evaluating barriers to adopting telemedicine worldwide: a systematic review. *Journal of Telemedicine and Telecare* 24(1), pp. 4-12. doi: 10.1177/1357633X16674087

Ku, B. and Lupton, E. 2022. *Health design thinking: creating products and services for better health*. Cambridge: The MIT Press.

Kuo, Y.L., Lee, T.H. and Tsai, Y.J. 2020. Evaluation of a cervical stabilization exercise program for pain, disability, and physical impairments in university violinists with nonspecific neck pain. *International Journal of Environmental Research and Public Health* 17(15), p.5430. doi: 10.3390/ijerph17155430

Laberge, M. and Ledoux, E. 2011. Occupational health and safety issues affecting young workers: A literature review. *Work* 39(3), pp. 215-232. doi: 10.3233/WOR-2011-1170

Lally, P., Wardle, J. and Gardner, B. 2011. Experiences of habit formation: a qualitative study. *Psychology, Health & Medicine* 16(4), pp. 484-489. doi: 10.1080/13548506.2011.555774

Laseur, D.J.G., Baas, D.C. and Kok, L.M. 2023. The prevention of musculoskeletal complaints in instrumental musicians: a systematic review. *Medical Problems of Performing Artists* 38(3), pp. 172-188. doi: 10.21091/mppa.2023.3022

Leaver, R. E., Harris, E. C., and Palmer, K. T. 2011. Musculoskeletal pain in elite professional musicians from British symphony orchestras. *Occupational Medicine* 61, pp. 549-555. doi: 10.1093/occmed/kqr129

Lee, J.G., Kim, G.H., Jung, S.W., Kim, S.W., Lee, J.H. and Lee, K.J. 2018. The association between long working hours and work-related musculoskeletal symptoms of Korean wage workers: data from the fourth Korean working conditions survey (a cross-sectional study). *Annals of Occupational and Environmental Medicine* 30, pp. 1-11. doi: 10.1186/s40557-018-0278-0

Lee, K.J. 2020. *Effects of sport-specific mental imagery on college athletes' confidence levels after an orthopedic injury*. PhD thesis, Grand Canyon University.

Lee, M.P., Hudson, H., Richards, R., Chang, C.C., Chosewood, L.C. and Schill, A.L. 2016. *Fundamentals of total worker health approaches: essential elements for advancing worker safety, health, and well-being*. Available at: https://stacks.cdc.gov/view/cdc/43275/cdc_43275_DS1.pdf [Accessed: 4 January 2021]

Lee, S.H., Carey, S., Dubey, R. and Matz, R. 2013. Intervention program in college instrumental musicians, with kinematics analysis of cello and flute playing: a combined program of yogic breathing and muscle strengthening-flexibility exercises. *Medical Problems of Performing Artists* 27(2), pp. 85-94. doi: 10.21091/mppa.2012.2016

Lee, S.H., Carey, S., Lazinski, M. and Kim, E.S. 2019. An integrative intervention program for college musicians and kinematics in cello playing. *European Journal of Integrative Medicine* 25, pp. 34-40. doi: 10.1016/j.eujim.2018.10.014

Leech-Wilkinson, D. 2020. *Challenging performance: classical music performance norms and how to escape them*. Available at:

<https://challengingperformance.com/the-book/> [Accessed: 24 March 2025]

Leedy, P.D. and Ormrod, J.E. 2015. *Practical research. Planning and design*. Boston: Pearson.

Leeming, D. 2018. The use of theory in qualitative research. *Journal of Human Lactation* 34(4), pp. 668-673. doi: 10.1177/0890334418794666

Leung, L. 2015. Validity, reliability, and generalizability in qualitative research. *Journal of Family Medicine and Primary Care* 4(3), pp. 324-327
doi: 10.4103/2249-4863.161306

Leung, W.-C. 2001. How to design a questionnaire. *Bmj* 322(Suppl S6), 0106187.
doi: 10.1136/sbmj.0106187

Levac, D., Colquhoun, H. and O'Brien, K.K. 2010. Scoping studies: advancing the methodology. *Implementation Science* 5, pp. 1-9. doi: 10.1186/1748-5908-5-69

Lichtman, M. 2013. *Qualitative research for the social sciences*. London: Sage Publications.

Lin, H. T., Li, Y. I., Hu, W. P., Huang, C. C. and Du, Y. C. 2019. A scoping review of the efficacy of virtual reality and exergaming on patients of musculoskeletal system disorder. *Journal of Clinical Medicine* 8(6), 791. doi: 10.3390/jcm8060791

Lin, I. et al. 2020. What does best practice care for musculoskeletal pain look like? Eleven consistent recommendations from high-quality clinical practice guidelines:

systematic review. *British Journal of Sports Medicine* 54(2), pp. 79-86. doi: 10.1136/bjsports-2018-099878

Lindsay, R.S., Larkin, P., Kittel, A. and Spittle, M. 2023. Mental imagery training programs for developing sport-specific motor skills: a systematic review and meta-analysis. *Physical Education and Sport Pedagogy* 28(4), pp. 444-465. doi: 10.1080/17408989.2021.1991297

Lipps, D.B., Oh, Y.K., Ashton-Miller, J.A. and Wojtys, E.M. 2014. Effect of increased quadriceps tensile stiffness on peak anterior cruciate ligament strain during a simulated pivot landing. *Journal of Orthopaedic Research* 32(3), pp. 423-430. doi: 10.1002/jor.22531

Lipps, D.B., Wojtys, E.M. and Ashton-Miller, J.A. 2013. Anterior cruciate ligament fatigue failures in knees subjected to repeated simulated pivot landings. *The American Journal of Sports Medicine* 41(5), pp.1058-1066. doi: 10.1177/0363546513477836

Littell, J. H. and Girvin, H. 2002. Stages of change: a critique. *Behavior Modification* 26(2), pp. 223-273. doi: 10.1177/0145445502026002006

Liu, S., Wang, B., Fan, S., Wang, Y., Zhan, Y. and Ye, D. 2022. Global burden of musculoskeletal disorders and attributable factors in 204 countries and territories: a secondary analysis of the Global Burden of Disease 2019 study. *BMJ Open* 12(6), e062183. doi: 10.1136/bmjopen-2022-062183

Llewellyn-Beardsley, J. et al. 2022. 'Maybe I shouldn't talk': the role of power in the telling of mental health recovery stories. *Qualitative Health Research* 32(12), pp. 1828-1842. doi: 10.1177/10497323221118239

Longo, L. et al. 2020. Voice parameter changes in professional musician-singers singing with and without an instrument: the effect of body posture. *Folia Phoniatrica et Logopaedica* 72(4), pp. 309-315. doi: 10.1159/000501202

Lonsdale, K., Laakso, E. and Tomlinson, V. 2014. Contributing factors, prevention, and management of playing-related musculoskeletal disorders among flute players internationally. *Medical Problems of Performing Artists* 29(3), pp. 155-162. doi: 10.21091/mppa.2014.3032

López, R.L. and Levy, J.J. 2013. Student athletes' perceived barriers to and preferences for seeking counseling. *Journal of College Counseling* 16(1), pp. 19-31. doi: 10.1002/j.2161-1882.2013.00024.x

López, T. and Farías Martínez, J. 2013. Strategies to promote health and prevent musculoskeletal injuries in students from the high conservatory of music of Salamanca, Spain. *Medical Problems of Performing Artists*, 28(2), pp. 100-106. doi: 10.21091/mppa.2013.2018

López-Íñiguez, G. and Bennett, D. 2021. Broadening student musicians' career horizons: the importance of being and becoming a learner in higher education. *International Journal of Music Education* 39(2), pp.134-150. doi: 10.1177/0255761421989111

Lorig, K. R. and Holman, H. R. 2003. Self-management education: history, definition, outcomes, and mechanisms. *Annals of Behavioral Medicine* 26(1), pp. 1-7. doi: 10.1207/S15324796ABM2601_0

Lorig, K.R., Ritter, P.L., Laurent, D.D. and Plant, K. 2006. Internet-based chronic disease self-management: a randomized trial. *Medical Care* 44(11), pp. 964-971. doi: 10.1097/01.mlr.0000233678.80203.c1

Lötters, F. and Burdof, A. 2002. Are changes in mechanical exposure and musculoskeletal health good performance indicators for primary interventions? *International Archives of Occupational and Environmental Health* 75(8), pp. 549–561. doi: 10.1007/s00420-002-0368-7

Lotze, M. and Halsband, U. 2006. Motor imagery. *Journal of Physiology—Paris*, 99(4-6), pp. 386-395. doi: 10.1016/j.jphysparis.2006.03.012.

Macdonald, H. M., Lavigne, S. K., Reineberg, A. E. and Thaut, M. H. 2022. Playing-related musculoskeletal disorders, risk factors, and treatment efficacy in a large sample of oboists. *Frontiers in Psychology* 12, 772357. doi: 10.3389/fpsyg.2021.772357

MacDonald, R. and Saarikallio, S. 2022. Musical identities in action: embodied, situated, and dynamic. *Musicae Scientiae* 26(4), pp. 729-745. doi: 10.1177/10298649221108305

MacDonald, R.A., Hargreaves, D.J. and Miell, D. 2002. *Musical identities*. Oxford: Oxford University Press

MacNamara, Á., Holmes, P. and Collins, D. 2008. Negotiating transitions in musical development: the role of psychological characteristics of developing excellence. *Psychology of Music* 36(3), pp. 335-352. doi: 10.1177/0305735607086041

Maier, C., Thatcher, J.B., Grover, V. and Dwivedi, Y.K. 2023. Cross-sectional research: a critical perspective, use cases, and recommendations for IS research. *International Journal of Information Management* 70, 102625. doi: 10.1016/j.ijinfomgt.2023.102625

Maitland, A., Hills, L.A. and Rhind, D.J. 2015. Organisational culture in sport—A systematic review. *Sport Management Review* 18(4), pp. 501-516. doi: 10.1016/j.smr.2014.11.004

Malliaras, P., Merolli, M., Williams, C.M., Caneiro, J.P., Haines, T. and Barton, C. 2021. 'It's not hands-on therapy, so it's very limited': telehealth use and views among allied health clinicians during the coronavirus pandemic. *Musculoskeletal Science and Practice* 52, 102340. doi: 10.1016/j.msksp.2021.102340

Malterud, K., Siersma, V.D. and Guassora, A.D. 2016. Sample size in qualitative interview studies: guided by information power. *Qualitative Health Research* 26(13), pp. 1753-1760. doi: 10.1177/1049732315617444

Manchester, R.A. 2014. Prevention of performance-related musculoskeletal disorders. *Medical Problems of Performing Artists* 29(4), pp.179-180. doi: 10.21091/mppa.2014.4037

Mann, S., Olsen, H.B., Paarup, H.M. and Søgaaard, K. 2023. The effects of an ergonomic chinrest among professional violin players. A biomechanical investigation in a randomised crossover design. *Applied Ergonomics* 110, 104018. doi:

10.1016/j.apergo.2023.104018

Mannion, R., Davies, H., Powell, M., Blenkinsopp, J., Millar, R., McHale, J. and Snowden, N. 2019. Healthcare scandals and the failings of doctors: do official inquiries hold the profession to account? *Journal of Health Organization and Management* 33(2), pp. 221-240. doi: 10.1108/JHOM-04-2018-0126

Marangunić, N. and Granić, A. 2015. Technology acceptance model: a literature review from 1986 to 2013. *Universal Access in the Information Society* 14, pp. 81-95. doi: 10.1007/s10209-014-0348-1

Marceau, L. D., Link, C., Jamison, R. N. and Carolan, S. 2007. Electronic diaries as a tool to improve pain management: is there any evidence? *Pain Medicine* 8 Suppl 3, pp. S101-109. doi: 10.1111/j.1526-4637.2007.00374.x

Marques, M.M. et al. 2021. A theory-and evidence-based digital intervention tool for weight loss maintenance (NoHoW Toolkit): systematic development and refinement study. *Journal of Medical Internet Research* 23(12), e25305. doi: 10.2196/25305

Marras, W.S., Cutlip, R.G., Burt, S.E. and Waters, T.R. 2009. National occupational research agenda (NORA) future directions in occupational musculoskeletal disorder health research. *Applied Ergonomics* 40(1), pp. 15-22. doi:

10.1016/j.apergo.2008.01.018

Marshall, E.A. and Gibson, A.M. 2017. The effect of an imagery training intervention on self-confidence, anxiety and performance in acrobatic gymnastics—a pilot study. *Journal of Imagery Research in Sport and Physical Activity* 12(1), 20160009. doi: 10.1515/jirspa-2016-0009

Maslach, C. and Leiter, M.P. 2016. Understanding the burnout experience: recent research and its implications for psychiatry. *World Psychiatry* 15(2), pp. 103-111. doi: 10.1002/wps.20311

Mason, M. 2010. Sample size and saturation in PhD studies using qualitative interviews. *Qualitative Social Research* 11(3). doi: 10.17169/fqs-11.3.1428

Matei, R. 2018. *Better practice: health promotion in the music conservatoire*. PhD Thesis, Manchester Metropolitan University in collaboration with The Royal Northern College of Music.

Matei, R. and Ginsborg, J. 2017. Music performance anxiety in classical musicians—what we know about what works. *BJPsych International* 14(2), pp. 33-35. doi: 10.1192/S2056474000001744

Matei, R. and Ginsborg, J. 2021. Physical activity, sedentary behavior, anxiety, and pain among musicians in the United Kingdom. *Frontiers in Psychology* 11, 560026. doi: 10.3389/fpsyg.2020.560026

Matei, R. and Ginsborg, J. 2022. Health education for musicians in the UK: a qualitative evaluation. *Health Promotion International* 37(2), daab146. doi: 10.1093/heapro/daab146

Matei, R. and Phillips, K. 2023. Health education in conservatoires: what should it consist of? Findings from workshops with experts (Part II). *Health Promotion International* 38(1), daac179. doi: 10.1093/heapro/daac179

Matei, R., Broad, S., Goldbart, J. and Ginsborg, J. 2018. Health education for musicians. *Frontiers in Psychology* 9, 1137. doi: 10.3389/fpsyg.2018.01137

Mayer, R.E. and Moreno, R. 2002. Animation as an aid to multimedia learning. *Educational Psychology Review* 14, pp. 87-99.

McCoy, C.E. 2017. Understanding the intention-to-treat principle in randomized controlled trials. *Western Journal of Emergency Medicine* 18(6), 1075. doi: 10.5811/westjem.2017.8.35985

McCrary, J.M., Halaki, M., Sorkin, E. and Ackermann, B.J. 2015. Acute warm-up effects in submaximal athletes: an EMG study of skilled violinists. *Medicine and Science in Sports and Exercise* 48(2), pp. 307-315. doi: 10.1249/MSS.0000000000000765

McGraw, D. and Mandl, K.D. 2021. Privacy protections to encourage use of health-relevant digital data in a learning health system. *NPJ Digital Medicine* 4(1), 2. doi: 10.1038/s41746-020-00362-8

McKnight, L. 2010. *Designing for ADHD: in search of guidelines*. Available at: <https://www.academia.edu/download/30912875/mcknight.pdf>
[Accessed: 26 March 2025]

McMullin, C. 2023. Transcription and qualitative methods: implications for third sector research. *Voluntas* 34(1), pp. 140-153. doi: 10.1007/s11266-021-00400-3

Merolli, M., Gray, K., Choo, D., Lawford, B.J. and Hinman, R.S. 2022. Use, and acceptability, of digital health technologies in musculoskeletal physical therapy: a survey of physical therapists and patients. *Musculoskeletal Care* 20(3), pp. 641-659. doi: 10.1002/msc.1627

Merriam, S. B. and Tisdell, E. J. 2015. *Qualitative research: a guide to design and implementation*. 4th ed. California: Wiley.

Mesa-Castrillon, C. I. et al. 2024. Effectiveness of an eHealth-delivered program to empower people with musculoskeletal pain in rural Australia: a randomized controlled trial. *Arthritis Care and Research (Hoboken)* 76(4), pp. 570-581. doi: 10.1002/acr.25272

Michaelson, M.M. and Esch, T. 2023. Understanding health behavior change by motivation and reward mechanisms: a review of the literature. *Frontiers in Behavioral Neuroscience* 17, 1151918. doi: 10.3389/fnbeh.2023.1151918

Michie, S. et al. 2013. The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. *Annals of Behavioral Medicine* 46(1), pp. 81-95. doi: 10.1007/s12160-013-9486-6

Michie, S., van Stralen, M. M. and West, R. 2011. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implementation Science* 6, 42. doi: 10.1186/1748-5908-6-42

Michie, S., Wood, C. E., Johnston, M., Abraham, C., Francis, J. J. and Hardeman, W. 2015. Behaviour change techniques: the development and evaluation of a taxonomic

method for reporting and describing behaviour change interventions (a suite of five studies involving consensus methods, randomised controlled trials and analysis of qualitative data). *Health Technology Assessment* 19(99), pp. 1-188. doi:

10.3310/hta19990

Milan, K.R. 1994. Injury in ballet: a review of relevant topics for the physical therapist. *Journal of Orthopaedic & Sports Physical Therapy* 19(2), pp.121-129. doi:

10.2519/jospt.1994.19.2.121

Miles, M. 2020. Knowing the audience: music performance anxiety and other performance experiences of a primary school choir. *Australian Journal of Music Education* 53(2), pp. 44-49. doi: 10.34632/jsta.2021.9853

Miles, M., Huberman, A. M. and Saldana, J. 2014. *Qualitative data analysis: a methods sourcebook*. 3rd ed. California: Sage Publications.

Mizera-Pęczek, P., Krasnova, A., Sasin, M. and Sieczych-Kukawska, A. 2024. Dual careers as sustainable careers for performing artists in times of crisis. A contextual approach to the construct of a sustainable arts career. *PloS One* 19(12), e0314933. doi: 10.1371/journal.pone.0314933

Möllenkamp, M., Zeppernick, M. and Schreyögg, J. 2019. The effectiveness of nudges in improving the self-management of patients with chronic diseases: a systematic literature review. *Health Policy* 123(12), pp. 1199-1209. doi:

10.1016/j.healthpol.2019.09.008

Moman, R.N., Dvorkin, J., Pollard, E.M., Wanderman, R., Murad, M.H., Warner, D.O. and Hooten, W.M. 2019. A systematic review and meta-analysis of unguided

electronic and mobile health technologies for chronic pain—is it time to start prescribing electronic health applications? *Pain Medicine* 20(11), pp. 2238-2255. doi: 10.1093/pm/pnz164

Money, A., Hall, A., Harris, D., Eost-Telling, C., McDermott, J. and Todd, C. 2024. Barriers to and facilitators of older people's engagement with web-based services: qualitative study of adults aged > 75 Years. *JMIR Aging* 7, e46522. doi: 10.2196/46522

Moore, G.F. and Evans, R.E. 2017. What theory, for whom and in which context? Reflections on the application of theory in the development and evaluation of complex population health interventions. *SSM—Population Health* 3, pp.132-135. doi: 10.1016/j.ssmph.2016.12.005

Moraes, G.F.D.S. and Antunes, A.P. 2012. Musculoskeletal disorders in professional violinists and violists: systematic review. *Acta Ortopedica Brasileira* 20, pp. 43-47. doi: 10.1590/S1413-78522012000100009

Morgan, D.L. 2002. *Focus group interviewing. Handbook of interview research: context and method*. London: Sage Publications

Morgan, D.L. 2014. Pragmatism as a paradigm for social research. *Qualitative Inquiry* 20(8), pp. 1045-1053. doi: 10.1177/107780041351373

Morren, M., van Dulmen, S., Ouwerkerk, J. and Bensing, J. 2009. Compliance with momentary pain measurement using electronic diaries: a systematic review. *European Journal of Pain* 13(4), pp. 354-365. doi: 10.1016/j.ejpain.2008.05.010

Morrison, L.G., Yardley, L., Powell, J. and Michie, S. 2012. What design features are used in effective e-health interventions? A review using techniques from critical interpretive synthesis. *Telemedicine and e-Health* 18(2), pp. 137-144. doi: 10.1089/tmj.2011.0062

Morse, J.M. 2015. Analytic strategies and sample size. *Qualitative Health Research* 25(10), pp.1317-1318. doi: 10.1177/1049732315602867

Moseley, G.L. 2005. Widespread brain activity during an abdominal task markedly reduced after pain physiology education: fMRI evaluation of a single patient with chronic low back pain. *Australian Journal of Physiotherapy* 51(1), pp. 49-52. doi: 10.1016/S0004-9514(05)70053-2

Motta-Valencia, K. 2006. Dance-related injury. *Physical Medicine and Rehabilitation Clinics* 17(3), pp. 697-723. doi: 10.1016/j.pmr.2006.06.001

Moura, N. and Serra, S. 2021. Listening to teachers' voices: constructs on music performance anxiety in artistic education. *Journal of Science and Technology of the Arts* 13(2), pp. 99-117. doi: 10.34632/jsta.2021.9853

Mozeiko, J.K. 2011. *The effects of participation in the Alexander technique on females violinists and violists: a mixed methods study*. PhD Thesis, Boston University

Murphy, K. et al. 2023. Using the COM-B model and Behaviour Change Wheel to develop a theory and evidence-based intervention for women with gestational diabetes (IINDIAGO). *BMC Public Health* 23(1), 894. doi: 10.1186/s12889-023-15586-y

Musicians' Union 2021. *UK music report reveals economic impact of COVID-19*.

Available at: <https://musiciansunion.org.uk/news/uk-music-report-reveals-economic-impact-of-covid-19> [Accessed: 7 January 2025].

Nadin, S. and Cassell, C. 2006. The use of a research diary as a tool for reflexive practice: Some reflections from management research, *Qualitative Research in Accounting & Management* 3(3), pp. 208-217. doi: 10.1108/11766090610705407

National Institute for Health and Care Excellence [NICE]. 2014. *Overview | Behaviour change: individual approaches*. Available at: <https://www.nice.org.uk/guidance/PH49>. [Accessed: 17 July 2024]

National Institute for Health and Care Excellence [NICE]. 2016. *Low back pain and sciatica in over 16s: assessment and management*. Available at: [low-back-pain-and-sciatica-in-over-16s-assessment-and-management-pdf-1837521693637 \(1\).pdf](#) [Accessed: 15 August 2021]

National Health Institute for Health and Care Excellence [NICE]. 2019. *Evidence standards framework for digital health technologies*. Available at: <https://www.nice.org.uk/about/what-we-do/our-programmes/evidence-standards-framework-for-digital-health-technologies> [Accessed: 17 December 2024].

National Institute for Health and Care Excellence [NICE]. 2021. *Evidence standards framework for digital health technologies*. Available at: <https://www.nice.org.uk/about/what-we-do/our-programmes/evidence-standards-framework-for-digital-health-technologies> [Accessed: 17 December 2023].

Nelligan, R. K., Hinman, R. S., Kasza, J., Schwartz, S., Kimp, A., Atkins, L. and Bennell, K. L. 2019. Effect of a short message service (SMS) intervention on adherence to a physiotherapist-prescribed home exercise program for people with knee osteoarthritis and obesity: protocol for the ADHERE randomised controlled trial. *BMC Musculoskeletal Disorders* 20(1), 428. doi: 10.1186/s12891-019-2801-z

Nicholas, M.K. 2007. The pain self-efficacy questionnaire: taking pain into account. *European Journal of Pain* 11(2), pp.153-163. doi: 10.1016/j.ejpain.2005.12.008

Nicholl, B.I. et al. 2017. Digital support interventions for the self-management of low back pain: a systematic review. *Journal of Medical Internet Research* 19(5), e179. doi: 10.2196/jmir.7290

Noble, H. and Heale, R. 2019. Triangulation in research, with examples. *Evidence-Based Nursing* 22(3), pp. 67-68. doi: 10.1136/ebnurs-2019-103145

Norton, N. 2016. Health promotion for musicians: Engaging with instrumental and vocal teachers. *Arts and Humanities in Higher Education*. Available at: <https://www.artsandhumanities.org/health-promotion-for-musicians-engaging-with-instrumental-and-vocal-teachers/> [Accessed 23 October 2023]

Norton, N. 2020. Considering musicians' health and wellness literature through the lens of the behaviour change wheel. Available at: [https://storage.googleapis.com/wzukusers/user20563976/documents/019d3c23ae59443bb750806623d0ff88/Nami%20Norton%20v2%20\(1\)](https://storage.googleapis.com/wzukusers/user20563976/documents/019d3c23ae59443bb750806623d0ff88/Nami%20Norton%20v2%20(1)) [Accessed 23 October 2023].

Nulty, D.D. 2008. The adequacy of response rates to online and paper surveys: what can be done? *Assessment & Evaluation in Higher Education* 33(3), pp. 301-314. doi: 10.1080/02602930701293231

Nurser, K.P., Rushworth, I., Shakespeare, T. and Williams, D. 2018. Personal storytelling in mental health recovery. *Mental Health Review Journal* 23(1), pp. 25-36. doi: 10.1108/MHRJ-08-2017-0034

Nussbaumer-Streit, B. et al. 2020. Excluding non-English publications from evidence-syntheses did not change conclusions: a meta-epidemiological study. *Journal of Clinical Epidemiology* 118, pp. 42-54. doi: 10.1016/j.jclinepi.2019.10.011.

Nutbeam, D. 2019. Health education and health promotion revisited. *Health Education Journal* 78, pp. 705–709. doi: 10.1177/0017896918770215

Nyberg, L.A., Sundberg, C.J., Wändell, P., Kowalski, J. and Hellénus, M.L. 2020. Long-term effects of group exercise intervention on maximal step-up height in middle-aged female primary care patients with obesity and other cardio-metabolic risk factors. *BMC Sports Science, Medicine and Rehabilitation* 12, pp. 1-13. doi: 10.1186/s13102-020-00161-4

Nyman, T., Wiktorin, C., Mulder, M. and Johansson, Y.L. 2007. Work postures and neck–shoulder pain among orchestra musicians. *American Journal of Industrial Medicine* 50(5), pp. 370-376. doi: 10.1002/ajim.20454

O'Connor, S., Hanlon, P., O'Donnell, C.A., Garcia, S., Glanville, J. and Mair, F.S. 2016. Understanding factors affecting patient and public engagement and recruitment to digital health interventions: a systematic review of qualitative

studies. *BMC Medical Informatics and Decision Making* 16, pp. 1-15. doi:

10.1186/s12911-016-0359-3

O'Reilly, M. and Parker, N. 2013. 'Unsatisfactory saturation': a critical exploration of the notion of saturated sample sizes in qualitative research. *Qualitative Research* 13(2), pp. 190-197. doi: 10.1177/1468794112446106

Oakland, J. 2014. Ageing and retirement: towards an understanding of the experiences of symphony musicians as they approach retirement. Available at: https://scholar.google.co.uk/scholar?hl=en&as_sdt=0%2C5&q=Oakland%2C+J.%2C+2014.+AGEING+AND+RETIREMENT%3A+TOWARDS+AN+UNDERSTANDING+OF+THE+EXPERIENCES+OF+SYMPHONY+MUSICIANS+AS+THEY+APPROACH+RETIREMENT.&btnG= [Accessed: 14 March 2025]

Oakland, J., MacDonald, R. and Flowers, P. 2013. Identity in crisis: the role of work in the formation and renegotiation of a musical identity. *British Journal of Music Education* 30(2), pp. 261-276. doi: 10.1017/S026505171300003X

Oakman, J., Macdonald, W., Bartram, T., Keegel, T., and Kinsman, N. 2018. Workplace risk management practices to prevent musculoskeletal and mental health disorders: what are the gaps? *Safety Science* 101, pp. 220–230. doi: 10.1016/j.ssci.2017.09.004

Oakman, J., Rothmore, P. and Tappin, D. 2016. Intervention development to reduce musculoskeletal disorders: is the process on target? *Applied Ergonomics* 56, pp. 179-186. doi: 10.1016/j.apergo.2016.03.019

O'Cathain, A. and Thomas, K. J. 2004. "Any other comments?" Open questions on questionnaires—a bane or a bonus to research? *BMC Medical Research Methodology* 4(1), pp. 1-7. doi: 10.1186/1471-2288-4-25.

O'Cathain, A. et al. 2019. Guidance on how to develop complex interventions to improve health and healthcare. *BMJ open* 9(8), e029954. doi: 10.1136/bmjopen-2019-029954

Ohlendorf, D., Maurer, C., Bolender, E., Kocis, V., Song, M. and Groneberg, D.A. 2018. Influence of ergonomic layout of musician chairs on posture and seat pressure in musicians of different playing levels. *PloS One* 13(12), e0208758. doi: 10.1371/journal.pone.0208758

Oliveira, V.C., Ferreira, P.H., Maher, C.G., Pinto, R.Z., Refshauge, K.M. and Ferreira, M.L. 2012. Effectiveness of self-management of low back pain: systematic review with meta-analysis. *Arthritis Care & Research* 64(11), pp. 1739-1748. doi: 10.1002/acr.21737

Orejudo, S., Zarza-Alzugaray, F.J., Casanova, O. and McPherson, G.E. 2021. Social support as a facilitator of musical self-efficacy. *Frontiers in Psychology* 12, 722082. doi: 10.3389/fpsyg.2021.722082

Orji, R., Lomotey, R., Oyibo, K., Orji, F., Blustein, J. and Shahid, S. 2018. Tracking feels oppressive and 'punishy': exploring the costs and benefits of self-monitoring for health and wellness. *Digital Health* 4, 2055207618797554. doi: 10.1177/2055207618797554

O'Sullivan, K., O'Sullivan, P., O'Sullivan, L. and Dankaerts, W. 2012. What do physiotherapists consider to be the best sitting spinal posture? *Manual Therapy* 17(5), pp. 432-437. doi: 10.1016/j.math.2012.04.007

Özden, F., Sarı, Z., Karaman, Ö. N. and Aydoğmuş, H. 2022. The effect of video exercise-based telerehabilitation on clinical outcomes, expectation, satisfaction, and motivation in patients with chronic low back pain. *Irish Journal of Medical Science (1971 -)* 191(3), pp. 1229-1239. doi: 10.1007/s11845-021-02727-8

Paarup, H.M., Baelum, J., Manniche, C., Holm, J.W. and Wedderkopp, N. 2012. Occurrence and co-existence of localized musculoskeletal symptoms and findings in work-attending orchestra musicians—an exploratory cross-sectional study. *BMC Research Notes* 5, pp. 1-15. doi: 10.1186/1756-0500-5-541

Page, M. J. et al. 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *British Medical Journal* 372, n71. doi: 10.1136/bmj.n71

Page, M. J., Higgins, J. P. and Sterne, J. A. 2019. Assessing risk of bias due to missing results in a synthesis. In: Higgins, J., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. and Welch, V. eds. *Cochrane Handbook for Systematic Reviews of Interventions*. Hoboken, NJ: Wiley, pp. 349-374. doi: 10.1002/9781119536604.ch13

Paloyo, A.R., Reichert, A.R., Reuss-Borst, M. and Tauchmann, H. 2015. Who responds to financial incentives for weight loss? Evidence from a randomized controlled trial. *Social Science & Medicine* 145, pp. 44-52. doi: 10.1016/j.socscimed.2015.09.034

Panagioti, M. et al. 2014. Self-management support interventions to reduce health care utilisation without compromising outcomes: a systematic review and meta-analysis. *BMC Health Services Research* 14, pp.1-14. doi: 10.1186/1472-6963-14-356

Pannucci, C.J. and Wilkins, E.G. 2010. Identifying and avoiding bias in research. *Plastic and Reconstructive Surgery* 126(2), pp. 619-625.
doi: 10.1097/PRS.0b013e3181de24bc

Park, A., Guptill, C. and Sumsion, T. 2007. Why music majors pursue music despite the risk of playing-related injuries. *Medical Problems of Performing Artists* 22(3), pp. 89-96. doi: 10.21091/mppa.2007.3021

Park, J., Han, B. and Kim, Y. 2020. Comparison of occupational health problems of employees and self-employed individuals who work in different fields. *Archives of Environmental & Occupational Health* 75(2), pp. 98-111. doi:
10.1080/19338244.2019.1577209

Patton, M.Q. 2002, *Qualitative research and evaluation methods*. 3rd ed. California: Sage Publications

Paul, L. A., and Quiggin, J. 2020. Transformative education. *Education Theory* 70 (5), pp. 561–579. doi: 10.1111/edth.12444

Pearson, J., Walsh, N., Carter, D., Koskela, S. and Hurley, M. 2016. Developing a web-based version of an exercise-based rehabilitation program for people with chronic knee and hip pain: a mixed methods study. *JMIR Research Protocols* 5(2), e5446. doi: 10.2196/resprot.5446

- Pecen, E., Collins, D. and Macnamara, A. 2016. Music of the night: performance practitioner considerations for enhancement work in music. *Sport, Exercise, and Performance Psychology* 5, pp. 377-395. doi: 10.1037/spy0000067
- Pecen, E., Collins, D. J. and MacNamara, Á. 2017. "It's your problem. Deal with it." Performers' experiences of psychological challenges in music. *Frontiers in Psychology* 8, 2374. doi: 10.3389/fpsyg.2017.02374
- Peek, N., Sujan, M. and Scott, P. 2023. Digital health and care: emerging from pandemic times. *BMJ Health and Care Informatics* 30(1). doi: 10.1136/bmjhci-2023-100861
- Peiris, C.L., Gallagher, A., Taylor, N.F. and McLean, S. 2023. Behavior change techniques improve adherence to physical activity recommendations for adults with metabolic syndrome: a systematic review. *Patient Preference and Adherence* 17, pp. 689-697. doi: 10.2147/PPA.S393174
- Pelletier, M.J., Krallman, A., Adams, F.G. and Hancock, T. 2020. One size doesn't fit all: a uses and gratifications analysis of social media platforms. *Journal of Research in Interactive Marketing* 14(2), pp. 269-284. doi: 10.1108/JRIM-10-2019-0159
- Pendenza, F. 2023. *The perceptions of Alexander technique in UK higher education music institutions: Alexander technique teachers, instrumental/vocal teachers, and music students*. PhD thesis, University of York.
- Peng, W., Kanthawala, S., Yuan, S. and Hussain, S.A. 2016. A qualitative study of user perceptions of mobile health apps. *BMC Public Health* 16, pp. 1-11. doi: 10.1186/s12889-016-3808-0

Peng, Y., Liu, E., Peng, S., Chen, Q., Li, D. and Lian, D. 2022. Using artificial intelligence technology to fight COVID-19: a review. *Artificial Intelligence Review* 55, pp. 1-37. doi: 10.1007/s10462-021-10106-z

Perkins, R., Reid, H., Araújo, L.S., Clark, T. and Williamon, A. 2017. Perceived enablers and barriers to optimal health among music students: a qualitative study in the music conservatoire setting. *Frontiers in Psychology* 8, 968. doi: 10.3389/fpsyg.2017.00968

Peters, M.D. et al. 2020. Updated methodological guidance for the conduct of scoping reviews. *JB I Evidence Synthesis* 18(10), pp. 2119-2126. doi: 10.11124/JBIES-20-00167

Peters, M.D., Godfrey, C.M., Khalil, H., McInerney, P., Parker, D. and Soares, C.B. 2015. Guidance for conducting systematic scoping reviews. *JB I Evidence Implementation* 13(3), pp. 141-146. doi: 10.1097/XEB.0000000000000050

Physitrack. 2024. *Be the physio everyone wishes they had*. Available at: <https://www.physitrack.com/> [Accessed: 8 January 2025].

Pirolli, P., Mohan, S., Venkatakrishnan, A., Nelson, L., Silva, M. and Springer, A. 2017. Implementation intention and reminder effects on behavior change in a mobile health system: a predictive cognitive model. *Journal of Medical Internet Research* 19(11), e397. doi: 10.2196/jmir.8217

Piwek, L., Ellis, D.A., Andrews, S. and Joinson, A. 2016. The rise of consumer health wearables: promises and barriers. *PLoS Medicine* 13(2), e1001953. doi: 10.1371/journal.pmed.1001953

Polinski, J.M., Barker, T., Gagliano, N., Sussman, A., Brennan, T.A. and Shrank, W.H. 2016. Patients' satisfaction with and preference for telehealth visits. *Journal of General Internal Medicine* 31, pp. 269-275. doi: 10.1007/s11606-015-3489-x

Pollard-Smith, T. and Thomson, O.P. 2017. Professional ballet dancers' experience of injury and osteopathic treatment in the UK: a qualitative study. *Journal of Bodywork and Movement Therapies* 21(1), pp. 148-156. doi: 10.1016/j.jbmt.2016.06.009

Pollock, D. et al. 2021. Undertaking a scoping review: a practical guide for nursing and midwifery students, clinicians, researchers, and academics. *Journal of Advanced Nursing*, 77(4), pp. 2102-2113. doi: 10.1111/jan.14743

Ponto, J. 2015. Understanding and evaluating survey research. *Journal of the Advanced Practitioner in Oncology* 6(2), pp. 168–171

Porter, E. 2021. *Isometric exercises and stretching warm-up program for university string musicians: an intervention study*. PhD Thesis, Lincoln University

Pradhita, W. 2022. Living in artistic career: the role of job crafting towards work identity for musicians. *Buletin Psikologi* 30, 315. doi: 10.22146/buletinpsikologi.64185

Prall, J. and Ross, M. 2019. The management of work-related musculoskeletal injuries in an occupational health setting: the role of the physical therapist. *Journal of Exercise Rehabilitation* 15(2), pp. 193-199. doi: 10.12965/jer.1836636.318

Price, A., Damaraju, A., Kushalnagar, P., Brunoe, S., Srivastava, U., Debidda, M. and Chu, L. 2021. Coproduction, coeducation, and patient involvement: everyone

included framework for medical education across age groups and cultures. *JMIR Medical Education* 7(4), e31846. doi: 10.2196/31846

Price, K. and Watson, A. H. 2011. Postural problems of the left shoulder in an orchestral trombonist. *Work* 40(3), pp. 317-324. doi: 10.3233/wor-2011-1238

Prizeman, K., McCabe, C. and Weinstein, N. 2024. Stigma and its impact on disclosure and mental health secrecy in young people with clinical depression symptoms: a qualitative analysis. *Plos One* 19(1), e0296221. doi: 10.1371/journal.pone.0296221

Prochaska, J.O. and Prochaska, J.M. 2019. *Lifestyle medicine*. 3rd ed. Florida: CRC Press.

Prochaska, J.O. and Velicer, W.F. 1997. The transtheoretical model of health behavior change. *American Journal of Health Promotion* 12(1), pp. 38-48.

Proper, K.I. and van Oostrom, S.H. 2019. The effectiveness of workplace health promotion interventions on physical and mental health outcomes—a systematic review of reviews. *Scandinavian Journal of Work, Environment & Health* 45(6), pp. 546-559. doi: 10.5271/sjweh.3833.

Public Health Wales, n.d. *Neurodiversity*. Available at: <https://phw.nhs.wales/services-and-teams/healthy-working-wales/workplace-guidance/healthy-work-environments/equality-diversity-andinclusion1/neurodiversity/> [Accessed: 3 March 2025].

Punnett, L. and Wegman, D.H. 2004. Work-related musculoskeletal disorders: the epidemiologic evidence and the debate. *Journal of Electromyography and Kinesiology* 14(1), pp. 13-23. doi: 10.1016/j.jelekin.2003.09.015

Quarrier, N.F. 1993. Performing arts medicine: the musical athlete. *Journal of Orthopaedic & Sports Physical Therapy* 17(2), pp. 90-95. doi: 10.2519/jospt.1993.17.2.90

Ramatally, A. 2021. Imposter syndrome & musicality. *Durham Undergraduate Research in Music & Science, Durham University Music Department* 4, pp. 68-74.

Rathnayake, A.P., Sparkes, V. and Sheeran, L. 2021. What is the effect of low back pain self-management interventions with exercise components added? A systematic review with meta-analysis. *Musculoskeletal Science and Practice* 56, 102469. doi: 10.1016/j.msksp.2021.102469

Redmond, M. and Tiernan, A.M. 2001. Knowledge and practices of piano teachers in preventing playing-related injuries in high school students. *Medical Problems of Performing Artists* 16(1), pp. 32-38. doi: 10.21091/mppa.2001.1006

Regmi, P.R., Waithaka, E., Paudyal, A., Simkhada, P. and Van Teijlingen, E. 2016. Guide to the design and application of online questionnaire surveys. *Nepal Journal of Epidemiology* 6(4), pp. 640-644. doi: 10.3126/nje.v6i4.17258

Reid, A.M., Brown, J.M., Smith, J.M., Cope, A.C. and Jamieson, S. 2018. Ethical dilemmas and reflexivity in qualitative research. *Perspectives on Medical Education* 7, pp. 69-75. doi: 10.1007/s40037-018-0412-2

Reid, D.J. and Reid, F.J. 2005. Online focus groups: an in-depth comparison of computer-mediated and conventional focus group discussions. *International Journal of Market Research*, 47(2), pp.131-162. doi: 10.1177/147078530504700204

Revilla, M. and Ochoa, C. 2017. Ideal and maximum length for a web survey. *International Journal of Market Research* 59(5), pp. 557-565. doi: 10.2501/IJMR-2017-039

Rhodes, R.E. and de Bruijn, G.J. 2013. What predicts intention-behavior discordance? A review of the action control framework. *Exercise and Sport Sciences Reviews* 41(4), pp. 201-207. doi: 10.1097/JES.0b013e3182a4e6ed

Richter, M., Rauscher, C., Kluttig, A., Mallwitz, J. and Delank, K. S. 2020. Effect of additional pain neuroscience education in interdisciplinary multimodal pain therapy on current pain. A non-randomized, controlled intervention study. *Journal of Pain Research* 13, pp. 2947-2957. doi: 10.2147/jpr.S272943

Rickert, D.L., Barrett, M.S. and Ackermann, B.J. 2013. Injury and the orchestral environment: part I. *Medical Problems of Performing Artists* 28(4), pp. 219-229. doi: 10.21091/mppa.2013.4043

Rickert, D.L., Barrett, M.S. and Ackermann, B.J. 2014. Injury and the orchestral environment: part II. Organisational culture, behavioural norms, and attitudes to injury. *Medical Problems of Performing Artists* 29(2), pp. 94-101. doi: 10.21091/mppa.2014.2020

Rickert, D.L., Barrett, M.S. and Ackermann, B.J. 2015. Are music students fit to play? A case study of health awareness and injury attitudes amongst tertiary student

cellists. *International Journal of Music Education* 33(4), pp. 426-441. doi:
10.1177/0255761415582343

Ritterband, L.M. and Tate, D.F. 2009. The science of internet interventions. *Annals of Behavioral Medicine* 38(1), pp.1-3. doi: 10.1007/s12160-009-9132-5

Riva, G. 2000. From telehealth to e-health: internet and distributed virtual reality in health care. *CyberPsychology & Behavior* 3(6), pp.989-998.

Roberts, J. P., Fisher, T. R., Trowbridge, M. J. and Bent, C. 2016. A design thinking framework for healthcare management and innovation. *Healthcare (Amsterdam)* 4(1), pp. 11-14. doi: 10.1016/j.hjdsi.2015.12.002

Rodríguez-Romero, B., Pérez-Valiño, C., Ageitos-Alonso, B. and Pérttega-Díaz, S. 2016. Prevalence and associated factors for musculoskeletal pain and disability among Spanish music conservatory students. *Medical Problems of Performing Artists* 31(4), pp. 193-200. doi: 10.21091/mppa.2016.4035

Rollman, B.L. et al. 2009. Telephone-delivered collaborative care for treating post-CABG depression: a randomized controlled trial. *Journal of the American Medical Association* 302(19), pp. 2095-2103. doi: 10.1001/jama.2009.1670

Roos, M. and Roy, J.S. 2018. Effect of a rehabilitation program on performance-related musculoskeletal disorders in student and professional orchestral musicians: a randomized controlled trial. *Clinical Rehabilitation* 32(12), pp. 1656-1665. doi:
10.1177/0269215518785000

Roos, M. et al. 2024. Workplace injury prevention and wellness program for orchestra musicians: a randomised controlled trial. *Journal of Orthopaedic & Sports Physical Therapy* 54(1), pp.1-27. doi: 10.2519/jospt.2024.12277

Roos, M., Roy, J.S. and Lamontagne, M.E. 2021. A qualitative study exploring the implementation determinants of rehabilitation and global wellness programs for orchestral musicians. *Clinical Rehabilitation* 35(10), pp. 1488-1499. doi: 10.1177/02692155211010254

Rose, D., Bartoli, A.J. and Heaton, P. 2019. Formal-informal musical learning, sex and musicians' personalities. *Personality and Individual Differences* 142, pp. 207-213. doi: 10.1016/j.paid.2018.07.015

Rosenman, R., Tennekoon, V. and Hill, L.G. 2011. Measuring bias in self-reported data. *International Journal of Behavioural and Healthcare Research* 2(4), pp. 320-332. doi: 10.1504/IJBHR.2011.043414

Rosenstock, I. M. 1974. The health belief model and preventive health behavior. *Health Education Monographs* 2(4), pp. 354-386. doi: 10.1177/109019817400200405

Rousseau, C., Chi, J.Y. and Ackermann, B. 2021. Immediate effect of scapular stabilisation exercises on shoulder and forearm muscles activation while playing the violin. *Gait & Posture* 81, 303. doi: 10.1016/j.gaitpost.2020.08.047

Roy, A. 2023. *The effects of Covid-19 on performing musicians*. Available at: <http://digitalcommons.sacredheart.edu/acadfest/2023/all/30/> [Accessed: 25 March 2025]

Russo, A., Aranceta-Garza, A., D'Emanuele, S., Serafino, F. and Merletti, R. 2019. HDsEMG activity of the lumbar erector spinae in violin players: comparison of two chairs. *Medical Problems of Performing Artists* 34(4), pp. 205-214.

doi: 10.21091/mppa.2019.4034

Ryan, G.W. and Bernard, H.R. 2003. Techniques to identify themes. *Field Methods* 15(1), pp. 85-109. doi: 10.1177/1525822X02239569

Ryan, J., Edney, S. and Maher, C. 2019. Anxious or empowered? A cross-sectional study exploring how wearable activity trackers make their owners feel. *BMC Psychology* 7, pp. 1-8. doi: 10.1186/s40359-019-0315-y

Sabo, M. 2013. Physical therapy rehabilitation strategies for dancers: a qualitative study. *Journal of Dance Medicine & Science* 17(1), pp. 11-17. doi: 10.12678/1089-313X.17.1.11

Sakai, N. 2002. Hand pain attributed to overuse among professional pianists: a study of 200 cases. *Medical Problems of Performing Artists* 17(4), pp. 178-180. doi: 10.21091/mppa.2002.4028

Sakai, N., Liu, M.C., Su, F.C., Bishop, A.T. and An, K.N. 2006. Hand span and digital motion on the keyboard: concerns of overuse syndrome in musicians. *The Journal of Hand Surgery* 31(5), pp. 830-835. doi: 10.1016/j.jhsa.2006.02.009

Santhosh, L., Rojas, J.C. and Lyons, P.G. 2021. Zooming into focus groups: strategies for qualitative research in the era of social distancing. *ATS Scholar* 2(2), pp. 176-184. doi: 10.34197/ats-scholar.2020-0127PS

Saragiotto, B.T., Maher, C.G., Yamato, T.P., Costa, L.O., Costa, L.C.M., Ostelo, R.W. and Macedo, L.G. 2016. Motor control exercise for nonspecific low back pain: a Cochrane review. *Spine* 41(16), pp.1284-1295. doi:

10.1097/BRS.0000000000001645

Saunders, B. et al. 2018. Saturation in qualitative research: exploring its conceptualization and operationalization. *Quality & Quantity* 52, pp. 1893-1907. doi:

10.1007/s11135-017-0574-8

Saunders, M., Lewis, P. and Thornhill, A. 2009. *Research methods for business students*. London: Pearson Education.

Savin-Baden, M. and Major, C. 2013. *Qualitative research: the essential guide to theory and practice*. London: Routledge.

Schechtman, H. and Bader, D.L. 1997. In vitro fatigue of human tendons. *Journal of Biomechanics* 30(8), pp. 829-835. doi: 10.1016/s0021-9290(97)00033-x

Scherer, R., Siddiq, F. and Tondeur, J. 2019. The technology acceptance model (TAM): a meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. *Computers & Education* 128, pp. 13-35.

j.compedu.2018.09.009

Scholz, C. et al. 2024. The effect of self-management techniques on relevant outcomes in chronic low back pain: a systematic review and meta-

analysis. *European Journal of Pain* 28(4), pp. 532-550. doi: 10.1002/ejp.2221

- Schueller, S.M., Neary, M., Lai, J. and Epstein, D.A. 2021. Understanding people's use of and perspectives on mood-tracking apps: interview study. *JMIR Mental Health* 8(8), e29368. doi: 10.2196/29368
- Setia, M.S. 2016. Methodology series module 3: cross-sectional studies. *Indian Journal of Dermatology* 61(3), pp. 261-264. doi: 10.4103/0019-5154.182410
- Sheens, E., Rhodes, P. and Dawson, L. 2016. Encountering anorexia: challenging stigma with recovery stories. *Advances in Eating Disorders* 4(3), pp. 315-322. doi: 10.1080/21662630.2016.1217495
- Shenton, A.K. 2004. Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information* 22(2), pp. 63-75. doi: 10.3233/EFI-2004-22201
- Shoebridge, A. and Osborne, M.S. 2025. Wellbeing for young elite musicians: development of a health protocol from a student perspective. *Frontiers in Psychology* 16, 1401511. doi: 10.3389/fpsyg.2025.1401511
- Shriane, A.E., Rigney, G., Ferguson, S.A., Bin, Y.S. and Vincent, G.E. 2023. Healthy sleep practices for shift workers: consensus sleep hygiene guidelines using a Delphi methodology. *Sleep* 46(12), zsad182. doi: 10.1093/sleep/zsad182
- Sillence, E., Briggs, P., Harris, P.R. and Fishwick, L. 2007. How do patients evaluate and make use of online health information? *Social Science & Medicine* 64(9), pp. 1853-1862. doi: 10.1016/j.socscimed.2007.01.012
- Silverman, D. 2015. *Qualitative research*. 4th ed. London: Sage Publications.

Sims, J.D. 2017. *A phenomenological examination of imposter phenomenon in music therapy students*. Doctoral Dissertation University of Kansas.

Singer, E. 2012. The empirical study of ethical issues in survey participation. In: Davidov, E., Reinecke, E. and Salzborn, S. eds. *Methods, theories, and empirical applications in the social sciences*. Wiesbaden: VS Verlag für Sozialwissenschaften, pp. 67-74.

Skivington, K. et al. 2021. A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance. *British Medical Journal* 374, n2061. doi: 10.1136/bmj.n2061

Skrepnik, N., Spitzer, A., Altman, R., Hoekstra, J., Stewart, J. and Toselli, R. 2017. Assessing the impact of a novel smartphone application compared with standard follow-up on mobility of patients with knee osteoarthritis following treatment with Hylan GF 20: a randomized controlled trial. *JMIR mHealth and uHealth* 5(5), e7179. doi: 10.2196/mhealth.7179

Slater, D., Korakakis, V., O'Sullivan, P., Nolan, D. and O'Sullivan, K. 2019. "Sit up straight": time to re-evaluate. *Journal of Orthopaedic & Sports Physical Therapy* 49(8), pp. 562-564. doi: 10.2519/jospt.2019.0610

Sloots, J. et al. 2021. Adherence to an eHealth self-management intervention for patients with both COPD and heart failure: results of a pilot study. *International Journal of Chronic Obstructive Pulmonary Disease* 16, pp. 2089-2103. doi: 10.2147/copd.S299598

Small, K., Mc Naughton, L. and Matthews, M. 2008. A systematic review into the efficacy of static stretching as part of a warm-up for the prevention of exercise-related injury. *Research in Sports Medicine* 16(3), pp. 213-231. doi: 10.1080/15438620802310784

Smith, C.T., Nixon, M.R. and Nader, R.S. 2004. Posttraining increases in REM sleep intensity implicate REM sleep in memory processing and provide a biological marker of learning potential. *Learning & Memory* 11(6), pp. 714-719. doi: 10.1101/lm.74904

Smithson, E.V., Reed Smith, E., McIlvain, G. and Timmons, M.K. 2017. Effect of arm position on width of the subacromial space of upper string musicians. *Medical Problems of Performing Artists* 32(3), pp. 159-164. doi: 10.21091/mppa.2017.3026

Smyth, J.M. and Heron, K.E. 2016. Is providing mobile interventions "just-in-time" helpful? An experimental proof of concept study of just-in-time intervention for stress management. Bethesda; Unites States, 25-27 October 2016. *IEEE Wireless Health (WH)*. doi: 10.1109/WH.2016.7764561

Sonney, J., Duffy, M., Hoogerheyde, L.X., Langhauser, E. and Teska, D. 2019. Applying human-centered design to the development of an asthma essentials kit for school-aged children and their parents. *Journal of Pediatric Health Care* 33(2), pp. 169-177. doi: 10.1016/j.pedhc.2018.07.008

Spahn, C., Strukely, S. and Lehmann, A. 2004. Health conditions, attitudes toward study, and attitudes toward health at the beginning of university study: music students in comparison with other student populations. *Medical Problems of Performing Artists* 19(1), pp. 26-33. doi: 10.21091/mppa.2004.1005

Spahn, C., Voltmer, E., Mornell, A. and Nusseck, M. 2017. Health status and preventive health behavior of music students during university education: merging prior results with new insights from a German multicenter study. *Musicae Scientiae* 21(2), pp. 213-229. doi: 10.1177/1029864917698197

Spahn, C., Wasmer, C., Eickhoff, F. and Nusseck, M. 2014. Comparing violinists' body movements while standing, sitting, and in sitting orientations to the right or left of a music stand. *Medical Problems of Performing Artists* 29(2), pp. 86-93. doi: 10.21091/mppa.2014.2019

Spencer, L., Ritchie, J. and O'Connor, W. 2003. Analysis: practices, principles and processes. In Ritchie, J. and Lewis, J. eds. *Qualitative research practice: a guide for social science students and researchers*. London: Sage Publications

Spink, A., Wagner, I. and Orrock, P. 2022. Common reported barriers and facilitators for self-management in adults with chronic musculoskeletal pain: a systematic review of qualitative studies. *Musculoskeletal Science and Practice* 56, 102433. doi: 10.1016/j.msksp.2021.102433

Stanhope, J. and Weinstein, P. 2021. Should musicians play in pain? *British Journal of Pain* 15(1), pp. 82-90. doi: 10.1177/2049463720911399

Stanhope, J., Cook, A., Pisaniello, D. and Weinstein, P. 2022b. Musculoskeletal symptoms in professional musicians: do self-employed and employer-employed musicians differ? *Annals of Work Exposures and Health* 66(8), pp. 1056-1069. doi: 10.1093/annweh/wxac046

Stanhope, J., Milanese, S. and Grimmer, K. 2014. University woodwind students' experiences with playing-related injuries and their management: a pilot study. *Journal of Pain Research* 7, pp.133-148. doi: 10.2147/JPR.S49620

Stanhope, J., Pisaniello, D. and Weinstein, P. 2022a. The effect of strategies to prevent and manage musicians' musculoskeletal symptoms: a systematic review. *Archives of Environmental & Occupational Health* 77(3), pp. 185-208. doi: 10.1080/19338244.2020.1860879

Statista. 2023. *Number of artists in the UK 2021-2024*. Available at: <https://www.statista.com/statistics/319264/number-of-artists-in-the-uk/> [Accessed: 03 March 2023].

Steinmetz, A., Scheffer, I., Esmer, E., Delank, K.S. and Peroz, I. 2015. Frequency, severity and predictors of playing-related musculoskeletal pain in professional orchestral musicians in Germany. *Clinical Rheumatology* 34(5), pp. 965-973. doi: 10.1007/s10067-013-2470-5

Stevens, W.J.M., van der Sande, R., Beijer, L.J., Gerritsen, M.G. and Assendelft, W.J. 2019. eHealth apps replacing or complementing health care contacts: scoping review on adverse effects. *Journal of Medical Internet Research* 21(3), e10736. doi: 10.2196/10736

Stewart, D.W. and Shamdasani, P. 2017. Online focus groups. *Journal of Advertising* 46(1), pp. 48-60. doi: 10.1080/00913367.2016.1252288

Stewart, K. and Williams, M. 2005. Researching online populations: the use of online focus groups for social research. *Qualitative Research* 5(4), pp. 395-416. doi: 10.1177/1468794105056916

Stitzer, M.L., Petry, N.M. and Peirce, J. 2010. Motivational incentives research in the national drug abuse treatment clinical trials network. *Journal of Substance Abuse Treatment* 38, pp. S61-S69. doi: 10.1016/j.jsat.2009.12.010

Strazdins, L. and Bammer, G. 2004. Women, work and musculoskeletal health. *Social Science & Medicine* 58(6), pp. 997-1005. doi: 10.1016/S0277-9536(03)00260-0

Su, Y.H., Lin, Y.J., Tang, H.Y., Su, M.J. and Chen, H.S. 2012. Effectiveness of an e-learning curriculum on occupational health for music performers. *Telemedicine and e-Health* 18(7), pp. 538-543. doi: 10.1089/tmj.2011.0215

Suman, A., Schaafsma, F.G., Van Dongen, J.M., Elders, P.J., Buchbinder, R., Van Tulder, M.W. and Anema, J.R. 2019. Effectiveness and cost-utility of a multifaceted eHealth strategy to improve back pain beliefs of patients with non-specific low back pain: a cluster randomised trial. *BMJ Open*, 9(12), e030879. doi: 10.1136/bmjopen-2019-030879

Sun, X., Yan, W., Zhou, H., Wang, Z., Zhang, X., Huang, S. and Li, L. 2020. Internet use and need for digital health technology among the elderly: a cross-sectional survey in China. *BMC Public Health* 20, pp. 1-8. doi: 10.1186/s12889-020-09448-0

Svendsen, M.J. et al. 2020. Barriers and facilitators to patient uptake and utilisation of digital interventions for the self-management of low back pain: a systematic review

of qualitative studies. *BMJ Open* 10(12), e038800. doi: 10.1136/bmjopen-2020-038800

Taak, K., Brown, J. and Perski, O. 2021. Exploring views on alcohol consumption and digital support for alcohol reduction in UK-based Punjabi-Sikh men: a think aloud and interview study. *Drug and Alcohol Review* 40(2), pp. 231-238. doi: 10.1111/dar.13172

Taherdoost, H. 2016. Sampling methods in research methodology; how to choose a sampling technique for research. *International Journal of Academic Research in Management* 5, pp. 18-27. doi: 10.2139/ssrn.3205035

Tang, S., Werner-Seidler, A., Torok, M., Mackinnon, A.J. and Christensen, H. 2021. The relationship between screen time and mental health in young people: a systematic review of longitudinal studies. *Clinical Psychology Review* 86, 102021. doi: 10.1016/j.cpr.2021.102021

Tarr, J. 2011. Educating with the hands: working on the body/self in Alexander Technique. *Sociology of Health & Illness* 33(2), pp. 252-265.

Tashakkori, A. and Teddlie, C. 2003. Issues and dilemmas in teaching research methods courses in social and behavioural sciences: US perspective. *International Journal of Social Research Methodology* 6(1), pp. 61-77. doi: 10.1080/13645570305055

Taylor, C.B. et al. 2006. Prevention of eating disorders in at-risk college-age women. *Archives of General Psychiatry* 63(8), pp. 881-888. doi: 10.1001/archpsyc.63.8.881

Teague, A. and Smith, G.D. 2015. Portfolio careers and work-life balance among musicians: an initial study into implications for higher music education. *British Journal of Music Education* 32(2), pp.177-193. doi: 10.1017/S0265051715000121

Terry, G., Hayfield, N., Clarke, V. and Braun, V. 2017. Thematic analysis. In Willig, C. and Stainton Rogers, W. eds. *The SAGE handbook of qualitative research in psychology*. 2nd ed. London: Sage Publications, pp. 17-36.

Thomas, D. R. 2017. Feedback from research participants: are member checks useful in qualitative research? *Qualitative Research in Psychology* 14(1), pp. 23-41. doi: 10.1080/14780887.2016.1219435

Thomas, E.C., Simmons, M.B., Mathai, C. and Salzer, M.S. 2023. Peer-facilitated decision making in mental health: promises, pitfalls, and recommendations for research and practice. *Psychiatric Services* 74(4), pp. 401-406. doi: 10.1176/appi.ps.20220086

Thompson, K., Johnson, M.I., Milligan, J. and Briggs, M. 2022. Rethinking pain education from the perspectives of people experiencing pain: a meta-ethnography to inform physiotherapy training. *BMJ Open* 12(1), e046363. doi: 10.1136/bmjopen-2020-046363

Thornton, G.M. and Hart, D.A. 2011. The interface of mechanical loading and biological variables as they pertain to the development of tendinosis. *Journal of Musculoskeletal and Neuronal Interactions* 11(2), pp. 94-105.

Thornton, G.M., Schwab, T.D. and Oxland, T.R. 2007. Fatigue is more damaging than creep in ligament revealed by modulus reduction and residual strength. *Annals of Biomedical Engineering* 35, pp. 1713-1721. doi: 10.1007/s10439-007-9349-z

Throsby, D. and Petetskaya, K. 2017. *Making art work. An economic study of professional artists in Australia*. Available at:
<https://researchers.mq.edu.au/en/publications/making-art-work-an-economic-study-of-professional-artists-in-aust> [Accessed: 11 March 2025].

Tramontana, J. 2011. *Sports hypnosis in practice: scripts, strategies and case examples*. Carmarthen: Crown House Publishing.

Tripepi, G., Jager, K.J., Dekker, F.W. and Zoccali, C. 2010. Selection bias and information bias in clinical research. *Nephron Clinical Practice* 115(2), pp. c94-c99. doi: 10.1159/000312871

Twenge, J. M., Joiner, T. E., Rogers, M. L., Martin, G. N. 2018. Increases in depressive symptoms, suicide-related outcomes, and suicide rates among U.S. adolescents after 2010 and links to increased new media screen time. *Clinical Psychological Science* 6(1), pp. 3–17. doi: 10.1177/2167702617723376

Unsworth, H. et al. 2021. The NICE evidence standards framework for digital health and care technologies—developing and maintaining an innovative evidence framework with global impact. *Digital Health* 7, 20552076211018617. doi: 10.1177/20552076211018617

Ursin, R., Baste, V. and Moen, B.E. 2009. Sleep duration and sleep-related problems in different occupations in the Hordaland Health Study. *Scandinavian Journal of Work, Environment & Health* 35(3), pp. 193-202. doi: 10.5271/sjweh.1325

Usgu, S., Akbey, H., Kocyigit, B.F., Akyol, A. and Yakut, Y. 2022. Comparison of the effectiveness of a structured exercise program on nonspecific neck pain in string and woodwind players. *Rheumatology International* 42(4), pp. 725-736. doi: 10.1007/s00296-021-05085-x

Vaag, J., Bjørngaard, J.H. and Bjerkeset, O. 2016b. Symptoms of anxiety and depression among Norwegian musicians compared to the general workforce. *Psychology of Music* 44(2), pp. 234-248. doi: 10.1080/15402002.2015.1007991

Vaag, J., Giæver, F. and Bjerkeset, O. 2014. Specific demands and resources in the career of the Norwegian freelance musician. *Arts & Health* 6(3), pp. 205-222. doi: 10.1080/17533015.2013.863789

Vaag, J., Saksvik-Lehouillier, I., Bjørngaard, J.H. and Bjerkeset, O. 2016a. Sleep difficulties and insomnia symptoms in Norwegian musicians compared to the general population and workforce. *Behavioral Sleep Medicine*, 14(3), pp. 325-342. doi: 10.1080/15402002.2015.1007991

Vaag, J., Sund, E.R. and Bjerkeset, O. 2018. Five-factor personality profiles among Norwegian musicians compared to the general workforce. *Musicae Scientiae* 22(3), pp. 434-445. doi: 10.1177/1029864917709519

- Vaaler, A. 2021. Music index with full text. *The Charleston Advisor* 23, pp. 35-37. doi: 10.5260/chara.23.1.35
- Vaismoradi, M., Turunen, H. and Bondas, T. 2013. Content analysis and thematic analysis: implications for conducting a qualitative descriptive study. *Nursing & Health Sciences* 15(3), pp. 398-405. doi: 10.1111/nhs.12048
- Van der Schyff, E.L., Amon, K.L., Ridout, B., Forsyth, R. and Campbell, A.J. 2023. Mental health help-seeking behavior of male video game players: an online survey. *Cyberpsychology, Behavior, and Social Networking* 26(9), pp. 717-723. doi: 10.1089/cyber.2023.0035
- Van Vliet, P.M. and Heneghan, N.R. 2006. Motor control and the management of musculoskeletal dysfunction. *Manual Therapy* 11(3), pp. 208-213. doi: 10.1016/j.math.2006.03.009
- Varani, J. et al. 2006. Decreased collagen production in chronologically aged skin: roles of age-dependent alteration in fibroblast function and defective mechanical stimulation. *The American Journal of Pathology* 168(6), pp. 1861-1868. doi: 10.2353/ajpath.2006.051302
- Velentgas, P., Dreyer, N.A. and Wu, A.W. 2013. Outcome definition and measurement. *Developing a protocol for observational comparative effectiveness research: a user's guide*. Rockville, MD: Agency for Healthcare Research and Quality (US). Available at: <https://www.ncbi.nlm.nih.gov/books/NBK126190/> [Accessed: 24 March 2024]

Viljanen, M., Malmivaara, A., Uitti, J., Rinne, M., Palmroos, P. and Laippala, P. 2003. Effectiveness of dynamic muscle training, relaxation training, or ordinary activity for chronic neck pain: randomised controlled trial. *British Medical Journal* 327(7413), 475. doi: 10.1136/bmj.327.7413.475

Vlaev, I., King, D., Darzi, A. and Dolan, P. 2019. Changing health behaviors using financial incentives: a review from behavioral economics. *BMC Public Health* 19, pp. 1-9. doi: 10.1186/s12889-019-7407-8

Waddell, G., Burton, A.K. and Kendall, N.A. 2008. *Vocational rehabilitation—what works, for whom, and when?* Available at: <https://huddersfield.box.com/s/z192d45rnr4th5njuy30u09no8v3vnnc> [Accessed 29 March 2025]

Wang, D., Chen, J., Zhao, D., Dai, F., Zheng, C. and Wu, X. 2017. Monitoring workers' attention and vigilance in construction activities through a wireless and wearable electroencephalography system. *Automation in Construction* 82, pp. 122-137. doi: 10.1016/j.autcon.2017.02.001

Warrington, J. 2003. Hand therapy for the musician: instrument-focused rehabilitation. *Hand Clinics* 19(2), pp. 287-301, vii. doi: 10.1016/s0749-0712(02)000951

Watson, A.H. 2009. *The biology of musical performance and performance-related injury*. London: Scarecrow Press.

Watson, E. E. and Minns Lowe, C. J. 2024. Exploring the experiences of UK-based private physiotherapists when running and progressing a physiotherapy business: a

hermeneutic phenomenological study. *Physiotherapy* 124, pp. 40-50. doi: 10.1016/j.physio.2024.04.349

Watson, R. 2015. Quantitative research. *Nursing Standard* 29(31), pp. 44-48. doi: 10.7748/ns.29.31.44.e8681

Weale, V., Stuckey, R., Kinsman, N. and Oakman, J. 2022. Workplace musculoskeletal disorders: a systematic review and key stakeholder interviews on the use of comprehensive risk management approaches. *International Journal of Industrial Ergonomics* 91, 103338. doi: 10.1016/j.ergon.2022.103338

Webb, C. and Kevern, J. 2001. Focus groups as a research method: a critique of some aspects of their use in nursing research. *Journal of Advanced Nursing* 33(6), pp. 798-805. doi: 10.1046/j.1365-2648.2001.01720.x

Webb, T., Joseph, J., Yardley, L. and Michie, S. 2010. Using the internet to promote health behavior change: a systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy. *Journal of Medical Internet Research* 12(1), e1376. doi: 10.2196/jmir.1376

Wegrzynek, P.A., Wainwright, E. and Ravalier, J. 2020. Return to work interventions for chronic pain: a systematic review. *Occupational Medicine* 70(4), pp. 268-277. doi: 10.1093/occmed/kqaa066

Weiss, D.S., Shah, S. and Burchette, R.J. 2008. A profile of the demographics and training characteristics of professional modern dancers. *Journal of Dance Medicine & Science* 12(2), pp. 41-46.

West, R. 2005. Time for a change: putting the Transtheoretical (Stages of Change) Model to rest. *Addiction* 100(8), pp. 1036-1039. doi: 10.1111/j.1360-0443.2005.01139.x

Whale, K. and Gooberman-Hill, R. 2022. The importance of sleep for people with chronic pain: current insights and evidence. *Journal of Bone and Mineral Research Plus* 6(7), e10658. doi: 10.1002/jbm4.10658

Wildenbos, G.A., Maasri, K., Jaspers, M. and Peute, L. 2018. Older adults using a patient portal: registration and experiences, one year after implementation. *Digital Health* 4(10), 2055207618797883. doi: 10.1177/2055207618797883

Willeke, K. et al. 2021. Occurrence of mental illness and mental health risks among the self-employed: a systematic review. *International Journal of Environmental Research and Public Health* 18(16), 8617. doi: 10.3390/ijerph18168617

Williamon, A. 2004. *Musical excellence: strategies and techniques to enhance performance*. Oxford: Oxford University Press.

Williamon, A. and Thompson, S. 2006. Awareness and incidence of health problems among conservatoire students. *Psychology of Music* 34(4), pp. 411-430. doi: 10.1177/03057356060671

Willis, S., Neil, R., Mellick, M.C. and Wasley, D. 2019. The relationship between occupational demands and well-being of performing artists: a systematic review. *Frontiers in Psychology* 10, pp. 393. doi: 10.3389/fpsyg.2019.00393

Wijsman, S. and Ackermann, B. J. 2018. Educating Australian musicians: are we playing it safe? *Health Promotion International* 34(4), pp. 869-876. doi:

<https://doi.org/10.1093/heapro/day030>

Wolf, R.C, Thurmer, H.P., Berg, W.P., Cook, H.E. and Smart, L.J. 2017. Effect of the Alexander technique on muscle activation, movement kinematics, and performance quality in collegiate violinists and violists: a pilot feasibility study. *Medical Problems of Performing Artists* 32(2), pp. 78-84. doi: 10.21091/mppa.2017.2014

Woolf, A.D., Erwin, J. and March, L. 2012. The need to address the burden of musculoskeletal conditions. *Best Practice & Research Clinical Rheumatology* 26(2), pp. 183-224. doi: 10.1016/j.berh.2012.03.005

World Confederation for Physical Therapy. 2011. *Policy statement: description of physical therapy*. Available at: <https://world.physio/policy/ps-descriptionPT>
[Accessed: 29 March 2025]

World Health Organisation. 1985. *WHO Expert Committee on Identification and Control of Work-Related Diseases. Identification and control of work-related diseases*. Available at: <https://iris.who.int/handle/10665/40176> [Accessed: 15 August 2021]

World Health Organisation. 2014. *Health education: theoretical concepts, effective strategies and core competencies. A foundation document to guide capacity development of health educators*. Available at:
<https://applications.emro.who.int/dsaf/emrp> [Accessed: 23 October 2023]

World Health Organization. 2021. *Musculoskeletal conditions*. Available at: <https://www.who.int/news-room/fact-sheets/detail/musculoskeletal-conditions> [Accessed: 15 October 2021].

World Health Organization. 2023a. *Osteoarthritis*. Available at: <https://www.who.int/news-room/fact-sheets/detail/osteoarthritis> [Accessed: 17 February 2025]

World Health Organization. 2023b. *Classification of digital interventions, services and applications in health: a shared language to describe the uses of digital technology for health*. Available at: <https://www.who.int/publications/i/item/9789240081949> [Accessed: 29 October 2022]

World Health Organization. 2024. *Burn-out an ‘occupational phenomenon’: International Classification of Diseases*. World Health Organization. Available at: <https://www.who.int/news/item/28-05-2019-burn-out-an-occupational-phenomenon-international-classification-of-diseases> [Accessed: 29 November 2024]

Wu, D., Wong, P., Guo, C., Tam, L. S. and Gu, J. 2021. Pattern and trend of five major musculoskeletal disorders in China from 1990 to 2017: findings from the Global Burden of Disease Study 2017. *BMC Medicine* 19(1), pp. 34. doi: 10.1186/s12916-021-01905-w

Wu, Z. et al. 2022. Self-management for knee osteoarthritis: a systematic review and meta-analysis of randomized controlled trials. *Pain Research and Management* 2022(1), 2681240. doi: 10.1155/2022/2681240

Yadav, D. 2022. Criteria for good qualitative research: a comprehensive review. *The Asia-Pacific Education Researcher* 31(6), pp. 679-689. doi: 10.1007/s40299-021-00619-0

Yam, M. F., Loh, Y. C., Tan, C. S., Khadijah Adam, S., Abdul Manan, N. and Basir, R. 2018. General pathways of pain sensation and the major neurotransmitters involved in pain regulation. *International Journal of Molecular Science* 19(8). doi: 10.3390/ijms19082164

Yan, X., Li, H., Li, A.R. and Zhang, H. 2017. Wearable IMU-based real-time motion warning system for construction workers' musculoskeletal disorders prevention. *Automation in Construction* 74, pp. 2-11. doi: 10.1016/j.autcon.2016.11.007

Yeo, C. et al. 2022. Uses and misuses of recorded mental health lived experience narratives in healthcare and community settings: systematic review. *Schizophrenia Bulletin* 48(1), pp. 134-144. doi: 10.1093/schbul/sbab097

Ylinen, J. et al. 2003. Active neck muscle training in the treatment of chronic neck pain in women: a randomized controlled trial. *Journal of the American Medical Association* 289(19), pp. 2509-2516. doi: 10.1001/jama.289.19.2509

Yoshimura, E. and Chesky, K. 2009. The application of an ergonomically modified keyboard to reduce piano-related pain. *MTNA e-journal*, November, pp. 2-13. Available at: https://paskpiano.org/wp-content/uploads/2021/09/Yoshimura-Chesky_MTNA_E_Journal.pdf

Yoshimura, E., Paul, P.M., Aerts, C. and Chesky, K. 2006. Risk factors for piano-related pain among college students. *Medical Problems of Performing Artists* 21(3), pp.118-125. doi: 10.21091/mppa.2006.3024

Zabuska, A., Ginsborg, J. and Wasley, D. 2018. A preliminary comparison study of burnout and engagement in performance students in Australia, Poland and the UK. *International Journal of Music Education* 36(3), pp. 366-379. doi: 10.1177/025576141775124

Zaza, C. 1998. Playing-related musculoskeletal disorders in musicians: a systematic review of incidence and prevalence. *Canadian Medical Association Journal* 158(8), pp.1019-1025.

Zaza, C., Charles, C. and Muszynski, A. 1998. The meaning of playing-related musculoskeletal disorders to classical musicians. *Social Science & Medicine* 47(12), pp. 2013-2023. doi: 10.1016/S0277-9536(98)00307-4

Zhao, P., Yoo, I., Lancey, R. and Varghese, E. 2019. Mobile applications for pain management: an app analysis for clinical usage. *BMC Medical Informatics and Decision Making* 19, pp.1-10. doi: 10.1186/s12911-019-0827-7

Appendices

Appendix 1: Table 1 Search Terms for Scoping Review Search Terms

PRMSDs	Performance-related musculoskeletal disorder* OR performance related musculoskeletal disorder* OR PRMD* OR PRMSD* playing-related pain OR playing-related musculoskeletal disorder* OR playing-related condition or music-related musculoskeletal dis* OR music-related musculoskeletal symptom* musculoskeletal symptom* OR musculoskeletal condition*
Music/ musical instrument/ musician	Music Or music playing OR musical perform* OR performing art OR instrumental music OR musician* OR conservatoire OR orchestra OR orchestral musician* OR music academy student* OR music student* OR student musician* OR tertiary student musician* college-level musician* OR university-level musician* OR instrument play* OR Instrumentalist* OR classical musician* OR piano OR pianist* OR piano play* OR violin OR violinist* OR violin play* OR viola* OR viola play* OR cello* OR cellist* OR cello play* OR double bass OR double bass play* OR double base play* OR bass play* OR bassist* OR flute OR flute play* OR flutist* OR oboe OR oboe play* or oboist* OR clarinet OR clarinet play* OR clarinettist* OR saxophone OR bassoon* OR bassoon play* OR bassoonist* OR trumpet OR trumpet play* OR trumpetist* OR trumpeter* OR trombone* OR trombone play* OR trombonist* OR tuba OR tuba play* OR horn* OR horn play* OR hornist OR harpsichord OR percussion play* OR percussionist* OR harp OR harp play* OR harpist OR harmonica OR organ OR church organ OR pipe organ OR organ play* OR organist* OR keyboard OR ukulele OR guitar OR guitar play* OR guitarist* OR string OR woodwind instrument* OR brass play* OR drum OR drummer* OR recorder OR pipe OR band OR Irish musician* OR military music OR martial music OR army music OR baroque music OR marching music OR jazz OR folk music OR concert* OR country OR opera* OR ensemble playing OR ensemble performance OR musical ensemble OR soloist OR instrumental solo OR solo instrument*
Digital health intervention	e-Health intervention* OR Electronic health OR Mobile health intervention* OR m-Health OR digital health intervention* OR digital health OR digital intervention* OR videoconference* OR Zoom OR website* OR internet OR VR or virtual reality or video*

Appendix 2: Table 1 Database Searches

Database Search	Records identified	Records Screened	Relevant studies
CINAHL (EbscoHost)	199	199	2
Music Index (EbscoHost)	560	560	0
Medline (Ovid)	3	3	1
Embase (Ovid)	3	3	1
AMED (Ovid)	0	0	0
TripPro	0	0	0
Proquest Dissertations and Theses Global	249	249	2

Appendix 2: Table 2 Data Screening Sheet

Eligibility	Authors / date	Yes / No / Unclear	Reasons
Are participants adult musicians with PRMSDs?			
Is it a self-management intervention?			
Does it include a DHI?			
Is the study relevant?			

Appendix 3: Figure 1 Ethical Approval



School of
Healthcare Sciences
Ysgol y Gwyddorau
Gofal Iechyd

Interim Head of School and Dean / Pennaeth yr Ysgol Dros Dro a Deon Professor David Whitaker

5 July 2022

Noudy Eleryan
Cardiff University
School of Healthcare Sciences

Dear Noudy Eleryan

Research project title: Understanding the role of self-management in musicians with MSDs:
Exploration of digital self-management strategies

SREC reference: REC889

The School of Healthcare Sciences Research Ethics Committee reviewed the above application via its proportionate review process.

Ethical Opinion

The Committee gave:

a favourable ethical opinion of the above application on the basis described in the application form, protocol and supporting documentation.

Additional approvals

This letter provides an ethical opinion only. You must not start your research project until all appropriate approvals are in place.

Amendments

Any substantial amendments to documents previously reviewed by the Committee must be submitted to the Committee via HCAREEthics@cf.ac.uk for consideration and cannot be implemented until the Committee has confirmed it is satisfied with the proposed amendments.

You are permitted to implement non-substantial amendments to the documents previously reviewed by the Committee but you must provide a copy of any updated documents to the Committee via HCAREEthics@cf.ac.uk for its records.

Monitoring requirements

The Committee must be informed of any unexpected ethical issues or unexpected adverse events that arise during the research project .e.g.

- End of project report ONLY;
- Annual reports;
- Periodic reports from and/or visits to the Chief/Principal Investigator;
- Oral updates to the Committee (by the Chief/Principal Investigator);
- Establishing a project-specific monitoring provision.



Registered Charity No. 1136855
Elusen Gofrestredig Rhif. 1136855

Cardiff University
Eastgate House
35-43 Newport Road
Cardiff
www.cardiff.ac.uk

Prifysgol Caerdydd
Ty Eastgate
35 - 43 Heol Casnewydd
Caerdydd
www.caerdydd.ac.uk

Appendix 3: Figure 2 Survey Electronic Consent Form

Consent form

The purpose of this form is to ensure that you are willing to take part in this study.

This part of the survey uses a table of questions, [view as separate questions instead?](#)

Please read the information below and select an option. * **Required**

	Yes	No
I confirm that I have read and understood the information for the above research project and that I have had the opportunity to ask questions and that these have been answered satisfactorily.	☐	☐
I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my legal rights and medical rights being affected.	☐	☐
I understand that once I click submit, my response cannot be excluded from the analysis.	☐	☐
I understand that if I choose to provide my contact details at the end of the survey, my survey response may no longer be anonymous to the researcher. However, no names or identifying information will be included in any publications or presentations based on these data.	☐	☐
I understand that the data from the survey maybe presented at conferences and in scientific journals. I understand that these will be used anonymously and that no individual respondent will be identified in such reports.	☐	☐

Please select one of the following options. **Required**

Please select

Please select

I consent to all of the above points and want to participate in this study.

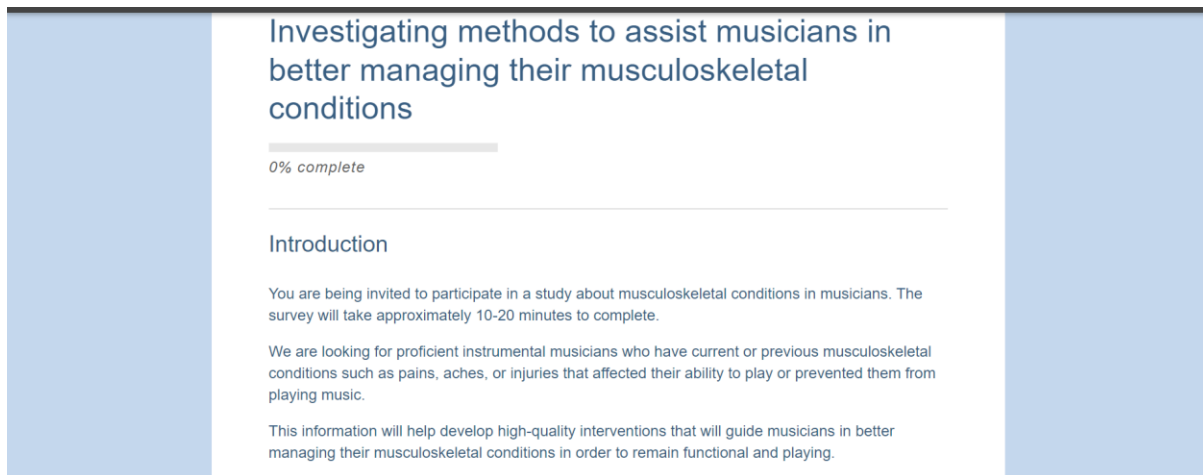
I do not want to participate in this study.

I am unsure and would like to ask some questions.

Appendix 3: Figure 3 Recruitment Poster



Appendix 3: Figure 4 Survey Welcome page on JISC

The image shows a survey welcome page with a light blue header and footer. The main content area is white. At the top, the title "Investigating methods to assist musicians in better managing their musculoskeletal conditions" is displayed in a dark blue font. Below the title is a progress bar showing 0% completion. The section "Introduction" is followed by three paragraphs of text. The first paragraph states that the user is invited to participate in a study about musculoskeletal conditions in musicians, which will take 10-20 minutes. The second paragraph explains that the study is looking for proficient instrumental musicians with current or previous musculoskeletal conditions like pain or injury. The third paragraph notes that the information will help develop high-quality interventions to guide musicians in better managing their conditions.

Investigating methods to assist musicians in better managing their musculoskeletal conditions

0% complete

Introduction

You are being invited to participate in a study about musculoskeletal conditions in musicians. The survey will take approximately 10-20 minutes to complete.

We are looking for proficient instrumental musicians who have current or previous musculoskeletal conditions such as pains, aches, or injuries that affected their ability to play or prevented them from playing music.

This information will help develop high-quality interventions that will guide musicians in better managing their musculoskeletal conditions in order to remain functional and playing.

Appendix 3: Figure 5 Online Survey Eligibility Criteria

Investigating methods to assist musicians in better managing their musculoskeletal conditions

6% complete

Eligibility criteria

Before you start the survey, it is important to confirm your eligibility to participate in the study. Please consider the following points and select one of the options below.

To participate in the survey, you need to confirm that:

- you are 18 years or older;
- you are a proficient musician (e.g., an amateur, a hobbyist, or a professional musician) or a university-level student musician majoring in a musical instrument;
- your average weekly playing time is 5-10 hours;
- in the last five years, you have had or are currently experiencing pains, aches and/or injuries that affected your ability to play or stopped you from playing music.

Please select an option

Please select

Please select
I confirm that I meet the eligibility criteria listed above.
I am not sure if I am eligible to participate and would like to ask some questions.
I am not eligible to participate in this study.
I do not want to participate in this study.

< Previous

Next >

Appendix 3: Figure 6 Email Invitation to Pilot Survey

With this email I would like to invite you to participate in a pilot survey about musculoskeletal disorders in instrumental musicians. The overall aim of the project is to develop high quality interventions that will guide musicians in better managing their musculoskeletal disorders in order to remain functional and playing.

To participate in the survey, you need to be a student or professional musician with current or previous musculoskeletal conditions such as pains, aches or injuries that affected your ability to play or stopped you from playing.

The survey will take approximately 10-15 minutes to complete. Once you finish the survey, please complete the feedback form which should take less than 5 minutes to complete. This will help us identify any problems in the survey before sending it out to a larger group of musicians. The links to the survey and the feedback form is at the bottom of this email.

Please let me know if anything is unclear or if you have any questions.

Thank you so much for your help.

Kind regards,
Noudy

Survey link:

https://cardiff.onlinesurveys.ac.uk/musician_msds_3

Feedback form:

<https://cardiff.onlinesurveys.ac.uk/-survey-feedback-form->

Appendix 3: Table 1 Survey Written Comments

Category	Frequency	Examples
Instrument advice	17	• More support with injuries/pains related to my specific instrument" • "Professional instrumentalists observing posture and correcting" • "Perhaps some help with posture by an instrumental specialist" • "Better ways to maintain physical health that is actually applied to the instrument playing posture and not before/after" • "Advice specific to playing my instruments" • "Information related to my instrument, what muscles we use and how to stretch/relax these muscles" • "What would maybe help is sessions to look at playing position and work out instrument-specific strength conditioning/warm ups. I have little trouble with piano and guitar and have only had issues with viola as it is a relatively heavy instrument to hold up with one instrument." • "Information on proper positions for spinal column when practicing on the Harp" • "Understanding how muscles work on an instrument-specific basis" • "Instrument warm up exercises that will throughouly prepare me for a practise session"

		• "Playing positions for woodwind players with musculoskeletal conditions eg arthritis in fingers, neck, spine, hips etc" • "Instrument specific advice on posture and what leads to aches and pains. exercises that will help strengthen and deter injury." • "Knowing the effects of repeated motion, especially with an oddly set up instrument like violin" • "How to stop wrist ache from holding instruments during long periods like shows where I can't stop." • "More information about those with back issues." • "Playing-specific strengthening advice" • "Knowing how to position yourself in a more 'natural' way whilst playing an instrument for long hours"
Pain management and recovery information (without having to stop playing)	20	• "How to relief pain without stopping playing" • "More information about RSI and how to manage it" • "Methods to alleviate symptoms and treat causes" • "Specific stretches for specific aches" • "Telling me which stretches to strengthen my muscles"

		• "How to read pain and sensation in relation to rest and strengthening" • "Holding tension in my muscles leads to my wrist and elbow trouble and I haven't seen that mentioned here or from any teachers or doctors. Learning to play without carrying muscle tension has been helpful for me. Maybe information on that would help?" • "More exercises" • "Information on joint pain relief mechanisms and how to reduce pain" • "How to release muscle knots on your back by yourself (without having to pay a physio/masseuse)" • "Ways to better prevent them and how to actually warm up muscles for safe practice" • "What exercises are needed to strengthen the active muscles that are jammed when playing a musical instrument, as well as exercises to relax and stretch active muscles." • "Medical information on causes of pain and what to do without having to stop playing" • "Specific cause & probability of complete recovery" • "Better knowledge of my own anatomy." • "Understanding of the muscle groups being worked, and how to develop complimentary muscle groups to maintain stability and balance through body." • "Knowing what the long-term impact on the body is"

		• "Information specific to the placement of injury" • "How to relate a specific pain to the probability to develop a serious chronic pain" • "How to manage the amount of hours required when feeling slight pain"
Early prevention	10	• "Warning signs of injury, preventative measure to be pro active instead of reactive" • "Pre-emptive info" • "Better training at a young age for performance posture." • "How to prevent them in the first Place" • "Everything at the beginning was what to do to be fixed not acknowledging what had lead to it in the first place" • "What to do to avoid pain, and what to do to mitigate it when it happens" • "To properly understand where the route of these issues apply in order to prevent them forever rather than just being given temporary solutions" • "I think more lectures on injury prevention and management would be highly beneficial. Throughout my degree I've only had one lesson on injury prevention and that was nearly two years ago." • "How to deal with it, how to prevent in the future"

		• "More information on injury risks specific to my instrument would help me better manage prmds. Information on likely recovery time would also help me to manage my injuries" • "More health care knowledge of how to prevent pain" • "Clearer information on the correct placement of the body during the practice." • "More widespread discussion and info out there to advise on good practice techniques and stretches. We all know injuries can happen but what are the best stretches and exercise that are useful for specific individual instruments?" • "Perhaps having advice available prior to injuries and pains becoming a problem, pilates is the most useful to me and should be offered on all performance programmes.
Cultural and organisational changes	7	• More understanding and acceptance visible in the musical community so it would be a more open topic of conversation" • "More knowledge with instrumental tutors & university lecturers in the first instance" • "Maybe a music medical specialist that can advise on how to treat pains without suggesting stopping playing (which isn't an option for a lot of people) or eventual surgery." • "I felt the Physios I had treated my problem like a sports injury so with a absence of playing and stretches it would improve. For me and a friend of mine that also plays guitar (who

		also had similar problems with the wrist), the advice of 'if it hurts dont play' was not very useful as it turned out in the long run that the more I played the more my symptoms were relieved." • "My doctor was very quick to subscribe pain medication, but this doesn't solve the root cause, it just puts a temporary plaster on the injury. I had to become my own doctor after exhausting all options, with the help of online resources and education." • I think more awareness of injuries and how to prevent them, would also be really good!" • "Very specific medical examinations".
Accessible information	9	• "More accessible information" • "More variety in financially accessible adjustments" • "Knowledge of websites or resources where musicians can access information regarding injuries or pains" • "Availability of resources for pain management" • "An understanding of where to go for help even if the pain is only mild" • "The more studies are done, the better!"

		• "More information on the lifestyle side of things, as well as information on how the mind and body could potentially be connected. Information on posture in our everyday lives etc." • "If there was a research done on my issue" • Maybe pamphlets with referrals to pain management places- medical or alternative (chiropractor, kinesiology etc)"
Peer support	6	• "I feel I need support" • "Just more support from other musicians in my position" • "Suggestions from others who have the similar related pains" • "Information from musicians with similar injuries sharing their experience or from physio/osteo who specialise in musician injuries rather than general injury" • "A deeper understanding of the causes of aches and pains; I found playing the cello (particularly picking it up after a couple of years between graduating my undergraduate music degree and taking on work as a professional musician) was the time I experienced most aches and pains. At that time, I didn't have a teacher so I felt like I didn't have anyone to ask about why I was experiencing those pains. I did find searching online for people who had experienced similar symptoms to me very helpful, and some kind of peer-to-peer

		resource where I could easily find out how other musicians managed similar issues would be something I think would be very helpful." • "Case-specific information. It would help to have somebody who knew my exact background and ongoing troubles who could give me personal guidance and advice.

Appendix 4: Initial Survey

This section will ask about your musculoskeletal problem(s).

1. In the past five years, how many times did you experience musculoskeletal problem(s) that interfered with your ability to play your main instrument at your normal level? _____ times
2. Please mark all the area(s) of your body that you experienced musculoskeletal problem(s) and how long they lasted for.

Area	Lastest less than 3 months	Lastest longer than 3 months	Ongoing
☐ Neck	☐	☐	☐
☐ Right shoulder	☐	☐	☐
☐ Left shoulder	☐	☐	☐
☐ Right elbow	☐	☐	☐
☐ Left elbow	☐	☐	☐
☐ Right wrist/hand	☐	☐	☐
☐ Left wrist/hand	☐	☐	☐
☐ Right hand fingers	☐	☐	☐
☐ Left hand fingers	☐	☐	☐
☐ Mid back	☐	☐	☐
☐ Lower back	☐	☐	☐
☐ Right hip	☐	☐	☐
☐ Left hip	☐	☐	☐
☐ Right knee	☐	☐	☐
☐ Left knee	☐	☐	☐
☐ Right ankle	☐	☐	☐
☐ Left ankle	☐	☐	☐

3. How would you describe your physical symptoms (Tick all that apply)?

☐ Ache ☐ Numbness ☐ Pins and Needles ☐ Weakness ☐ Tingling ☐ Burning sensation ☐ Stabbing pain ☐ Shooting pain ☐ Pain that worsens with movement ☐ Muscle tension ☐ Fatigue ☐ Pressure ☐ Other – please specify

4. Please put a mark to rate the intensity of your physical symptoms with zero being no pain and 10 being the most severe.



5. What do you think makes your musculoskeletal problem(s) worse? (Tick all that apply)

- ☐ Not taking enough rest days between performances/concerts
- ☐ Sitting/standing for a long time
- ☐ Lifting/carrying load
- ☐ Being stressed and/or anxious
- ☐ Being physically fatigued
- ☐ Not getting enough sleep
- ☐ Any activity that I do for a long time
- ☐ Other (please specify)
- ☐ It's the same all the time

6. With my musculoskeletal problem(s), ... (Tick the most appropriate)

- ☐ I remained in the same role
- ☐ I moved to a new less demanding role
- ☐ I had to change instruments
- ☐ I had to stop playing in professional contexts
- ☐ I am unable to commit to demanding schedules (e.g., music tours and festivals)

7. Did you take time off work because of your musculoskeletal problem(s)?

☐ Yes

☐ No

8. How much time did you take off work because of your musculoskeletal problem(s)?

☐ Less than 1 week

☐ Less than 2 weeks

☐ Between 2-4 weeks

☐ More than 1 month

9. What do you think caused your musculoskeletal problem(s)?

10. Do you think your work as a musician contributed to your musculoskeletal problem(s)?

☐ Yes

☐ No

☐ Unsure

Section 3: Impact on lifestyle and social connections

This section will ask about the impact of your musculoskeletal problem(s) on your lifestyle and relationships with others.

1. Since my musculoskeletal problem(s), I feel more stressed and anxious.

☐ Yes

☐ No

☐ Unsure

2. Stress makes my symptoms worse.

☐ Yes

☐ No

☐ Unsure

3. Since my musculoskeletal problem(s), I have been having trouble sleeping.

☐ Yes

☐ No

☐ Unsure

4. Not getting enough sleep makes my symptoms worse.

☐ Yes

☐ No

☐ Unsure

5. Regardless of my musculoskeletal problem(s), I try to stay active and take pleasure in doing things.

☐ Yes

☐ No

☐ Unsure

6. I feel supported by my friends and family.

☐ Yes

☐ No

☐ Unsure

Section 4: Management methods

This section will ask about methods that you find helpful and beneficial in managing your musculoskeletal problem(s).

1. What strategies did you try to manage your musculoskeletal problem(s) and how effective were they? (Tick all that apply)

	Not helpful		Extremely helpful			
Pain-relief medication	☐	☐	☐	☐	☐	☐
Cortisone injection	☐	☐	☐	☐	☐	☐
Ergonomic equipment	☐	☐	☐	☐	☐	☐
Relaxation techniques/stress management	☐	☐	☐	☐	☐	☐
Yoga	☐	☐	☐	☐	☐	☐
Pilates	☐	☐	☐	☐	☐	☐
Alexander technique	☐	☐	☐	☐	☐	☐
Feldenkrais Method	☐	☐	☐	☐	☐	☐
Body mapping	☐	☐	☐	☐	☐	☐
Tai-chi	☐	☐	☐	☐	☐	☐
Manual therapy/massage	☐	☐	☐	☐	☐	☐
Bowen therapy	☐	☐	☐	☐	☐	☐
Meditation	☐	☐	☐	☐	☐	☐
Breathing exercise	☐	☐	☐	☐	☐	☐
Strengthening exercise	☐	☐	☐	☐	☐	☐
Stretching exercise	☐	☐	☐	☐	☐	☐
Warm-up/cool-down routine	☐	☐	☐	☐	☐	☐
Massage	☐	☐	☐	☐	☐	☐
Heat/cold	☐	☐	☐	☐	☐	☐
Stress management	☐	☐	☐	☐	☐	☐
Resting/lying down	☐	☐	☐	☐	☐	☐
Avoiding activities certain activities	☐	☐	☐	☐	☐	☐
Heat/cold	☐	☐	☐	☐	☐	☐

2. What changes did you make to your playing routine and how effective were they? (Tick all that apply)

	Not helpful		Extremely helpful		
I take more regular breaks	☐	☐	☐	☐	☐
I stop playing when my physical symptoms get worse	☐	☐	☐	☐	☐
I pace my playing (e.g., gradual build-up of speed)	☐	☐	☐	☐	☐
I regularly change my playing position/posture (e.g., changing frequently from right to left hand, sitting to standing)	☐	☐	☐	☐	☐
I reduced my daily self-practise	☐	☐	☐	☐	☐
Other (please specify)	☐	☐	☐	☐	☐

3. Did you seek professional help for your musculoskeletal problem(s)?

☐ Yes ☐ No

4. Are you aware of any digital intervention and/or online resources that provide management advice to musicians?

☐ Yes ☐ No

5. Which digital platform and/or online resources did you use? (Tick all that apply)

☐ Musicians' organisations websites

☐ YouTube videos

☐ Facebook or Instagram

☐ Mobile health applications

☐ Other – please specify

6. How confident do you feel in managing your musculoskeletal problem(s)?

☐ Confident

☐ No confident

☐ I still need more knowledge and information

7. What would help you better manage your musculoskeletal problem(s)?

[Submit]

Thank you for taking time to complete the survey.

Appendix 5: Revised Survey

Section 1: About you

This section will ask general questions about you.

- 1. What do you identify as?** ☐ Female ☐ Male ☐ non-binary ☐ Prefer not to say
- 2. What is your age?** _____ years
- 3. What is your music-specific employment status? (Tick all that apply)**

☐ Student

☐ Employed

☐ Self-employed

- 4. Do you have any other employment?**

☐ Yes – Question 5

☐ No

- 5. Please state your additional employment type.**

☐ Health care and social services

☐ Transportation

☐ Retail and hospitality

☐ Manual work

☐ Administrative services

☐ Other (Please give details)

- 6. How many hours per a week do you work in all roles?** _____ hours

Section 2: About playing your musical instrument(s)

This part will ask questions about your career as a musician.

- 7- What is your primary instrument?** _____

8- Do you play any additional instrument(s)?

☐ Yes

☐ No

9- Please specify any additional instrument(s) that you play. _____

10-What type of music do you play? (Tick all that apply)

☐ Contemporary

☐ Classical

☐ Other (Please give details)

11- Which of the following best describes your current job?

☐ Solo artist

☐ Band member

☐ Theatre musician

☐ Orchestral musician

☐ Music teacher

☐ Other (Please give details)

12- On average, how many hours per week do you practice playing a musical instrument? _____ hour(s)

13- Tick what best describes you.

☐ All of my practice time consists of playing a single musical instrument.

☐ My practice time consists of playing mostly one musical instrument with some additional play of other instruments.

☐ I play a range of musical instruments and my practice time varies.

Section 3: About your physical health

This section will ask about your physical health and how it impacts your music.

14- How many times in the last five years have you had pains, aches, and injuries that impaired your ability to play or prevented you from playing for more than 48 hours?

- ☐ 0 – 2 times
- ☐ 2 – 5 times
- ☐ More than 5 times

15- Please mark all the area(s) of your body that you experienced pain, aches, and injuries and how long they lasted for. (Tick all that apply)

Area	Lastest less than 3 months	Lastest longer than 3 months	Ongoing
☐ Neck	☐	☐	☐
☐ Shoulder	☐	☐	☐
☐ Elbow	☐	☐	☐
☐ Wrist	☐	☐	☐
☐ Hand/fingers	☐	☐	☐
☐ Mid back	☐	☐	☐
☐ Lower back	☐	☐	☐
☐ Hip	☐	☐	☐
☐ Knee	☐	☐	☐
☐ Ankle	☐	☐	☐
Other (please specify) ☐	☐	☐	☐

16- On average, how long were you not able to play for?

- ☐ Less than 1 week
- ☐ 1-4 weeks
- ☐ 5-8 weeks
- ☐ More than 8 weeks
- ☐ I was able to continue playing despite my pains, aches and injuries

17- What do you think were the contributing factors to your pains, ache and injuries? (Tick all that apply)

- ☐ Playing too much
- ☐ Not getting enough rest
- ☐ Poor posture
- ☐ Travelling
- ☐ Setting up the equipment
- ☐ Carrying the instrument(s) and/or equipment
- ☐ Lack of strength
- ☐ Poor flexibility
- ☐ Lack of fitness
- ☐ Lifestyle (e.g., alcohol consumption, poor nutrition)
- ☐ Stress
- ☐ Tiredness
- ☐ Lack of sleep
- ☐ Other (Please give details)

18- With my pains, aches and injuries, ... (Tick what best describes you)

- ☐ I carried on playing regardless
- ☐ I moved to a less demanding role
- ☐ I had to work less hours
- ☐ I declined offers of work involving demanding schedules (e.g., music tours and festivals)
- ☐ I stopped accepting job offers
- ☐ Other (Please give details)

Section 4: Impact on lifestyle and social connections

This section will ask about the impact of your pains, aches and injuries on your lifestyle and social connections.

19. I have felt stressed and anxious because of my pains, aches and injuries.

☐ Yes

☐ No

☐ Unsure

20. Stress of having pains, aches and injuries have made my physical symptoms worse.

☐ Yes

☐ No

☐ Unsure

21. Stress of having pains, aches and injuries have affected my relationships with my family and friends.

☐ Yes

☐ No

☐ Unsure

Section 5: Management methods

This section will ask about how you manage your pains, aches and injuries.

22. Did you seek professional help for your pains, aches and injuries?

☐ Yes

☐ No

23. Who did you seek professional help from? (Tick all that apply).

☐ Your employer/employing organisation

☐ Physiotherapist

☐ Osteopath

☐ Chiropractor

- ☐ Personal trainer
- ☐ Strength and conditioning coach
- ☐ GP
- ☐ Surgeon
- ☐ Other (Please give details)

24. Have you received any help from your employer/employing organisation to manage your pains, aches and injuries?

- ☐ Yes (Please give details of what support you were provided)
- ☐ No
- ☐ Not applicable

25. Was this through the NHS or paid for privately? (Tick all that apply).

- ☐ NHS
- ☐ Private insurance
- ☐ Self-paid

26. What treatment and advice have you received and how helpful was it? (Tick all that apply)

	Not helpful			Extremely helpful	
	1	2	3	4	5
Advice to rest and/or take breaks	☐	☐	☐	☐	☐
Advice to use heat and/or ice	☐	☐	☐	☐	☐
Advice to modify your playing position	☐	☐	☐	☐	☐
Advice to stay active (e.g. walking)	☐	☐	☐	☐	☐
Advice to use ergonomic equipment (e.g. chin rests, shoulder pad)	☐	☐	☐	☐	☐
Advice to use liquid plasters	☐	☐	☐	☐	☐
Specific exercise programmes	☐	☐	☐	☐	☐

Complimentary therapies (e.g., Alexander Technique, Reflexology, Acupuncture, Reiki)	☐	☐	☐	☐	☐
Pain-relief medication	☐	☐	☐	☐	☐
Steroid injection	☐	☐	☐	☐	☐

27. What have you tried by yourself, and how helpful was it? (Tick all that apply)

	Not helpful				Extremely helpful
	1	2	3	4	5
Rest and/or take breaks	☐	☐	☐	☐	☐
Using heat and/or ice	☐	☐	☐	☐	☐
Being more active (e.g., walking, doing gym-based exercise)	☐	☐	☐	☐	☐
Warming up and cooling down exercises before and after practice	☐	☐	☐	☐	☐
Strengthening/stretching exercises	☐	☐	☐	☐	☐
Specific exercise routines (e.g., Yoga, Pilates, Alexander Technique)	☐	☐	☐	☐	☐
Modify playing position	☐	☐	☐	☐	☐
Pacing your instrument playing (e.g., gradual build-up of complex pieces)	☐	☐	☐	☐	☐
Other (please specify)	☐	☐	☐	☐	☐

28. How confident do you feel in being able to manage your pains, aches and injuries?

- ☐ Confident
- ☐ Not confident
- ☐ I need more knowledge and information

29. What kind of information would help you better manage your pains, aches and injuries?

30. Are you using any type of digital health applications and technology to help manage your pains, aches and injuries?

- ☐ Yes (Please give details)
- ☐ No

31. What kind of digital health applications and technology would help you better manage your pains, aches and injuries? (Tick the most appropriate)

- ☐ Advice and information websites
- ☐ Video consultations
- ☐ Smartphone health applications
- ☐ Activity tracker device
- ☐ Wearable devices to monitor spinal posture
- ☐ None
- ☐ Other (Please give details)

[Submit]

Appendix 6: Survey Feedback form

Please fill out this brief feedback form.

- 1- How long did it take to complete the survey?

- 2- Were the instructions provided for each section clear and unambiguous?

Yes ☐

No ☐

Please provide any additional comments or suggestions.

- 3- Were there any terms or words you did not know, or thought were misused?

Yes ☐

No ☐

Please provide any additional comments or suggestions.

- 4- Did any of the questions and/or responses make you feel uncomfortable?

Yes ☐

No ☐

Please provide any additional comments or suggestions.

5- Did you experience any problems accessing and/or submitting the survey?

Yes ☐

No ☐

Please provide any additional comments or suggestions.

questions that you think should be included?

Yes ☐

No ☐

If you selected Yes, please provide details.

additional comments, questions, or concerns?

Yes ☐

No ☐

If you selected Yes, please provide details.

6- Are there any additional

7- Do you have any

Appendix 7: Survey Participant Information Sheet

Title of research project: Understanding the role of self-management in musicians with MSDs: Exploration of digital self-management strategies

Name of researcher: Noudy Eleryan

You are being invited to take part in a survey. Before you decide whether or not to take part, it is important for you to understand why the research is being undertaken and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish.

Thank you for reading this.

1. What is the purpose of this research project?

Musicians are constantly exposed to continuous and repeated physical movements that can lead to musculoskeletal conditions, including pains, aches and injuries. These conditions can cause severe disability, making it difficult for musicians to play and perform. The overall aim of this project is to gather information from musicians about their musculoskeletal conditions. This information will help us develop high-quality interventions that guide musicians in better managing their musculoskeletal conditions by themselves to remain functional and playing.

2. Why have I been invited to take part?

You've been invited because you're 18 or older, a professional musician or a tertiary student musician majoring in a musical instrument, and you've had current or previous musculoskeletal problems, such as discomfort, pain, weakness, numbness, tingling, or burning sensations that have interfered with your ability to play your musical instrument at the level you're accustomed to in the last five years (January 2020). This may include not being able to play your primary or secondary instrument for as long as you are used to, not being able to play at the same speed or rhythm, not being able to participate in as many concerts/performances, having to take time off from playing, or having to change your playing position or routine due to your musculoskeletal problems.

You are not eligible to participate in the study if your musculoskeletal problem was caused by a traumatic accident or is a result of a surgical procedure, genetic conditions, inflammatory conditions, arthritic conditions, autoimmune conditions, or any other specific condition.

3. Do I have to take part?

No, your participation in this research project is entirely voluntary and it is up to you to decide whether or not to take part. If you decide to take part, you will be given this information sheet to keep and you will be asked to sign a consent form. If you decide not to take part, you are free to withdraw your consent to participate in the research project at any time, without giving a reason, even after signing the consent form. You can withdraw from the study by simply closing the browser page at any stage of the survey. A decision to withdraw at any time, or a decision not to take part, will not affect the standard of care you receive.

Please note that once you have submitted the questionnaire, it will not be possible to have your results excluded from the analysis because you will not be identifiable.

4. What will taking part involve?

The research will consist of an online self-administered questionnaire hosted by Bristol Online Surveys. This can be completed using any computer/tablet/mobile device with internet access. The survey questionnaire will take approximately 15-20 minutes to complete.

At the end of the survey, you will be asked if you would like to participate in future research. This will involve providing your contact information which compromises your anonymity; however, this information will only be available to the researchers and will not be stored with the actual data collected.

4. Will I be paid for taking part?

No, there will be no payments for participating in this study.

5. What are the possible benefits of taking part?

There will be no direct benefits for any participant. However, your participation in the survey and the study outcomes will contribute to research directed programme for the development of digital self-management tool for musicians' musculoskeletal problems.

6. What are the possible risks of taking part?

It is not anticipated that you will be adversely affected by taking part in this research. However, if you have found any questions distressing or been negatively affected in any way, you may find the following resources/services helpful:

British Association for Performing Arts Medicine (Mon-Fri 9am-5pm, UK): 020 8167 4775

Help Musicians (Mon-Fri 9am-5:30pm, UK): 020 7239 9100

NHS counselling: <https://www.nhs.uk/conditions/counselling/>

HSE: <https://www.hse.ie/eng/services/list/4/mental-health-services/national->

CALM (Helpline, daily 5pm to midnight, UK): 0800 58 58 58

Aware (Helpline, 10am to 10pm daily, Ireland and UK): 1800 66 66 66

Pieta House (Helpline and Free Mental Health Services, Ireland): 01 6010000

Samaritans (7 days a week, 24 hours a day, UK and Ireland): 116123

Also, a risk of breach of confidentiality always exists with research studies and steps will be taken to minimize this risk as outlined in the sections below

7. Will my taking part in this research project be kept confidential?

Only members of the research team can read your answers. Your survey answers will be sent to a link at onlinesurveys.ac.uk where data will be stored in a password protected electronic format. Bristol Online Surveys does not collect identifying information such as your name, email address, or IP address. No one will be able to identify you or your answers, and no one will know whether you participated in the study.

However, after completing the survey, you will be asked if you want to be contacted to participate in future research. If you choose to provide contact information such as your phone number or email address, your survey responses may no longer be anonymous to the researcher. However, no names or identifying information will be included in any publications or presentations based on these data, and your responses to this survey will remain confidential. Please see 'What will happen to my Personal Data?' (below) for further information.

8. What will happen to my Personal Data?

All participants data will be de-identified and coded. The electronic data will be saved in a password protected folder in a locked computer with a passcode only known by the researcher. Cardiff University is the Data Controller and is committed to respecting and protecting your personal data in accordance with your expectations and Data Protection legislation. Further information about Data Protection, including:

- your rights
- the legal basis under which Cardiff University processes your personal data for research
- Cardiff University's Data Protection Policy
- how to contact the Cardiff University Data Protection Officer
- how to contact the Information Commissioner's Office

can be found at <https://www.cardiff.ac.uk/public-information/policies-and-procedures/data-protection>

After completion of the PhD, the research team will anonymise all the data it has collected from, or about, you in connection with this research project, except for your consent form. Your consent form will be retained for 15 years and may be accessed by members of the research team and, where necessary, by members of the University's governance and audit teams or by regulatory authorities. Anonymised information will be kept for a minimum of 15 years but may be published in support of the research project and/or retained indefinitely, where it is likely to have continuing value for research purposes.

If the participant wants to withdraw from the project after completion of the PhD, it is not possible to withdraw their personal data after being anonymised already or published.

9. What happens to the data at the end of the research project?

The personal identifiable data can be destroyed on completion of the PhD project. The research data will be retained for a minimum period of 15 years after the end of the project or after publication of any findings based upon the data as mentioned in Section 2.9 ('Research Project Conduct') of the University's Research Records Retention Schedule.

10. What will happen to the results of the research project?

It is our intention to publish the results of this research project in academic journals and present findings at conferences. Participants will not be identified in any report, publication, or presentation.

11. What if there is a problem?

If you wish to complain or have grounds for concerns about any aspect of the manner in which you have been approached, please contact Noudy Eleryan on email: eleryann@cardiff.ac.uk or +44 (0) 7525047241. If your complaint is not managed to your satisfaction, please contact the Chair of the School Research Ethics Committee Dr Kate Button on email: ButtonK@cardiff.ac.uk or [+44 \(0\)29 206 87734](tel:+4412920687734).

If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, you may have grounds for legal action, but you may have to pay for it.

12. Who is organising and funding this research project?

The research is currently not funded, and it is organised by the PhD student: Noudy Eleryan under the supervision of Dr Liba Sheeran, Dr Rebecca Hemming and Professor Valerie Sparkes at the School of Healthcare Science in Cardiff University.

13. Who has reviewed this research project?

This research project has been reviewed and given a favourable opinion by the School of Healthcare Sciences Research Ethics Committee, Cardiff University.

14. Further information and contact details

Should you have any questions relating to this research project, you may contact us during normal working hours:

Contact details:

Name: Noudy Eleryan

Address: Eastgate house, School of Healthcare Sciences, Cardiff university

Email: eleryann@cardiff.ac.uk

Thank you for considering taking part in this research project. If you decide to participate, you will be given a copy of the Participant Information Sheet and a signed consent form to keep for your records.

Appendix 8: Statistical Analysis

Table 1 Frequency of PRMSDs by Music-Specific Employment Status

PRMSDs * 7. What is your music-specific employment status? (Tick all that apply) Crosstabulation

Count

		7. What is your music-specific employment status? (Tick all that apply)			
		Employed	Employed, Self-employed	Self-employed	Student
PRMSDs	0-2 times	4	1	20	13
	3-5 times	1	2	10	11
	More than 5 times	53	2	21	12
Total		8	5	49	38

Table 2 Overall Distribution of PRMSD Frequency among Musicians

PRMSDs * 7. What is your music-specific employment status? (Tick all that apply) Crosstabulation

Count

		Total
PRMSDs	0-2 times	38
	3-5 times	24
	More than 5 times	38
Total		100

Table 3 Chi-Square Tests of Association Between PRMSDs and Employment Status

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.159 ^a	6	.789
Likelihood Ratio	3.208	6	.782
Linear-by-Linear Association	.000	1	1.000

N of Valid Cases	100		

Table 4 Descriptive Statistics for Age, Weekly Practice Hours, and Total Weekly Working Hours

Descriptives

		Statistic	Std. Error
6. What is your age?	Mean	30.03	1.363
	95% Confidence Interval for Mean	Lower Bound 27.33	
		Upper Bound 32.73	
	5% Trimmed Mean	28.52	
	Median	24.00	
	Variance	185.807	
	Std. Deviation	13.631	
	Minimum	18	
	Maximum	76	
	Range	58	
	Interquartile Range	10	
	Skewness	1.782	.241
	Kurtosis	2.300	.478
14. On average, how many hours per week do you practice playing a musical instrument?	Mean	13.67	.924
	95% Confidence Interval for Mean	Lower Bound 11.84	
		Upper Bound 15.50	
	5% Trimmed Mean	12.91	
	Median	10.00	
	Variance	85.395	
	Std. Deviation	9.241	
	Minimum	1	
	Maximum	45	
	Range	44	
	Interquartile Range	13	
	Skewness	1.300	.241
	Kurtosis	1.346	.478
9. How many hours per week do you work in all roles?	Mean	30.87	2.067
	95% Confidence Interval for Mean	Lower Bound 26.76	
		Upper Bound 34.97	
	5% Trimmed Mean	29.57	
	Median	30.00	
	Variance	427.075	
	Std. Deviation	20.666	
	Minimum	0	
	Maximum	168	
	Range	168	
	Interquartile Range	25	

Skewness	2.938	.241
Kurtosis	18.486	.478

Table 5 Tests of Normality for Age, Weekly Practice Hours, and Total Weekly Working Hours

Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
6. What is your age?	.240	100	.000	.741	100	.000
14. On average, how many hours per week do you practice playing a musical instrument?	.204	100	.000	.873	100	.000
9. How many hours per week do you work in all roles?	.139	100	.000	.784	100	.000

Figure 1 Deviation from Normal Distribution for Participant Age Distribution

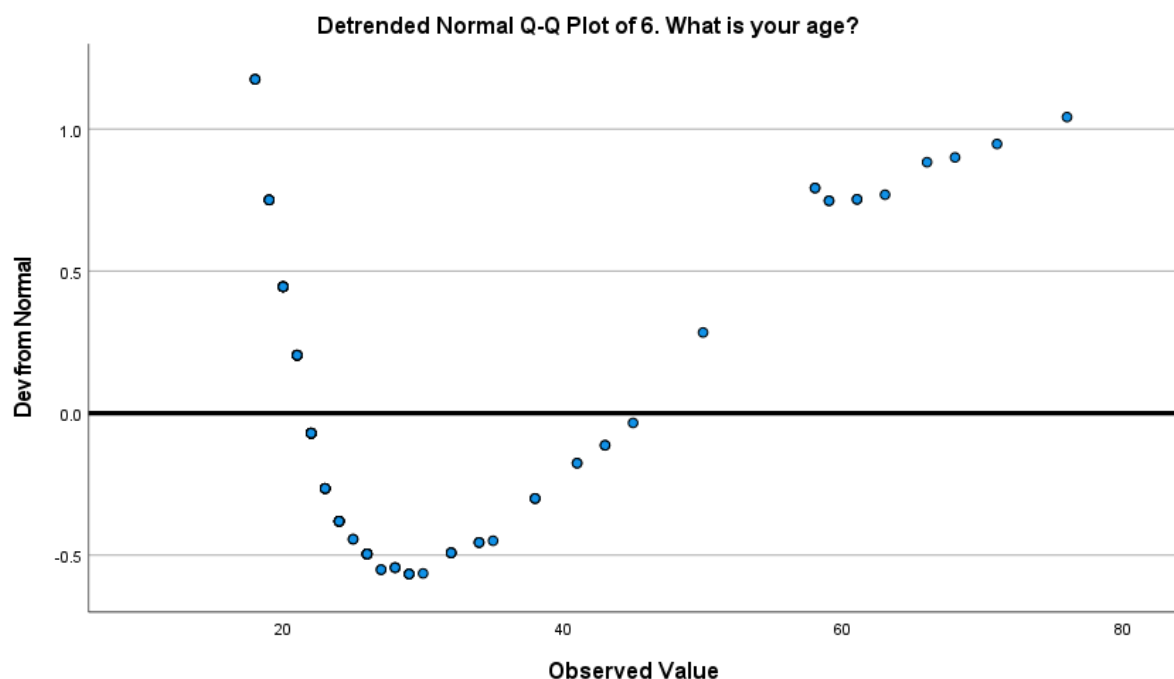


Figure 2 Box Plot of Participant Age Distribution with Outliers

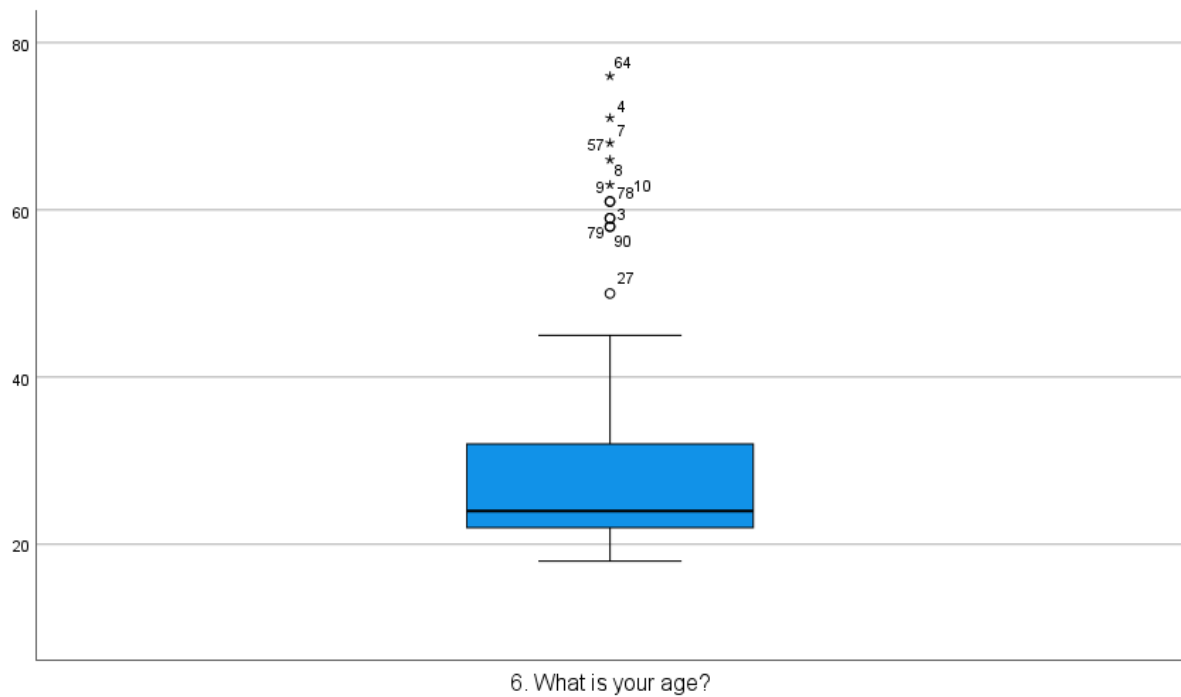


Figure 3 Deviation from Normal Distribution for Weekly Practice Hours

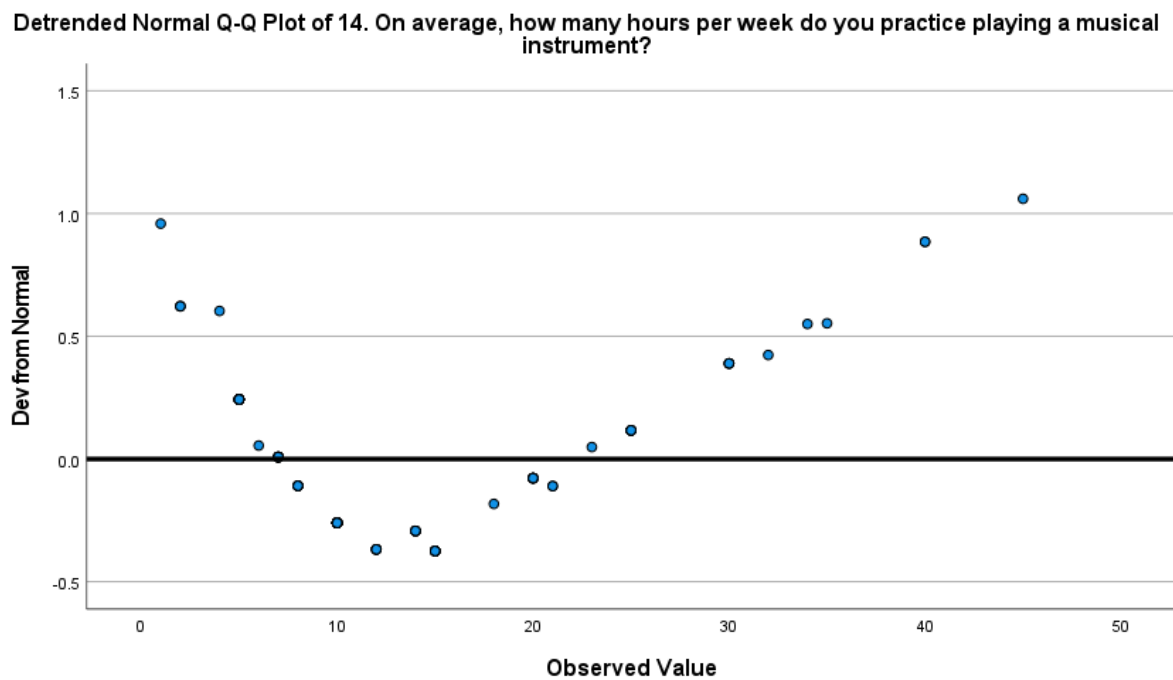


Figure 4 Box Plot of Weekly Practice Hours with Outliers

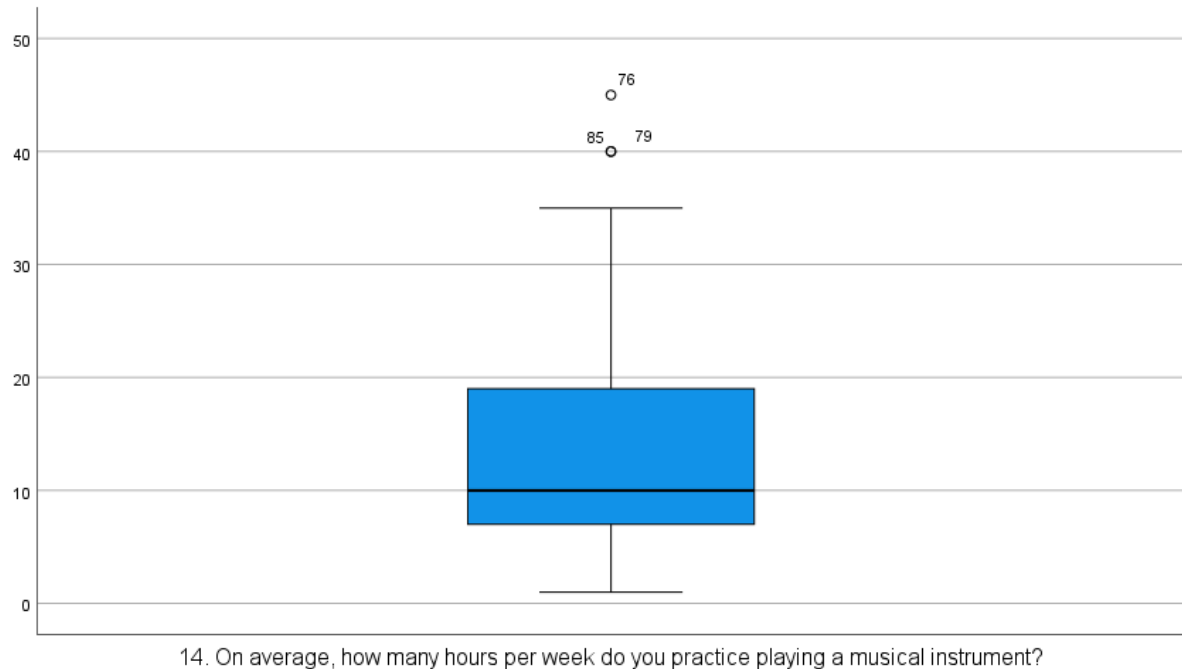


Figure 5 Deviation from Normal Distribution for Total Weekly Working Hours

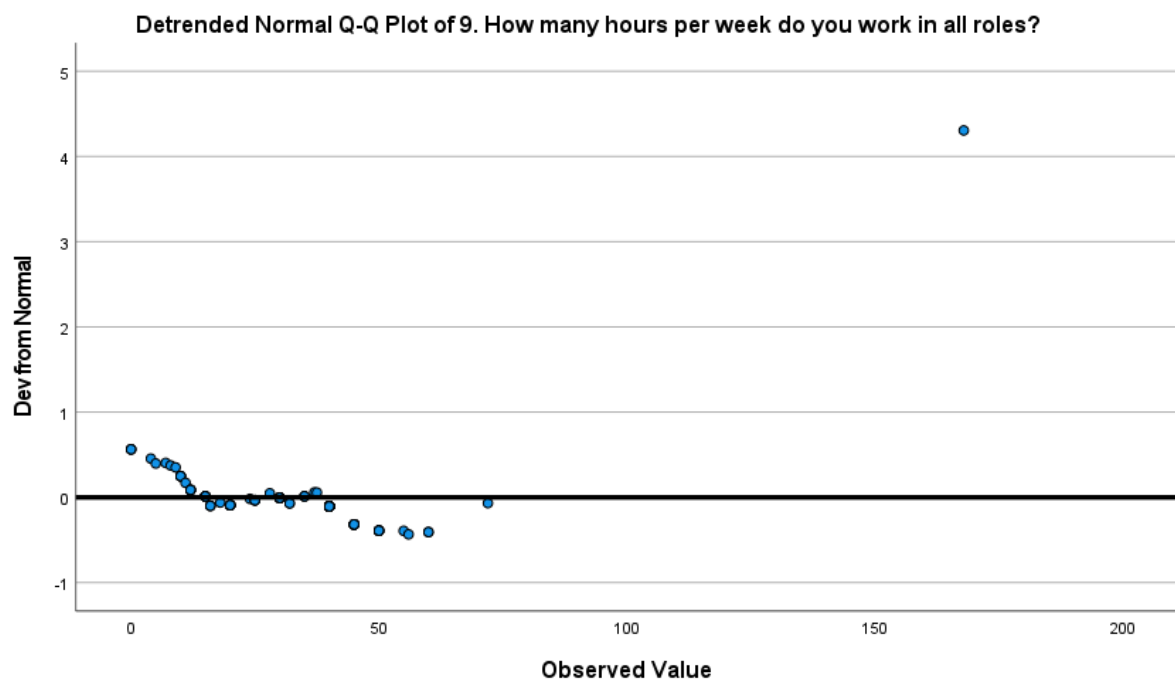


Figure 6 Box Plot of Total Weekly Working Hours with Extreme Outlier

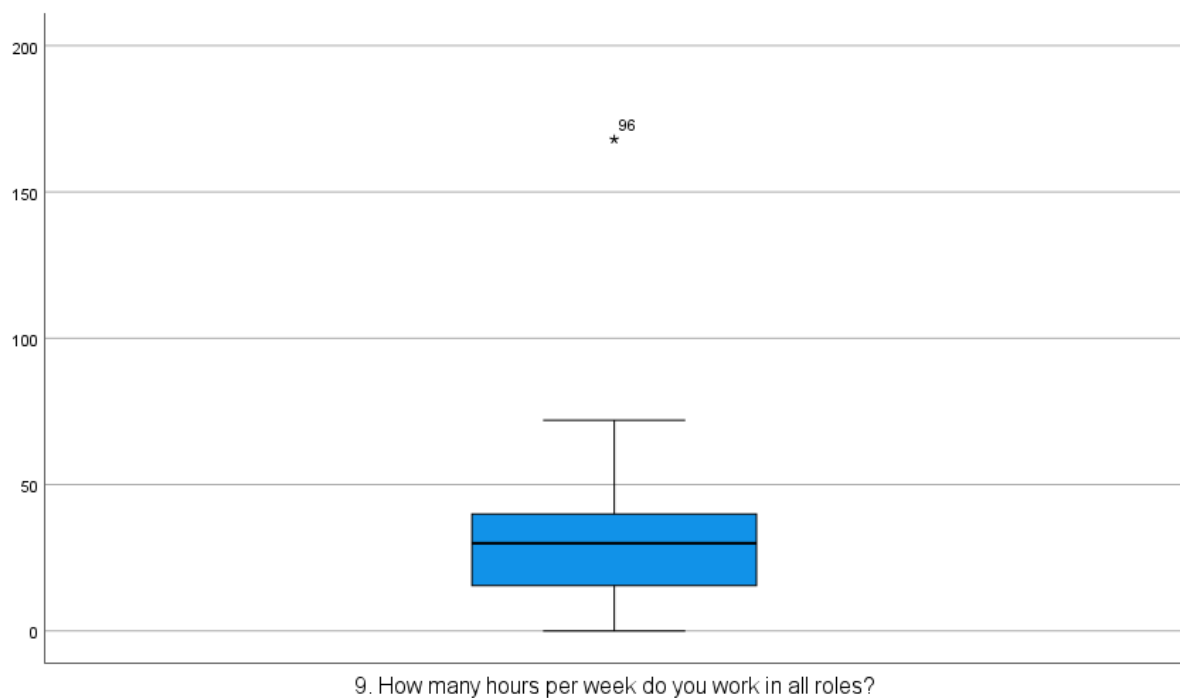


Table 6 ANOVA Results Comparing Age, Weekly Working Hours, and Weekly Practice Hours across PRMSD Frequency Groups

ANOVA

		Sum Squares	of Df	Mean Square	F
6. What is your age?	Between Groups	527.004	2	263.502	1.430
	Within Groups	17867.906	97	184.205	
	Total	18394.910	99		
9. How many hours per week do you work in all roles?	Between Groups	2683.289	2	1341.645	3.287
	Within Groups	39597.138	97	408.218	
	Total	42280.428	99		
14. On average, how many hours per week do you practice playing a musical instrument?	Between Groups	345.783	2	172.892	2.068
	Within Groups	8108.327	97	83.591	
	Total	8454.110	99		

Table 7 Significance Values for ANOVA Comparing Age, Weekly Working Hours, and Weekly Practice Hours across PRMSD Frequency Groups

ANOVA

		Sig.
6. What is your age?	Between Groups	.244
	Within Groups	
	Total	
9. How many hours per week do you work in all roles?	Between Groups	.042
	Within Groups	
	Total	
14. On average, how many hours per week do you practice playing a musical instrument?	Between Groups	.132
	Within Groups	
	Total	

Table 8 Tukey HSD Post-Hoc Multiple Comparisons of Age, Weekly Working Hours, and Weekly Practice Hours across PRMSD Frequency Groups

Post Hoc Tests

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) PRMSDs	(J) PRMSDs	Mean Difference (I-J)	Std. Error
6. What is your age?	0-2 times	3-5 times	2.656	3.539
		More than 5 times	-3.211	3.114
	3-5 times	0-2 times	-2.656	3.539
		More than 5 times	-5.866	3.539
	More than 5 times	0-2 times	3.211	3.114
		3-5 times	5.866	3.539
9. How many hours per week do you work in all roles?	0-2 times	3-5 times	4.750	5.268
		More than 5 times	11.829*	4.635
	3-5 times	0-2 times	-4.750	5.268
		More than 5 times	7.079	5.268

14. On average, how many hours per week do you practice playing a musical instrument?	More than 50-2 times	-11.829*	4.635
	3-5 times	-7.079	5.268
	0-2 times	-1.971	2.384
	More than 5 times	52.737	2.098
	3-5 times	1.971	2.384
	More than 5 times	54.708	2.384
	More than 50-2 times	-2.737	2.098
	3-5 times	-4.708	2.384

Table 9 Significance Values and Confidence Intervals for Tukey HSD Post-Hoc Comparisons across PRMSD Frequency Groups

Multiple Comparisons

Dependent Variable	(I) PRMSDs	(J) PRMSDs	Sig.	95% Confidence Interval Lower Bound
6. What is your age?	0-2 times	3-5 times	.734	-5.77
		More than 5 times	.559	-10.62
	3-5 times	0-2 times	.734	-11.08
		More than 5 times	.227	-14.29
	More than 5 times	0-2 times	.559	-4.20
		3-5 times	.227	-2.56
9. How many hours per week do you work in all roles?	0-2 times	3-5 times	.641	-7.79
		More than 5 times	.033	.80
	3-5 times	0-2 times	.641	-17.29
		More than 5 times	.375	-5.46
	More than 5 times	0-2 times	.033	-22.86
		3-5 times	.375	-19.62
14. On average, how many hours per week do you practice playing a musical instrument?	0-2 times	3-5 times	.687	-7.65
		More than 5 times	.396	-2.26
	3-5 times	0-2 times	.687	-3.70
		More than 5 times	.124	-.97
	More than 5 times	0-2 times	.396	-7.73
		3-5 times	.124	-10.38

Table 10 Upper Bounds of Confidence Intervals for Tukey HSD Post-Hoc Comparisons across PRMSD Frequency Groups

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) PRMSDs	(J) PRMSDs	95% Confidence Interval Upper Bound
6. What is your age?	0-2 times	3-5 times	11.08
		More than 5 times	4.20
	3-5 times	0-2 times	5.77
		More than 5 times	2.56
	More than 5 times	0-2 times	10.62
		3-5 times	14.29
9. How many hours per week do you work in all roles?	0-2 times	3-5 times	17.29
		More than 5 times	22.86
	3-5 times	0-2 times	7.79
		More than 5 times	19.62
	More than 5 times	0-2 times	-.80
		3-5 times	5.46
14. On average, how many hours per week do you practice playing a musical instrument?	0-2 times	3-5 times	3.70
		More than 5 times	7.73
	3-5 times	0-2 times	7.65
		More than 5 times	10.38
	More than 5 times	0-2 times	2.26
		3-5 times	.97

Table 11 Homogeneous Subsets for Age across PRMSD Frequency Groups

Homogeneous Subsets

6. What is your age?

Tukey HSD^{a,b}

PRMSDs	N	Subset for alpha = 0.05
3-5 times	24	26.79
0-2 times	38	29.45
More than 5 times	538	32.66
Sig.		.202

Table 12 Homogeneous Subsets for Weekly Working Hours across PRMSD

Frequency Groups

9. How many hours per week do you work in all roles?

Tukey HSD^{a,b}

PRMSDs	N	Subset for alpha = 0.05 1
More than times	538	24.67
3-5 times	24	31.75
0-2 times	38	36.50
Sig.		.056

Table 13 Homogeneous Subsets for Weekly Practice Hours across PRMSD

Frequency Groups

On average, how many hours per week do you practice playing a musical instrument?

Tukey HSD^{a,b}

PRMSDs	N	Subset for alpha = 0.05 1
More than times	538	11.50
0-2 times	38	14.24
3-5 times	24	16.21
Sig.		.105

Table 14 Kruskal-Wallis Test Results Comparing Age, Weekly Working Hours, and Weekly Practice Hours across PRMSD Frequency Groups

Kruskal-Wallis Test

Ranks

	PRMSDs	N	Mean Rank
6. What is your age?	0-2 times	38	51.43
	3-5 times	24	46.13
	More than times	538	52.33

	Total	100	
9. How many hours per week do you work in all roles?	0-2 times	38	58.18
	3-5 times	24	54.17
	More than times	538	40.50
	Total	100	
14. On average, how many hours per week do you practice playing a musical instrument?	0-2 times	38	52.99
	3-5 times	24	57.88
	More than times	538	43.36
	Total	100	

Table 15 Kruskal-Wallis Test Statistics for Age, Weekly Working Hours, and Weekly Practice Hours

Test Statistics^{a,b}

	6. What is your age?	9. How many hours per week do you work in all roles?	14. On average, how many hours per week do you practice playing a musical instrument?
Kruskal-Wallis H	.740	7.648	4.192
Df	2	2	2
Asymp. Sig.	.691	.022	.123

Table 16 Model Fitting Information for Ordinal Regression Predicting PRMSD Frequency

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	215.574			
Final	206.944	8.630	4	.071

Table 17 Goodness-of-Fit Statistics for Ordinal Regression Model Predicting PRMSD Frequency

Goodness-of-Fit

	Chi-Square	Df	Sig.
Pearson	199.330	194	.381
Deviance	206.944	194	.249

Table 18 Pseudo R-Square Values for Ordinal Regression Model Predicting PRMSD Frequency

Pseudo R-Square

Cox and Snell	.083
Nagelkerke	.094
McFadden	.040

Table 19 Parameter Estimates for Ordinal Regression Model Predicting PRMSD Frequency

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.
Threshold	[PRMSDs = 1]	-1.460	1.140	1.638	1	.201
	[PRMSDs = 2]	-.411	1.132	.132	1	.716
Location	Age	.012	.015	.675	1	.411
	WeeklyWorkingHours	-.030	.013	5.003	1	.025
	WeeklyPlayingHours	-.006	.022	.066	1	.797
	EmploymentStatus	-.092	.239	.149	1	.699

Table 20 Confidence Intervals for Parameter Estimates in Ordinal Regression Model Predicting PRMSD Frequency

Parameter Estimates

		95% Confidence Interval	
		Lower Bound	Upper Bound
Threshold	[PRMSDs = 1]	-3.695	.775

	[PRMSDs = 2]	-2.630	1.807
Location	Age	-.017	.041
	WeeklyWorkingHours	-.057	-.004
	WeeklyPlayingHours	-.049	.038
	EmploymentStatus	-.561	.376

Table 21 Ordinal Regression Model Predicting PRMSD Frequency

Test of Parallel Lines^a

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	206.944			
General	200.307 ^b	6.637 ^c	4	.156



Appendix 9: Email Invitation to Survey Participants

Dear [Participant's Name],

Thank you for taking part in our survey and for your interest in this project.

We are pleased to invite you to join a focus group aimed at developing self-management interventions to help musicians better manage their pains, aches, and injuries. Your insights are crucial to tailoring interventions that truly address the unique challenges of your work.

Focus Group Details:

The focus group will discuss:

- **Barriers and Facilitators:** What helps or hinders you in managing your pains, aches, and injuries.
- **Treatment Priorities:** Which treatment aspects are most important to you.
- **Preferred Treatment Methods:** How you like to receive treatment.
- **Preferred Delivery Methods:** The best ways to access and engage with treatment options.

Your contributions will directly influence the design of interventions that are better suited to your needs as a musician.

Session Information:

- Duration: Approximately 1.5 hours.
- Format: Online via Zoom.
- Available Sessions:
 - Thursday, 2nd March 2023 at 11:00 AM
 - Friday, 17th March 2023 at 3:00 PM
 - Monday, 27th March 2023 at 6:00 PM

If you would like to participate, please reply to this email confirming your attendance and indicating your preferred date and time. If none of the proposed dates work for you, please let us know, and we will do our best to accommodate your schedule.

Please find the attached Participant Information Sheet for further details.

Thank you again for your valuable contribution to this project.

Appendix 10: Focus Group Consent Form

Participant Identification number for this study:

Title of research project: Understanding the role of self-management in musicians with MSDs: Exploration of digital self-management strategies

Name of researcher: Noudy Eleryan

Please Initial box

- 1- I confirm that I have read the information sheet (version 2) dated
for the above study. I have had the opportunity to consider the information,
ask questions and have had these answered satisfactorily. ☐
- 2- I understand that my participation is voluntary and that I am free to withdraw
at any time without giving any reason, without my legal or medical rights being
affected. ☐
- 3- I understand that once my data has been recorded, it will not be possible to
exclude it from the analysis. ☐
- 4- I agree to maintain the confidentiality of the information discussed by all
participants and researchers during the focus group/workshop ☐
- 5- I agree to have my conversation recorded during the research ☐
- 6- I understand that all data recorded including audio record will be stored
securely for a maximum of 15 years following the publication of the research. ☐
- 7- I understand that these audio recordings will be used anonymously and that
no individual respondent will be identified in such report. ☐
- 8- I understand that the findings and potentially secondary analysis of the
findings and associated data from the study may be presented at conference
and in scientific journals. I understand that these will be used anonymously
and that no individual respondent will be identified in such report. ☐
- 9- I give consent for the use of verbatim anonymised quotes in publications and
conference presentations.
- 10-I agree to take part in the above study ☐

☐

Name of Participant

Date

Signature

Name of person taking consent

Date

Signature

THANK YOU FOR PARTICIPATING IN OUR RESEARCH

YOU WILL BE GIVEN A COPY OF THIS CONSENT FORM TO KEEP

Appendix 11: Focus Group Participant Information Sheet

Title of research project: Understanding the role of self-management in musicians with MSDs: Exploration of digital self-management strategies

Name of researcher: Noudy Eleryan

You are being invited to take part in a focus group study. Before you decide whether or not to take part, it is important for you to understand why the research is being undertaken and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish.

Thank you for reading this.

5. What is the purpose of this research project?

Musicians are constantly exposed to continuous and repeated physical movements that can lead to musculoskeletal conditions, including pains, aches and injuries. These conditions can cause severe disability, making it difficult for musicians to play and perform. The overall aim of this project is to gather information from musicians about their musculoskeletal conditions. This information will help us develop high-quality interventions that guide musicians in better managing their musculoskeletal conditions by themselves to remain functional and playing.

To participate in this study, we ask that you participate in a focus group discussion.

6. Why have I been invited to take part?

You have been invited because you took part in the first stage of this study (survey) and agreed to be contacted for future research.

7. Do I have to take part?

No, your participation in this research project is entirely voluntary and it is up to you to decide whether or not to take part. If you decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. If you decide not to

take part or to withdraw from the study, you do not have to explain your reasons and it will not affect your legal rights. If you are receiving care from your occupational health service or from the NHS for your musculoskeletal problem(s), your decision to take part or not to take part will not affect the care you receive.

Please note that it will be difficult to exclude your response after participating in the study. This is because in group discussions, meaning is derived from dialogue that occurs between participants, rather than from what individual participants have said. Thus, the removal of a part of dialogue may make it hard to meaningfully interpret subsequent dialogue.

8. What will taking part involve?

First, the researcher will contact you by phone to explain the research and answer any questions you might have. If you are still interested in participating in the study, you will be asked to sign and send an electronic consent form via email. Once you consent to participating in the study, you will receive a Zoom invite email and an email reminder one day before the focus group.

The focus group discussion will be held online via Zoom using audio and possibly video technology if you are happy to do so. With your permission, the conversation will only be audio-recorded (your videos will not be recorded). You will be asked to reaffirm your consent verbally with the following statement: "I ... consent to being involved in this research study and am aware of what is being asked of me and how my data will be used. I have been given the opportunity to ask any questions I am aware that I can withdraw from the study at any time without my medical or legal rights being affected. I understand that once I consent to being recorded, it will not be possible to exclude my response from the analysis."

The focus group will last approximately 60-90 minutes and 5-8 other healthcare professionals will participate. The researcher will present topic guides for the discussion, and you will be expected to share your opinion. The audio-recording will be transcribed anonymously, and you will be asked to verify the accuracy of the information by checking a copy of the transcript.

9. Will I be paid for taking part?

No, there will be no payments for participating in this study.

10. What are the possible benefits of taking part?

There will be no direct benefits for any participant who will take part in this study. However, your participation in this study and the study outcomes will contribute to research directed program for developing a digital self-management tool for musicians' musculoskeletal problems.

11. What are the possible risks of taking part?

It is not anticipated that you will be adversely affected by taking part in this research. However, if you have found any questions distressing, you can refuse to discuss any of the topics that make you feel uncomfortable, or you simply do not want to discuss, and you may withdraw from the focus group at any time without giving any reason. In case you think you have been negatively affected in any way; you may find the following resources/services helpful:

British Association for Performing Arts Medicine (Mon-Fri 9am-5pm, UK): 020 8167 4775

Help Musicians (Mon-Fri 9am-5:30pm, UK): 020 7239 9100

NHS counselling: <https://www.nhs.uk/conditions/counselling/>

HSE: <https://www.hse.ie/eng/services/list/4/mental-health-services/national->

CALM (Helpline, daily 5pm to midnight, UK): 0800 58 58 58

Aware (Helpline, 10am to 10pm daily, Ireland and UK): 1800 66 66 66

Pieta House (Helpline and Free Mental Health Services, Ireland): 01 6010000

Samaritans (7 days a week, 24 hours a day, UK and Ireland): 116123

Also, a risk of breach of confidentiality always exists with research studies and steps will be taken to minimize this risk as outlined in the sections below

12. Will my taking part in this research project be kept confidential?

All information collected from or about you during the research project will be kept confidential and any personal information you provide will be managed in accordance with data protection legislation. To minimise the risk of confidentiality, only the workshop will be recorded and Zoom settings will be adjusted so that only authorised participants can join. Personal identifiable data such as name or contact details will not be part of the audio recording. You will be reminded before starting the focus group that you should not disclose any information that could identify you during data collection e.g., full name, address or contact details. If you accidentally do that, the information will not be included in the transcription. The information collected will be transcribed anonymously and a pseudonym (i.e., a name other than your real name) will be used during reporting of findings.

The results will be published in academic journals and will be included in the researcher's PhD dissertation, in both cases your anonymity will be ensured. It may be necessary to use your words in the presentation of the findings and your permission for this is included in the consent form.

13. What will happen to my Personal Data?

All data collected will be de-identified and coded so that you cannot be identified from the consent forms. Hard copies of your consent form will be saved in a separate locked cupboard in the researcher office. The electronic data will be saved in a password protected folder in a locked computer with a passcode only known by the researcher.

Cardiff University is the Data Controller and is committed to respecting and protecting your personal data in accordance with your expectations and Data Protection legislation. Further information about Data Protection, including:

- your rights
- the legal basis under which Cardiff University processes your personal data for research
- Cardiff University's Data Protection Policy
- how to contact the Cardiff University Data Protection Officer
- how to contact the Information Commissioner's Office

may be found at <https://www.cardiff.ac.uk/public-information/policies-and-procedures/data-protection>

After completion of the PhD, the research team will anonymise all the personal data it has collected from, or about, you in connection with this research project, except for your consent form. Your consent form will be retained for 15 years and may be accessed by members of the research team and, where necessary, by members of the University's governance and audit teams or by regulatory authorities. Anonymised information will be kept for a minimum of 15 years but may be published in support of the research project and/or retained indefinitely, where it is likely to have continuing value for research purposes.

If you want to withdraw from the project after completion of the PhD, it is not possible to withdraw your personal data after being anonymised already or published.

14. What happens to the data at the end of the research project?

The personal identifiable data will be destroyed on completion of the PhD project. The research data will be retained for a minimum period of 15 years after the end of the project or after publication of any findings based upon the data as mentioned in Section 2.9 ('Research Project Conduct') of the University's Research Records Retention Schedule.

15. What will happen to the results of the research project?

It is our intention to publish the results of this research project in academic journals and present findings at conferences. Participants will not be identified in any report, publication, or presentation.

16. What if there is a problem?

If you wish to complain or have grounds for concerns about any aspect of the manner in which you have been approached, please contact Noudy Eleryan via email: eleryann@cardiff.ac.uk or via phone +44 (0) 7525047241. If your complaint is not managed to your satisfaction, please contact the Chair of the School Research Ethics Committee Dr Kate Button on email: ButtonK@cardiff.ac.uk or +44 (0)29 206 87734.

If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, you may have grounds for legal action, but you may have to pay for it.

17. Who is organising and funding this research project?

The research is currently not funded, and it is organised by the PhD student: Noudy Eleryan under the supervision of Dr Liba Sheeran, Dr Rebecca Hemming and Professor Valerie Sparkes at the School of Healthcare Sciences, Cardiff University.

18. Who has reviewed this research project?

This research project has been reviewed and given a favourable opinion by the School of Healthcare Sciences Research Ethics Committee, Cardiff University.

19. Further information and contact details

Should you have any questions relating to this research project, you may contact us during normal working hours:

Contact details:

Name: Noudy Eleryan

Address: Eastgate house, School of Healthcare Sciences, Cardiff university

Email: eleryann@cardiff.ac.uk

Thank you for considering taking part in this research project. If you decide to participate, you will be given a copy of the Participant Information Sheet and a signed consent form to keep for your records.

Appendix 12: Focus Group Instructions Email

Dear [Participant's Name],

Thank you for confirming your participation in our focus group on [selected date] at [selected time]. We are excited to include your valuable perspective in our research on developing self-management interventions for musicians.

Meeting Details

- **Date:** [Thursday, 2nd March 2023 / Friday, 17th March 2023 / Monday, 27th March 2023]
- **Time:** [11:00 AM / 3:00 PM / 6:00 PM]
- **Duration:** Approximately 1.5 hours
- **Platform:** Zoom
- **Meeting Link:** [Zoom link]
- **Meeting ID:** [ID number]
- **Passcode:** [passcode]

What to Prepare

1. **Equipment Needed:**
 - A computer, tablet, or smartphone with a stable internet connection
 - Working microphone and speakers/headphones
 - Webcam (optional but encouraged to facilitate group interaction)
 - A quiet, private space where you can speak freely
 -
2. **Before the Meeting:**
 - Please take a few minutes to reflect on your experiences with pain, aches, or injuries related to your musical practice/performance
 - Consider what strategies have worked or not worked for you in managing these issues
 - Think about what kind of support or interventions would be most helpful for you
3. **Focus Group Format:**
 - The session will begin with brief introductions
 - A moderator will guide the discussion through the topics mentioned in our previous email
 - We encourage open and honest sharing of experiences and ideas
 - There are no right or wrong answers—all perspectives are valuable

Using Zoom

- **Joining:** Click the meeting link above 5 minutes before the scheduled start time. Alternatively, open Zoom and enter the Meeting ID and Passcode manually.
- **Audio Settings:** Upon joining, select "Join with Computer Audio." You can test your audio by clicking "Test Speaker and Microphone."
- **Video:** You may turn your video on or off as you prefer, though having video on helps create a more engaging group discussion.

- **Participation Tools:**
 - Mute/Unmute: Please keep yourself muted when not speaking to minimize background noise
 - Raise Hand: Use this feature if you wish to speak next
 - Chat: You can use the chat feature to share brief comments without interrupting the speaker

Confidentiality and Recording

- The focus group will be recorded to ensure we accurately capture all insights shared
- Recordings will be transcribed and anonymized for research purposes only
- All information shared will be kept confidential within the research team
- We ask that all participants respect the privacy of fellow group members and not share others' comments outside the focus group

Questions or Concerns

Should you have any questions about the focus group or need to reschedule, please contact myself at eleryann@cardiff.ac.uk

We look forward to your participation and valuable input.

Kind regards,

Noudy Eleryan

PhD candidate, Cardiff University

Appendix 13: Focus group PowerPoint



School of
Healthcare Sciences
Ysgol y Gwyddorau
Gofal Iechyd

Phase 1:
Evidence review

Phase 2:
Consultations with
musicians

Phase 3:
Consultations with
HCPs

- Epidemiology and risk factors of PRMDs
- Current interventions: passive and active treatment, government's policies and organisations' support

- Survey study
- Focus group discussion

- Interviews
- Mapping process

[Graphical representation](#) of the UK Medical Research Council on developing complex interventions (Skivington et al., 2021).



School of
Healthcare Sciences
Ysgol y Gwyddorau
Gofal Iechyd

Aims of the survey

- 1) To determine the relevant contributing factors to musicians' MSDs.
- 2) To explore the management methods used by musicians, their perceived efficacy and preferences for better management.



BRITISH ASSOCIATION FOR
**PERFORMING
ARTS MEDICINE**



School of Music
Ysgol Cerddoriaeth



ROYAL WELSH COLLEGE
OF MUSIC & DRAMA
COLEG BRENHINOL
CERDD A DRAMA CYMRU



Musicians'
Union
mu



Royal
Academy
of Music

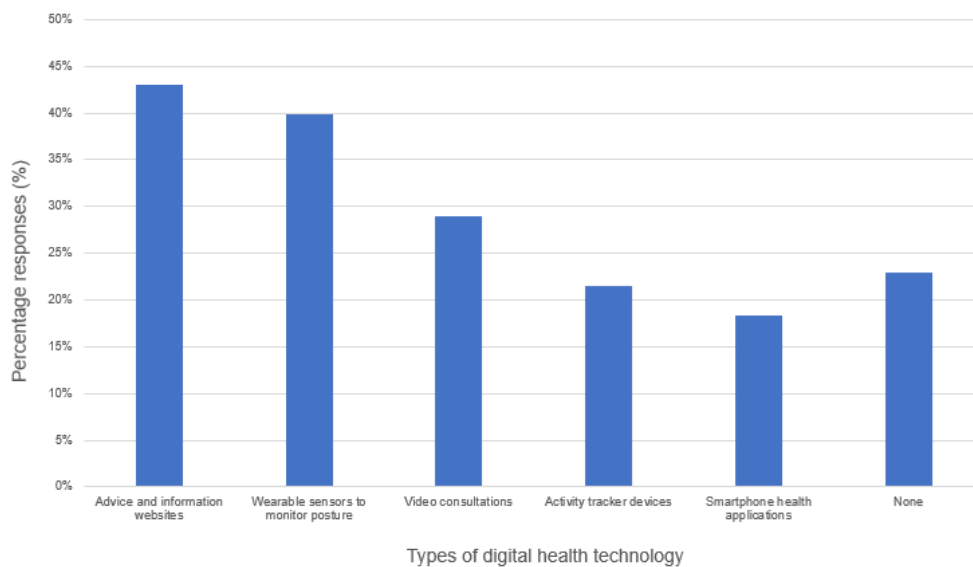


f i t

Key messages

1. 100 responses
2. Active strategies such as exercise and pacing playing were considered more effective
3. Needs: Pain management, organisational and cultural changes, peer support and accessible resources
4. 75% considered technology may help them better manage their pains, aches and injuries

Technology



Static Job Toolkit

Static Posture Back Stretch Routine - Exercise Guide

Click on each exercise for an animated tutorial:



Resilient Spine Toolkit

Resilient Spine Routine: Exercise Guide

Click on each exercise for an animated tutorial:



Physical Job Toolkit

Active Backs Warm Up Routine: Exercise Guide

Click on each exercise for an animated tutorial:





Digital Badges



get **U** better

Click to self-refer 

Back pain , Back and leg, Neck, Knee and Shoulder



One app for many conditions
For new or recurrent problems

Available on the
App Store

Get it on
Google Play



Ground rules

- “There are no right or wrong answers but rather differing points of view.”
- “Please share your point of view even if it differs from what others have said.”
- “We’re recording what is said because we don’t want to miss any comments.”
- “We will be on a first name basis today, and in our later reports no names will be attached to comments.”
- “Please be assured of complete confidentiality.”

Verbal consent

- I understand that my participation is voluntary and that I am free to withdraw at any given time without giving any reason
- I understand that once my data has been recorded, it will not be possible to exclude it from the analysis
- I agree to maintain the confidentiality of the information discussed by all participants during the focus group
- I agree to have my conversation recorded during the research

Appendix 14: Fourth Focus Group Transcript

Moderator: I don't. I don't know if it wasn't in the presentation or not. But this is something that came up in in the focus groups that yes, there was. Musicians did take that they wish there. There was awareness about this very early on before they are going into unique. But my question is, what kind of awareness? So what? What do you think you should have been told?

P9: I mean, you know there are methods out there like Alexander technique which I just started to explore myself. So, I don't have a lot to say on it yet. But something like that that there is this sense of I mean, I think there's 2. There's 2 sides of it. There's the body awareness, and noticing what feels wrong, essentially when you're playing but also the understanding of our bodies. And like what muscles we're using on a daily basis because there is no one like no like if I say to like a friend of mine also, what muscles are using to hold up your instrument or no one's gonna know they're not gonna know that. And I I get it like, I don't know it unless I you know. Only now am I discovering those things but I think it needs, I think, that should I mean personally, and not many people are probably that interested. But I think it should be something that is maybe talked about a little bit more.

Moderator: And where would you expect that to be so before you do join me when you were learning with your, with your music teacher?

P10: Yeah, I mean, I guess it. It would depend who you go to, and what their interest, what their interests are, which is probably part of my issue. But I think definitely at Uni. Whether that's before, as you know. I don't know in an in an ideal world. Yes, before, but I think that would depend on your teacher or your institution that you end up going to. Yeah, I don't know. I think for me. It's more in uni like in the first few years of college.

Moderator: No, I think I think this is great. Because I do think that this where the focus should be as well because it's such a lot of pressure and such a competitive world. As well. And I think when you go into uni, you're sort of surprised about how difficult it is. I think it's also that musicians tend to be quite tense people, anyway, because of the pressure you're under constantly. And to counter that. I'm not saying every single music to count, to find ways of countering that basically, I think.

Moderator: And what do you think?

P9: I think your research is really interesting. Coming from the self-management side? I think definitely is. there's so many factors as to being a musician, and how we can counter this issue of pain and injury. So I, the reason why I got interested in your study because I'm also looking into researching that, but from the aspect of from education side, from the teaching side, because, like what Isabel just said like, that's lacking so much in our education, you know, from like young going up to Uni. I think there's so much more that teachers need to do for students because it we shouldn't be like playing playing play. And then we get to Uni level. Then we get injured. And then we don't know what to do with ourselves, because that's like kind of too late. And you know, people always say prevention is better than cure. So I think definitely more needs to be done in the education side, which is something I'm I'm hoping to look into and try and influence the change, because I don't think there's a lot of talk about it just

yet. And like it's about said like, it depends on who your teacher is but like, I think every teacher should be equipped with this knowledge to, you know. Like, if you if you see your students playing in like an awkward way, like, why are we not fixing that? Why, we just letting it happen. And then I mean, sometimes teachers don't know how to fix that. And or maybe they don't even realize that. So yeah, that's like a huge issue for me in terms of educating yourself. I think technology now is so huge like I see so much stuff on Instagram. For, like Ballerina's and dancers and all that, I'm like, why do we not have this for like musicians. Yeah. And I mean, even watching stuff. For, like Ballerina's, I'm just like, actually, I can take that away and apply it to myself. I mean, I'm not there like doing all this stuff, but it's the same muscle groups, in a sense, all like the same concepts off, like, you know, you need to like stretch before and after, and then you need to take care of like how you know how you cool down, how you warm up? So I think those things can spread really quickly on the Internet. So I think in your in your graph, the highest one was yeah. And I think people tend to take to that really quickly from what they see on their phones, which is so set. Now we're still stuck on our phones. And I don't know if apps will be a huge thing, but it also depends on how people perceive the apps. yeah, I do think the monitoring thing I have heard of people mentioning like Oh, you know, if you had like something on your wrists to have you like manage your pain, but I think something to add onto the bodies. Mix it like a very. It's a bit foreign, and sometimes when you have something on you and makes you like obsess over it. And it just affects everything. So I think that once also a little bit tricky like you said, but yeah that's what I think for now.

Moderator: I just want to build up on this idea of technology or why we included it in the in the study. It's just life as a musician is very difficult. You're always on Tours, you are everywhere. You spend hours and hours and hours performing, and then you you know you you go somewhere with with the, with your team or with the rest of the musicians, and you know you will go home really, really late. You don't have time to see somebody anything. It's a difficult career so I think this is where the I idea of technology came from. It's the to help it be more accessible, because I know that, like you mentioned Isabel, I think you musicians don't know where to go for help, so if there's a place to try and put all the relevant information for them in in one way, whether it's an app or a website.

P9: I mean, I think the idea of like receiving. I don't know even like a like a newsletter or like a it's something like weekly from my like university, for example. Would be, I think, amazing like that as an exactly. That's what something that just popped into my head just now, as you were talking about technology and the Internet. I think I mean, there is a lot out there already, and but for some reason it doesn't. I've never found it easy to find stuff, you know. All things that are worth relating to what I've been looking for, you know but any I mean any kind of app related to music musicians and stretching and warming, warming up, warming down exercises to strengthen certain muscle groups, I think, would be amazing. And like, I know that there are probably things already out there for like dancers. And you know, there might be stuff out of music athletes. Yeah, basically. I think that would be awesome. But I like, I yeah how well received that would be I don't know, because I feel like people tend to be a little bit cautious about stuff on the Internet as well like I don't know. It's a tricky, the tricky one, I think, having stuff like face to face is so much people can trust it more, almost but I know that with, Yeah.

Moderator: I think you're right. I think you're right. Yeah. And this is why I did the project that way, I guess, it is to think about it with the people you. So what do you think an important feature for you as a musician would be?

P9: I almost think, like body body awareness, and like body mapping is something that people. I mean, I haven't talked to anyone about this very openly, like I don't know what my friends think, you know, but this is very from like from personal experience. As I've gained more awareness of my body and read more about it, I think, like, imagine like being able to sit in a practice room and listen to something someone like talking you through your body essentially, and I know you can do that for yourself. But it's very hard to do that when you're not used to doing it so like as a starter. Perhaps I don't know something that's kind of meditative, and can also like, focus your mind before you play, or something I don't know. And then I think it would be really cool to have like informative, like descriptions of how your muscles work, or, you know, like in video form, or whatever. yeah. So the part about somebody talking to you or I think Alexander teachers do that.

Moderator: What about P10?

P10: Yeah, I think we don't need to learn so much of like the specific muscles. But like, I think, the muscle groups are important, because, like, I think only recently, like, let's say, the last maybe 3 years or so. Then did I realize that, you know, actually via for violinists, we should be doing like shorter workouts. And I think a lot of the times like we get this wrong information that oh, you know, you shouldn't work out because, you know, you're gonna like, get like tenser muscles instead. But in actual fact, we should be like strengthening these muscles so that we can like hold our instrument up for longer periods of time. So I think, maybe like learning about what which muscles we need to strengthen or we use. So we understand how we're using our body. Yeah, and I think an app could work really well for that, because visually we can see it. Yeah, and I think I don't know if apps are capable of like bringing people together, because I think a support network is really important, even if we're not talking to professionals by even like just talking to to your peers, you know, like what is about it? She doesn't know what her friends think about it. And then sometimes we're like to worried to bring it out because we don't know how it's gonna be perceived by other people and be like, Oh, you're so weird, you know. But actually, I think maybe a lot of us inside just really wanted to talk about these topics together. But we're just worried about it. So I think that community aspect is quite important as well, yeah. And I think videos are really powerful today. I've seen a lot where I don't know if it's like a filter on the person with the muscle group in place, and then they're moving, and then you can see like as if you've got X ray eyes. I think those are quite useful as well. Yeah.

Moderator: Yeah, no. I think the social aspect is very important, and I think for musicians as a whole, for performing arts. It's really good to start talking about your pain and your injuries. And what's happening? Because I, from my experience at least, I think this is not something discussed enough with the, with your peers or with your teachers. So I think that this idea of a social platform, or being able to connect with other people and also learn, is quite important. I want to ask you about something, because I thought, I think this is quite common for musicians, and if I'm not wrong also violinists is posture. And I'm just wondering what you think about that.

P9: I from personal experience. I you know there's always the classic, you know. Sit up straight, and then you end up sticking your stomach out and curving your spine in which then puts pressure to the like. The bottom bit which has been the whole. My whole issue with my back and it you know, I say, that I'm body like I'm aware of my, I'm aware of my body. But actually, I feel like I wasn't at all. And this this idea, now that I have of my spine going all the way down into going further down than I realized, has kind of like solved everything in a way to, you know, to like, sit back on your sitting bones, and I think a lot of people when they sit. I mean a lot of people sit down for long, long periods of time and that is you. You spend most of your time sitting down. So we need to learn to sit. Basically I know posture doesn't just doesn't just mean when you're sitting down, of course. But it's, I think, for me, it's definitely having that visual of like your shoulders like also that like not doing that, sticking your shoulders back. That's also not natural, you know. So I think a lot of people although it's talked about a lot, don't actually know what a good posture is from like seeing people also in my daily life.

Moderator: So I, at the beginning of my project I did a bit of maybe you would call it field work where I went orchestra performances and watch musicians playing, and I remember discussing this with a violinist exactly what she said, and there was a lot of resistance. So, I think, go. I think it's going back to what you were told when you were younger. And it's so difficult to get out of it.

P9: Yeah. I mean, I guess for me it's more how to sit, how to sit properly. And the realization that actually to hold yourself. I I all of this feels like really silly to say, but to to that actually, all the strength comes from your core and from your the middle bit of your body, and you can't hold yourself up by sticking your shoulders like back. Or you know all of those simple things. A lot of people don't know that. And just because they haven't been. I only know this from like my own research and my own, like talking to professionals going to physios going to osteopaths. And hardly any of the people that I'm around at Uni have those things So I don't know if they know that like. And I think it. It needs to be common knowledge. And that's where the educational side. like it needs to be. It needs to be an important aspect of how we learn to play. I think.

Moderator: Yeah, I think we're very, very good point. I also have to point something out as a clinician. If, when you stitch like this you can't breathe and that will affect the the sound of music that you make as well. I was just wondering, what do you think, P10?

P10: Sorry my cat keeps jumping on my table? I feel like, maybe maybe I'm contradicting what you've researched, but I feel like posture hasn't been mentioned enough. Interest from the education side, or maybe, if it has not in the best of ways, like. I think the most common thing is, can you stand up straight? Can you stop straight? And I find that really annoying, because there's no such thing as standing up straight like out. Spine is not straight is is curved in a natural way. And I think the word posture brings so much like negative connotations that, like. yeah, I try not to use that word so much with like students now, because they start doing strange things with their bodies like, once you say that word, yeah. And I do think like I mentioned earlier on that, teachers need to help students right from the very young age to learn about their bodies because it's it at that young age our bodies are so like malleable, and if we just allow it to happen, then the kids grow up with that kind of posture. There's

no better word for it. Especially with the violin, like I've seen. I've seen this girl. She came in for a lesson, and, like her chest, was like stuck out, and her head was down like this, and, like her, mom, goes with her to listen. She's like only 6, and I'm like, can you not see that her spine is going to develop in like the most horrible way? And the teachers didn't comment on it. And I feel like we have, like teachers, have such a huge power to change that and to prevent that and it's just very sad and annoying to see that like, that's not being done for musicians at the at the start. And even at like higher levels when students are older, yeah. And I think a lot of just how to do what we do. even if in our everyday lives, not just playing instrument, you know, if we're sitting at a computer a long time. How is how we supposed to sit the best of ways? And it's just so natural, with like the stresses of life to use our bodies badly. I don't know why we end up doing it. But yeah, yeah.

Moderator: I mean, I would say that there isn't a good posture or a bad posture. I think the main thing which is very difficult in in your context is that you need to keep moving or, as you said you, you sit down and play for hours and it's very difficult to try and break that.

P9: I mean, I definitely a big part of what I've been discovering through my own journey since. Like joining being at Uni is how much I need to look after my body as a whole in in order to actually be able to play for long periods of time and doing other kinds of exercise, not things that are just going to help me. In in like, in holding up my instrument, or you know, for example. So you know, like the more holistic side of like taking care of yourself. I'm sleeping, eating like nutritiously and and exercising in different ways, like running, swimming, swimming, I think, is a game changer, in my opinion. Get so for violinists and string players, especially because you're using your shoulders, and there's no exercise where you constantly go like that out of the water, you know, like, I think every violinist should go swimming. But yeah, I think that that has been a big part of discovering what I need like what my body needs.

Moderator: No, I think I think a really good point to make the idea of general well-being to your physical health. It's your psychological help is what you're eating while you're sleeping and just building on this point, there's a lot of tracking technology and advice based on what is measured. I'm wondering, what do you think about that?

P9: I yeah, I think that's I mean, I've got an apple watch myself, and it's been quite interesting. Tracking my sleep, for example. That's just one thing that I like have never really counted if I if I didn't have it. And yeah, I mean, if if an app can tell you to do to do certain, or to say, Oh, maybe try. Do this for this pain, or you know, like, and it not just be so violin related, or whatever instrument you play. And then you start thinking about your body not just related to your instrument, because I think musicians tend to think that the relationship with the instrument is almost too close in some ways which is very normal, and it's something that everyone goes through in in one way or another. But to kind of also do the things that you need to do outside of playing to be healthy. And I think, yeah, if you've got like a reminder or something. For example, I don't see why that wouldn't be helpful.

Moderator: What about other things? That might be more music related like playing time so trying to help you schedule your practice better.

P9: I think. I mean, I'm I definitely think that you can either be practiced like for hours and hours. Nonstop. It just depends how much focus you have? But if you've got, if you I mean, I don't know. For example, I think it would be quite helpful for some people. if that is an issue for them that they can't stop practising, or they don't take a break to have a like to log in when you start, and then you have a reminder to take a break. For example.

P10: I do think the reminders really good cause. I recently started using a galaxy watch and it had this thing where it would tell me to get up and move, which I found really helpful. But I mean, sometimes I just like just go away kind of thing. But I think that's helpful for us musicians. Very practice, because we sometimes, I mean depends. Sometimes we keep track of time, sometimes we don't and when we don't, we just like so focus tunnel vision on the music that we forget to take breaks but I think even reminders on, like what we could do is helpful, because I find for myself. Sometimes, like I'll practice for a certain period of time, and then I'll come away from it, and when I reflect on them like, why was I sold down to like push myself so? How, when I could have like taken like 5Â min off, and I come back to it all. I could done something differently. And at this, like, I feel like my time has been wasted. Yeah. So I think reminders on an app would be pretty helpful. And I guess tracking could be helpful. But that only works if you like start and stop something. Yeah.

P9: I also think. you know, if you're ideas of maybe what you could do in a break might be quite interesting, because I think often. you know, for example, if I'm not in a not very focused mood, and I take a break. I will probably break for longer than I need to and do something that is not very helpful. And more distracting than restful. For example, you know, like go for like a 10Â min, walk outside, and then come back in or lie down on your back for 5Â min or something, you know. Instead of going on your phone, it really but there are a lot more other distracting things, I'm sure, but that is, that is the one issue that I think people get caught up in.

Moderator: I think I want to ask you about is you know, we we discussed a lot of good management practices. But again. If if you don't have the motivation to do it, then you're not going to do it. My question is, do you think there's any way to try and break that cycle so that you're motivated to do the right things before it gets to that.

P10: I feel like this is something that I'm currently as a question I'm struggling with in terms of the education side, because, you know, I'm like so passionate to like, educate everyone on these topics. But in the same time I'm like, you know, what this person doesn't want to learn about it. I can't really force them right. And I feel like so much. So many young musicians come up, you know, to thinking that you know I am undefeatable, you know I can't practice 8Â HA day, 7 days a week, and I'm gonna be fine which is really dangerous. But at the same time. I guess I'm trying to come to terms of it. From the way that you know, I can put this information out there, I can do my best to educate people and just hope for the best. And hopefully, this education would like have a water ripple effect. You know, it's really great that you know. It's about like you. You're so young, and you're already. So like aware of these things like, I definitely wasn't aware of these things. Man, I started undergrad, and I wish I had so I think they're starting to have a change in the aspect, and I guess we can only be hopeful that this change will slowly have a bigger effect and reach with the future generations to come. But I'm not sure if it could be like, if if it could change faster or

we couldn't do more to like, hey, you know this, this app, or like this, this thing that you could do for yourself? Yeah. This, I think, is a really tricky one.

P10: Yeah, I mean, I think it. It almost has to come from the institutions, like, I think you know, being at Guild at the moment, there's no word of. Yeah. There's Alexander's technique that I can do and pay for which is like the price is much less than if I went to some one privately, but you know it. There needs to be some kind of compulsory aspect, whether that's Alexander technique or a movement class for half an hour or a stretching class that is compulsory. It's not going to happen. People aren't going to go voluntarily. I just know that from seeing you know other voluntarily voluntary things and even if it is to benefit their overall education and their body when they play, it's not going to happen unless it is, it comes quite seriously from those places.

Moderator: I might. I think I think so. It's a fair point. Yeah. But if you make the link to musicians, that what you do now will affect you are playing. This is, I think when they start to listen to you? What do you think are the barriers to follow information or to get information through technology.

P9: I guess the tangibility of it in in terms of it being on a screen and like relate. I know you know, whatever form it's in, whether it's in video form or an article or something or someone I know to kind of relate that yourself to yourself. I reckon that might be quite a challenge for some people. Is is that what you were touching? Yeah, I guess so like. And also people not having the right understanding potentially of like what they're doing wrong, or if they're doing anything wrong at all. Or.

P10: Sorry to jump in yeah, I do think an app is useful in giving us the information. But I think sometimes the help we need just needs, like a physical touch which comes like either from a teacher, or if you go to like a physician or something like that, I think. Oh, oh, see! I think I was gonna say, Oh, I just lost my train of thought. I'm so sorry. Never mind if it comes back to me, I'll shout it out.

Moderator: I think I think you're both correct. I mean, the way we're thinking about it is this will be so to sort of an adjunct to going to see a clinician or something, maybe, that you could try on your own to see if that could help you with your problem.

P9: I think a lot could come out from that. But I still feel like people will be tentative or not so interested in something that's not really not there in front of them. Because I know I despite, like our generation being so online and so on their phones all the time. I feel like the struggle that will. What will probably occur, maybe, is that people won't just will be a bit like not sure about the I like the app and or an app or an whatever it is, in whatever form. But, I guess it really depends how it's like also put across and like and what's offered. But I think I mean, I definitely use it, but depends if like, if I don't know. I guess it depends who it is, but from personal experience as well. I'm always quite tentative about stuff on line, despite being on line myself.

P10: I do have a question so like with they always say like, Oh, you know, we have like a list of practitioners or clinicians, who, you know, have registered with us, who are licensed to do like all this stuff with us. But then, my wonder is like I have this huge list available to me. How do I pick that one person like? I think that's the difficult part for us as well? Besides, the issue of cost is like, how do we know who to go to without

knowing who these people are? I mean, we can read a bio on the website. They've worked with Da Da. Da. They've done this and that. But I think that part is also really difficult. I mean, it's the same with any kind of health condition really like. Which, doctor, do you go to Doctor A, who's near my house, or Dr. B. Who is like further down the road, and I think that's a tricky one to decide what? What would be important for you to make that decision of who to go to. I feel like word of mouth recommendations always work best, I mean because cost is one thing. Time is another thing as well. We don't have the luxury of like money and time to try this one and like, Oh, maybe get another a trial with another person. And yeah, I think that's one thing that I'm I'm a little bit hesitant with, like going for Physio, or like the yeah. So I rather just be able to do it myself. Yeah. Well, that that brings us back to self-management, and if I just feel like I don't know, maybe I'm a little bit like jaded. But I think trying to cater to everyone's needs is really difficult. Especially when you're trying to help people and I always think it's really down to the individual, whether they choose to take the information or the help as horrible as it sounds, because you can't force someone to get help if they don't want to. And maybe the time is not right for them. You know, they haven't accepted that they need help. Yeah, yeah, that's quite a mean thing to say. But yeah.

Moderator: I think that brings us back to self-management. Well, I have come to the end of my questions. I think if you have any questions to me, anything you you'd like to add. Please, for free. I'd like to like to know anything you want to say or ask. Anything you think I have missed.

P9: No, I found this really interesting, and it's nice to know that other people are thinking about it, not just me by myself. I feel like sometimes I'm just like a loose end in terms of not understanding why. This isn't something that my biggest thing is, why aren't institutions doing more? And that goes, you know, with what you're saying, about just educationally. People don't really know a lot of teachers don't really know where or how to help which is funny, because they're musicians themselves violinist themselves, and you know, maybe they've been through an injury, and and in that way are some help. But a lot of people actually don't know, because they just have never had to face those problems. I think often the people that have to go through all of the discovery of what? What works for them and what they need to do. In in their practice breaks and stretching and warming down are people that have had actual injuries and have had to stop playing. And you know all of that kind of stuff. So it's hard to. I don't know, but but the whole app idea is very interesting, and I feel like it. Could it really help. But for me the biggest issue is, is the institutions not doing? Not doing more. But yeah

Appendix 15: Example of Fourth Focus Group Coding

Data	Code
"I mean, you know there are methods out there like Alexander technique which I just started to explore myself." (P9)	Awareness of specialised techniques
"There's the body awareness, and noticing what feels wrong, essentially when you're playing but also the understanding of our bodies. And like what muscles we're using on a daily basis..." (P9)	Need for body awareness
"I think it should be something that is maybe talked about a little bit more." (P9)	Lack of educational emphasis
"I think definitely at Uni. Whether that's before, as you know. I don't know in an ideal world. Yes, before, but I think that would depend on your teacher or your institution that you end up going to." (P9)	Timing of education intervention
"I've got a lot of trauma to my back because of playing so I'm currently having that treated which I'm very lucky enough to be able to do" (P9)	Experience of playing-related injuries
"all the normal aches and pains that a violinist or a musician would get like shoulders being tight" (P9)	Normalisation of pain
"finding the things that you can do to release that tension and to yeah, to relax a bit more" (P10)	Need for tension relief strategies
"musicians tend to be quite tense people, anyway, because of the pressure you're under constantly" (P10)	Psychological factors in physical tension

"I'm also looking into researching that, but from the aspect of from education side, from the teaching side" (P10)	Educational perspective
"that's lacking so much in our education, you know, from like young going up to Uni" (P10)	Gaps in educational approach
"people always say prevention is better than cure" (P10)	Value of preventive approach
"I think every teacher should be equipped with this knowledge" (P10)	Teacher responsibility
"technology now is so huge like I see so much stuff on Instagram. For, like Ballerina's and dancers and all that, I'm like, why do we not have this for like musicians" (P10)	Transferable knowledge from other disciplines
"stretch before and after, and then you need to take care of like how you know how you cool down, how you warm up" (P10)	Importance of preparation and recovery
"people tend to take to that really quickly from what they see on their phones" (P10)	Acceptance of mobile-based information
"I have heard of people mentioning like Oh, you know, if you had like something on your wrists to have you like manage your pain" (P10)	Interest in wearable technology
"something to add onto the bodies. Mix it like a very. It's a bit foreign, and sometimes when you have something on you and makes you like obsess over it." (P10)	Concerns about wearable tech
"receiving. I don't know even like a like a newsletter or like a it's something like weekly from my like university" (P9)	Desire for consistent information delivery
"I've never found it easy to find stuff, you know. All things that are worth relating to what I've been looking for" (P9)	Difficulty finding relevant resources

"any kind of app related to music musicians and stretching and warming, warming up, warming down exercises to strengthen certain muscle groups, I think, would be amazing" (P9)	Interest in musician-specific apps
"people tend to be a little bit cautious about stuff on the Internet" (P9)	Skepticism about online information
"having stuff like face to face is so much people can trust it more" (P9)	Preference for in-person guidance
"body body awareness, and like body mapping is something that people" (P9)	Value of body mapping
"imagine like being able to sit in a practice room and listen to something someone like talking you through your body essentially" (P9)	Guided body awareness
"informative, like descriptions of how your muscles work, or, you know, like in video form" (P9)	Need for visual educational content
"we don't need to learn so much of like the specific muscles. But like, I think, the muscle groups are important" (P10)	Appropriate level of anatomical detail
"we should be like strengthening these muscles so that we can like hold our instrument up for longer periods of time" (P10)	Need for targeted strengthening
"learning about what which muscles we need to strengthen or we use. So we understand how we're using our body" (P10)	Functional anatomy knowledge
"an app could work really well for that, because visually we can see it" (P10)	Value of visual learning tools
"a support network is really important, even if we're not talking to professionals by even like just talking to to your peers" (P10)	Importance of peer support

"sometimes we're like to worried to bring it out because we don't know how it's gonna be perceived by other people" (P10)	Stigma around discussing injuries
"the community aspect is is quite important as well" (P10)	Value of community
"videos are really powerful today. I've seen a lot where I don't know if it's like a filter on the person with the muscle group in place" (P10)	Engaging visual educational tools
"Sit up straight, and then you end up sticking your stomach out and curving your spine in which then puts pressure to the like. The bottom bit" (P9)	Misconceptions about posture
"I feel like I wasn't at all [aware of my body]" (P9)	Limited body awareness
"to like, sit back on your sitting bones" (P9)	Specific posture techniques
"to hold yourself. I I all of this feels like really silly to say, but to to that actually, all the strength comes from your core" (P9)	Core strength awareness
"I only know this from like my own research and my own, like talking to professionals going to physios going to osteopaths" (P9)	Self-directed learning
"hardly any of the people that I'm around at Uni have those things" (P9)	Limited access to care
"It needs to be an important aspect of how we learn to play" (P9)	Integration with music education
"I feel like posture hasn't been mentioned enough" (P10)	Inadequate posture education
"the word posture brings so much like negative connotations" (P10)	Negative framing of posture
"our bodies are so like malleable, and if we just allow it to happen, then the kids grow up with that kind of posture" (P10)	Early intervention importance

"teachers have such a huge power to change that and to prevent that" (P10)	Teacher influence
"how much I need to look after my body as a whole in in order to actually be able to play for long periods of time" (P9)	Holistic approach to physical health
"like the more holistic side of like taking care of yourself. I'm sleeping, eating like nutritiously and and exercising in different ways" (P9)	Wellness behaviours beyond playing
"swimming, swimming, I think, is a game changer, in my opinion." (P9)	Beneficial cross-training activities
"what my body needs" (P9)	Individualised approach
"it's been quite interesting. Tracking my sleep, for example" (P9)	Value of health tracking
"I think musicians tend to think that the relationship with the instrument is almost too close in some ways" (P9)	Over-identification with instrument
"if you've got like a reminder or something. For example, I don't see why that wouldn't be helpful" (P9)	Value of reminders
"if you I mean, I don't know. For example, I think it would be quite helpful for some people. if that is an issue for them that they can't stop practising" (P9)	Practice management
"it would tell me to get up and move, which I found really helpful" (P10)	Movement reminders
"we just like so focus tunnel vision on the music that we forget to take breaks" (P10)	Practice tunnel vision
"why was I sold down to like push myself so? How, when I could have like taken like 5 min off" (P10)	Reflection on practice efficiency
"ideas of maybe what you could do in a break might be quite interesting" (P9)	Structured break activities

"if I take a break. I will probably break for longer than I need to and do something that is not very helpful" (P9)	Unproductive break behaviours
"go for like a 10 min, walk outside, and then come back in or lie down on your back for 5 min" (P9)	Beneficial break activities
"so many young musicians come up, you know, to thinking that you know I am undefeatable" (P10)	Invincibility mindset
"you know I can't practice 8 HA day, 7 days a week, and I'm gonna be fine which is really dangerous" (P10)	Dangerous practice habits
"I guess we can only be hopeful that this change will slowly have a bigger effect" (P10)	Gradual cultural change
"it almost has to come from the institutions" (P9)	Institutional responsibility
"Alexander's technique that I can do and pay for which is like the price is much less than if I went to some one privately" (P9)	Cost as barrier
"there needs to be some kind of compulsory aspect" (P9)	Need for mandatory interventions
"People aren't going to go voluntarily" (P9)	Limitations of voluntary participation
"tangibility of it in in terms of it being on a screen and like relate... whatever form it's in, whether it's in video form or an article or something or someone I know to kind of relate that yourself to yourself" (P9)	Challenge of relating digital content to self
"people not having the right understanding potentially of like what they're doing wrong, or if they're doing anything wrong at all" (P9)	Limited self-awareness of issues

"sometimes the help we need just needs, like a physical touch which comes like either from a teacher, or if you go to like a physician" (P10)	Limitations of digital-only approaches
"I feel like the struggle that will. What will probably occur, maybe, is that people won't just will be a bit like not sure about the I like the app" (P9)	Skepticism about digital tools
"I'm always quite tentative about stuff on line, despite being on line myself" (P9)	Digital trust issues
"I have this huge list available to me. How do I pick that one person" (P10)	"I have this huge list available to me. How do I pick that one person" (P10)
"word of mouth recommendations always work best" (P10)	Trust in peer recommendations
"cost is one thing. Time is another thing as well" (P10)	Multiple barriers to accessing care
"So I rather just be able to do it myself" (P10)	Preference for self-management
"trying to cater to everyone's needs is really difficult" (P10)	Challenge of personalisation
"it's really down to the individual, whether they choose to take the information or the help" (P10)	Individual responsibility
"my biggest thing is, why aren't institutions doing more?" (P9)	Institutional accountability
"a lot of teachers don't really know where or how to help which is funny, because they're musicians themselves" (P9)	Limited teacher knowledge
"people that have to go through all of the discovery of what? What works for them... are people that have had actual injuries and have had to stop playing" (P9)	Learning through injury

Appendix 16: Example of Focus Group Analysis

Larger code	Codes	Data
Education and awareness	Lack of Early Education	"I mean, I think there's 2. There's 2 sides of it. There's the body awareness, and noticing what feels wrong, essentially when you're playing." (P9) "But also the understanding of our bodies. And like what muscles we're using on a daily basis." (P9) "Because there is no one like no like if I say to like a friend of mine also, what what muscles are using to hold up your instrument or no one's gonna know they're not gonna know that." (P9) "And then we don't know what to do with ourselves, because that's like kind of too late. And you know, people always say prevention is better than cure (P10) We don't need to learn so much of like the specific muscles. But like, I think, the muscle groups are important, because, like, I think only recently, like, let's say, the last maybe 3 years or so." (P10) "We should be like strengthening these muscles so that we can like hold our instrument up for longer periods of time" (P10)

	Teacher responsibility	I think there's so much more that teachers need to do for students because it we shouldn't be like playing playing play. And then we get to Union level. Then we get injured." (P10) I think definitely more needs to be done in the education side, which is something I'm I'm hoping to look into and try and influence the change, because I don't think there's a lot of talk about it just yet (P10) "Teachers need to help students right from the very young age to learn about their bodies. because it's it. At that young age our bodies are so like malleable, and if we just allow it to happen, then the kids grow up with that kind of posture." (P10) "Her chest, was like stuck out, and her head was down like this, and, like her, mom, goes with her to listen. She's like only 6, and I'm like, can you not see that her spine is going to develop in like the most horrible way?" (P10) "Definitely. I think, yeah. Uh, teachers are very important and, um, because, well, when you're playing at professional level, you, you have to play a lot. And sometimes, um, with a good teacher, they can guide you and say, look, if, um, you don't need to spend a lot of time playing, what you need is to focus your practice and have good practice sessions, for example." (P1)

		"You know there's always the classic, you know. Sit up straight, and then you end up sticking your stomach out and curving your spine in which then puts pressure to the like. The the bottom bit which has been the the whole." (P9) "So I think a lot of people although it's talked about a lot, don't actually know what a good posture is from like seeing people also in my daily life." (P9) "I feel like posture hasn't been mentioned enough. Interest from the education side, or maybe, if it has not in the best of ways." (P10) "I think the word posture brings so much like negative connotations that, like. Yeah, I try not to use that word so much with like students now, because they start doing strange things with their bodies like, once you say that word." (P10) Posture, Posture, Posture. The most important thing (P1) It's all about posture again. Um, posture and breathing. And, and it seems, it seems very simple, but just like learning how to breathe while you play that, that's very important (P2)

	Posture good / misconceptions	
Habits / lifestyle	Long practice hours	"So many young musicians come up, you know, to thinking that you know I am undefeatable, you know I can't practice 8 HA day, 7 days a week, and I'm gonna be fine which is really dangerous." (P9)

Access to care	Finding specialists Access to Care and Finding Specialists "Which, doctor, do you go to Doctor A, who's near my house, or Dr. B. Who is like further down the road, and I think that's a tricky one to decide." (P10) "I feel like word of mouth recommendations always work best. Because cost is one thing. Time is another thing as well. We don't have the luxury of like money and time to try this one and like, Oh, maybe get another a trial with another person." (P10) I've never had a good physio personally, but I would, whenever I get my information, I would always be, I'd be more receptive if a personally plays a similar instrument to me. (P6) But I feel like with the most helpful advice think would be ask my tutor or something like that and just ask what I do with this pain. Cause like I said, a lot of pains are kind of instrument specific or more or less. And I think it knowing if I know my physio is has they know more about what is with say clarinet, they have experience, not whoever diagnosed me, they've never held a clarinet life, whatever. Obviously know education probably it is all they learn all but either mind knowing that they know kind of what's happened. – opposing idea to this (P7) Previous experiences and challenges in accessing specialised care "just because you're doing music doesn't mean that you should talk to a musician about that injury like as a priority. Because I, if you like. If you get into the sport, you go and see someone like a medical professional, like just when someone, someone, someone else who does music might be able to relate to what you're saying." (P8)

		Well, because for me, one of the things I would know to look for now Yeah. Is A, someone who specializes in musicians, but b, if that person actually plays an instrument themselves. That's even better because then they, they understand personally, you know. But my surgeon is, he's a trumpeter. Okay. He's jolly good. He's played at Ronnie Scott's. So, he understands more than someone who doesn't play how terribly important, aside from earning your, your living, how important the love of music is, and how terrible it is when it's taken away from you (P1) In my case, uh, well, when I went to the GP with, um, uh, back pain, uh, they gave me, uh, medicines. So pain learns on stuff. Um, that actually makes it worse because if you're not feeling the pain, then you carry on playing, you carry on playing. Um, that's just, and, and, and that's a very clear point where, um, well, the doctor didn't know what I'm actually doing, so I, I I can't stop playing, but I need to do something. So what, what can I do? So that, that's why I think what what we saying is actually, uh, a good point is, uh, when some, someone is a musician or at least knows a little bit the musician's routine, you can drive that person better through the options. Um, and in my case, when I have the, um, sports massages that she, she was a clarinet player, that was much better because she knew also in the moment, she, she saw me walking in, she said, okay. Right. You are a bass player, because you walk like this. (P2) And also they don't, the people who, who don't, you don't, you don't necessarily have to be a full-time musician, but people who don't play anything at. People do not understand. I mean, the number of times people said to me, how many hours do you play? And I say, oh, well, sometimes eight or nine a day. Yeah. Well, how can you do that on earth? Do you want to do that? Because I love it. Yeah. Yeah. Um, and they don't understand the drive and how difficult it is not to play. You know, I felt as in my life had ended when I couldn't play. It was just (P1) Yeah. Because for, for example, when sometimes you have, you have a pain in the arm or, or whatever, and, and you go to someone and they

		say, just rest. And then sometimes say, how much should I rest? One, two days? No, no, three, four weeks. So that, that's not possible. (P2) So I think maybe you don't need to be a musician, but you need to understand what we do. Or, or at least, uh, go with someone that's a musician and live the, the life of the musician rehearsing every day. Um, that that's what we do (P2) "It went on for years. It started in 2016. And I went to the doctor who said go early. So I went to the local hospital and there was an awful physiotherapist who bent, well, he really was, he was a sports specialist, so he didn't understand what, what your hands mean to a musician. And he bent my finger up, bent it over backwards like that, and put it into a splint, which hurt terribly badly. And I cried all night with pain. And then the next day a friend of mine turned up to pick up some music and I met her at the front door going, whoa. So she took me back to the hospital and we insisted that he'd take it off. That was in October, 2016 (P1). This went on for months. I went to a different hospital where they did, they did the same thing, but more gently. Then in 2017, in August, back then, I, I went for a BAPAM, uh, appointment to see if there was anything they could do. And they said that there was this surgeon who did things privately who is reputably the best hand surgeon for musicians in the country. So I got an appointment with him on the National Health, which was good. Um, and then they followed, well, I had the first operation in February 2018, and he tried to fuse my finger in the bank position, but that operation failed, so he had to operate again, and now he's fused it flat. So, I can't, I can't bend it anymore. (P1)

		Yes. But I, you know, the pain that was under was far worse than childbirth <laugh>. I've never known pain like that. So, I, I, I, I relearned to play without my little finger. So, but then with muscle memory, uh, so I taught myself, when you're jumping down two octaves to land with either my third or my fourth limb. And simply not use the little finger well, I didn't use it because it was splinted most of the time or plastered or, and then afterwards I had a support, like a sort of, it's got gel on the inside and it's like a tuby grip, but it's got gel on the inside and a sort of stretching material on the outside, which I wore all the time to support it. So I couldn't, for a year I couldn't play at all because my hand hurt too much. But then now that I can play again, uh, my arm knows where to go from my third feeling to learn it instead of my little finger. So, I've had to relearn that.” (P1) It will be so useful to have on, on the NHS somebody who like that your, your Yeah. Person who is a clarinettist. Yeah. Um, but you know, you're terribly lucky. You, you go to the GP and they are exactly that. They're a general practitioner. Yeah. So they're not a specialist in anything. Yeah. And they say, go to a chiropractor, go to a physio, go to an osteopath, which is terribly expensive and musicians aren't exactly, well paid” (P1) “I've been to this physiotherapist before. They sometimes just draw you a diagram and then you just have to remember what they actually told you. And sometimes the action, the exercise you might be doing is just completely different after two weeks or maybe the pain come back after a month or a year, you just don't remember what they told you (P5)

Institutions	Institutional pressures / lack of responsibility / care towards musicians	"I think it's also that musicians tend to be quite tense people, anyway, because of the pressure you're under constantly. And to counter that." (P9) "It almost has to come from the institutions, like, I think you know, being at Guild at the moment, there's no word of. Yeah. There's Alexander's technique that I can do and pay for which is like the price is much less than if I went to some one privately, but you know it." (P9) "There needs to be some some kind of compulsory aspect, whether that's Alexander technique or a movement class for half an hour or a stretching class that is compulsory." (P9) "It's not going to happen. People aren't going to go voluntarily. I just know that from seeing you know other voluntarily voluntary things." (P9) "For me the biggest issue is, is the institutions not doing? Not doing more." (P9)
Hollistic health		"A big part of what I've been discovering through my own journey since. Like joining being at Uni is how much I need to look after my body as a whole in in order to actually be able to play for long periods of time and doing other kinds of exercise." (P9). "So you know, like the more holistic side of like taking care of yourself. I'm sleeping, eating like nutritiously and and exercising in different ways, like

	Body awareness/ body therapy	running, swimming, swimming, I think, is a game changer, in my opinion." (P9). "I almost think, like body body awareness, and like body mapping is something that people... I mean, I haven't talked to anyone about this very openly." (P9) "Imagine like being able to sit in a practice room and listen to something someone like talking you through your body essentially... something that's kind of meditative, and can also like, focus your mind before you play." (P9)
Instrument-related advice	Relationship with instruments / Instrument-related advice	"Then you start thinking about your body not just related to your instrument, because I think musicians tend to that. The relationship with the instrument is almost too close in some ways." (P9) Oh yeah. If there is a very specific information that applicable to the general professions, let's say instrument groups, then I think it would be much more relatable and useful. (P6)

		Yeah. Cause I play mostly clarinet and sax and...HE percussion, and I feel we probably have different places where we have pains. (P7). Information related to instruments groups would be much more relatable and useful. (P6)
Attitudes to online information / DHIs	Barriers to online SM: Too dangerous Age/health and technology illiteracy Reliance of online resources for SM Trust in reputable online sources for exercise	I cannot afford to go online and go to an app and make things worse. I need to play. Yeah. And, and, uh, it is, it is not that I'm playing one or two hours. Sometimes we are playing for six, seven hours per day. And so I I I, I need something that I really can trust. I cannot try something out. Yeah. So, uh, and some, uh, and its dangerous Yes. It's too, it's too dangerous.” – “Okay. If, if for any reason I do something that I found in an app and it went worse, then well, if I can't go on tour, then well, that, that's a lot happening <laugh>. So, uh, yeah. It's, yeah. It's too valuable. So yeah, I don't" (P2) I never went online. Maybe it's cuz I'm old. I, you know, there's so much rubbish. (P1) Yeah, I'd probably, if I were in the situation I would probably look up a YouTube video or something. That's why I normally do, if I have pain. I look up stretches and do those. So all of them I think would be very helpful. (P6) “I feel if you think of stretches and everything, if I try those sometimes and I get results, which I normally do, I'd be happy then that I normally can find

	App for musicians	reputable sources and common exercises. So if it was medically cited I would probably trust it more." (P7) "People tend to be a little bit cautious about stuff on the Internet as well like I don't know. It's a tricky one, I think, having stuff like face to face is so much people can trust it more, almost." (P9) "But any I mean any kind of app related to music musicians and stretching and warming, warming up, warming down exercises to strengthen certain muscle groups, I think, would be amazing." (P9).
Content	Visualisation / Visual learning	"An app could work really well for that, because visually we can see it." (P10) "I think videos are really powerful today. I've seen a lot where I don't know if it's like a filter on the person with the muscle group in place, and then they're moving, and then you can see like as if you've got X ray eyes. I think those are quite useful as well." (P8) "Informative, like descriptions of how your muscles work, or, you know, like in video form, or whatever." (P9)

Features	Goal setting/ reflection	"An app that I used to use was clear... It actually makes you think on your own like, ask 2 questions, and you like type stuff in the app like what you want in the app, and it tracks it for you, which I found quite helpful, because sometimes all we need is to just reflect on our own what we did." (P5)
	Break suggestion	"I also think. you know, if if you're ideas of maybe what you could do in a break might be quite interesting." (P9)
	Sleep tracking	"I will probably break for longer than I need to and do something that is not very helpful. And more distracting than restful." (P9)
	Alcohol tracking	
	Water tracking	"I've got an apple watch myself, and it's been quite interesting. Tracking my sleep, for example. That's just one thing that I like have never really counted if I if I didn't have it." (10)
		To, to be fair, the, the sober thing is, is a big pool. Like, like that is where I think I'm going at the minute. (P3)
		Yeah, I think even if a lot of it things like you drink more water, it's kind of stating the obvious but I think we're better to say it than to have it be left to the person to figure out. So I think any just general points would be good. (P5)

Larger code	Code	
Facilitators To DHIs	Personalisation of treatment: based on individual goals,	"Yeah, I think definitely the, the thing of maybe being able to personalise it a bit. So I've started, for example, I, I quit

	Tailoring reminders, prompts, and notifications to individual needs and motivations Choice matters: ability to choose time and location of engagement, ability to turn off/on reminders Tailoring treatment	smoking tobacco like two weeks ago and there's this like NHS app that gives you like prompts. So I wanna stop smoking so I can, you know, spend less money, but you can add your own. So one of mine was I wanna stop smoking for my voice and for my lungs and for my health and that comes up as well. So I think something that you could personalise and tailor to you so you can get those like affirmations or those notifications coming up. As well, I have really, I was diagnosed with ADHD very recently, so kind of being reminded in a repetitive way is really helpful, especially when you are a musician. You've got a busy schedule. I think just being able to, I guess, tweak the reminders or, or you know, tailor it to you so it can maybe get through to you in your own way, if that makes sense.” (P5)

		"I recently started using a galaxy watch and it had this thing where it would tell me to get up and move, which I found really helpful. But I mean, sometimes I just like just go away kind of thing." (P10) I think probably personalised wouldn't you'd want, you'd wanna have a set to turn it off probably. Okay. Or I, you might get, yeah, (P7) You could even have an option. For example, you could put in your schedule for example. So if you know that you are going on tour or you'll know you're about to go and like do a couple of weeks of sessioning in the studio, you could put, okay, two week tour, remind me at this time to do this in the morning. Remind me just before I go on stage. Do you know

		what I mean? like to kind of have your schedule, your timetable integrated into that somehow. (P5) “ I think give feature in the app would be a planning thing that they give us. So let's say if you type in I have one hour practice and I want to do it and then I press start, they explain, okay, five minutes this exercise, five minutes this exercise and then your warmup thing you do. And then here are the 40 minutes actual practice. Second time you can do whatever you want. If they have something that already layout and planned it out for us, it will be more attempting to actually do whatever we've been suggested. Yeah. Because sometimes we know some of the exercise but actually we see one hour of practising time, we just practising one hour. We don't want to, it's not our intuitive that we, I'm splitting my practising time

		into this. So if the app has doing those stuff for you, it'll be more tempting I guess. (P8) Well I find that my practise routines tend, if I go into practise it'll be a bit more spontaneous. I won't necessarily be doing 15 minutes, warm up 40 minutes, play 15 minutes. I'll just be, I'll warm up and then I will, I'll have a goal in mind. There'll be to practise a silly piece or get a piece to a certain taboo. So I think I would probably not benefit from just if it was completely structured in an app for me I would find it almost a bit chore to have to go through everything. I would prefer to just have general points when I use something. I think what we're talking about would be very similar to something like doolingo and I find with something like that personally I don't find that very good because sometimes you know you must day or

		whatever and I feel I'm almost stressed to the process process then if I was just you. (P9)
	Feedback and motivation	"I remember having that with the quit smoking one and it would tell you how much life you've got left. Like, yeah. <Laugh>, you know, <laugh> literally like you've just added another couple minutes to your, to your what? Bloody life, you know, it's good for you. But yeah, I guess stuff like that to make you feel like you're getting points, you're, you're you're growing or something. Cause it's hard to reject whether you are growing by yourself these days." (P5) I think you've say you've followed the schedule that you're supposed to do and then at the end it shows a result of some data like saying it helps your body relieving in some way. It

		will, it'll be quite a good a reward system that you have if they have some sort of data that showing you what you have actually managed to achieve, that would be quite good. (P8) Yeah, I think reminder or how those motivational apps works, they have a, I wouldn't say mini games, but they have a progress tracker that is sort of fun. It gives you a drive to work on it. (P9). Yeah, badges or a progress bar. Yeah, it'll work well (P9) Be really interesting as well. I just think of it would be nice to have those statistics for sure. You're making progress interesting to look at as well. (P8)

		I find personally the motivation really is I have a recital and I'm ever in a weeks or months and I don't want to be in pain for that. So I want to know when I'm not going to start having pains like the week before the recital or something like that sort of during it. So it's really, it's more just a very personal motivated for. I think practicing tends to be quite a personal thing unless you're practicing for a concert or something like that. More broader exercise running gem back. Yeah it's good to have a friend that sometimes, but we're practicing at practice room rare with someone else unless I'm doing a piece with someone else. (P8) aspects to the app. So I think i'll be quite satisfied to see it. You could maybe maybe do like a reward system. And I didn't

		mean that in like I just mean. I know I have this app where it's like. It's basically to get you to do more active stuff. So if you if if you go to a walk, or if you ride a bike. it adds up the minutes, it tracks it, and then you get a certain amount of points. You get like 10% off a local shop which is linked to that with links with the app, maybe more of. An it's more of an environment that just like, get the bus cycle of work instead of drive, which is great for me because I don't drive it so. I don't have a choice. It's just like. (P9). But I also just quite like the analytics as well. I think It'd probably be incentive enough. (P7)

		I think it would. I think that'd be good, because I mean at least for my generation. We've grown up playing a lot of video games where you have a lot of reward-based systems. So, and being able to see your progress like in real time. So that would be quite satisfying, I think. (P7)
	Comprehensive plan/solution - Practicality	James: Interaction? Well, I don't really know if it's related, but if I have an app and it doesn't redo anything for me, so I still have to, let's say it suggests that a solution maybe call this GP around you and I still have to look up the GP, call them by myself, then it's less appealing to me. Why do I have to use the app when I can just use Google for it? So if the app has integrated more integrated stuff, let's say the plan thing, I mentioned if you plan for you if I need medical help, they have

		already listed some details that they found online or something. But in the app, so I don't have to switch around stuff, I don't have to leave the app, it makes me want to stay on the app longer. That would be more useful to me I guess. (P4) I think anything longer than one minute is very long. So I think a 15 to 30 second video, literally just one repetition of the thing you want people to do would be perfect. (P6) I would really mind a longer video if I'm watching a video like that. It's probably cause I decided okay, I'm going to try and fix whatever problem is. So I would be fine if anybody I'm under 10 minutes maybe if it shows multiple approaches, if

		it's focusing the one thing far too long, obviously that's a problem. Those values if find where they're showing stretches and all there, they're showing multiple stretches, there's fine, there's one use for stretches and is 10 minutes long, but it shows about 20 different stretches. I think that that's fine enough for me I think. (P7) Yeah, I, I would agree. I, I think definitely having the option to have a video, you know, like in, at some, at one point in like the app or the website, but also having like a gif or something, you know, just like have the actual motion that is just quick, easy, accessible because a GIF is so quick, you know, it just does its thing and then continues doing its thing. So yeah, just

		like a little reminder I guess, to just bring it up. So yeah, both is, both is good. (P3)
	Social support	"I don't know if apps are capable of like bringing people together, because I think a support network is really important." (P9) I think this sense of community, you know, like, I guess raising awareness of this so people know about it. And just being able like interact with people on there and like have a profile or something like that. You know, something like Reddit where you have like a forum and then you just have your

		profile there and you can like, have things that, you know, affect you or you, you are interested in talking about (P10) I think options for sure. And I think, I guess the ability to kind of like post, you know, like on Twitter or Facebook or whatever where you have, you know, you can type and then like post something out with like the hashtag scoliosis or chronic pain if, if that makes sense. Like hashtags or something that groups certain things together. (P10) Yeah, I think I'd, I think I'd agree forefront is the, the community act, and, and yeah, if you can make it like a sort

		of social platform of sorts and grouping it, I think, yeah, I think that seems, I think I'm in line with T... ideas. That's cool. (P5) “I think it would be good for all the musicians to connect together and if there is a platform to ask for advice” – link to that fellow musicians would probably no more that the GPs – need for a monitoring system to avoid misinformation (preferably by a healthcare professional) – “It's just like it'd be I'd be great to talk to the people. You have the same thing. But I guess what would you Would you have a monitoring system to see what likes to say? Actually, that's not quite true.” / “I probably wouldn't recommend that.” (P8)

	Clinical endorsement	“if people direct me to the app, qualified people (musically or health-related) who were saying the app was good/if my teacher recommends it”, if there is an official website, let’s say they have some sort of certificate description or on app store or something and they also put the same app on the website, it would be a better option.” (P4) Well, I think I would prefer the face to face and the digital. Okay. So maybe if this app was recommended from a GP in one of the GP session? No, not gp, sorry, the physiotherapist. If it came from the physiotherapist session that you are already going and then it would be a good way to start spreading the use of this digital health app. (P4)

		Either or. I mean if someone trusted Relay or someone kind of got, okay, if I recommended, probably I would just use it for my teacher recommended. I'd definitely check at least. So yeah, if they, what about random person? Never wouldn't. I think that's a very good point of just if, let's say we only know about it because we are having this discussion, but let's say I'm just someone who know absolutely nothing and I found this app on the app store, I would really question about the liability of it. So I think it would be great if there is a official website, if it's on the official website, let's say they have some sort of certificate description or on app store or something and then they also put the same app on the website, it would be a better option. (P4)

		Yeah, there are people, qualified people who were saying that the app was good. I would definitely think we're using it over anything. (P6) BAPAM, if musicians knew about them (P1) I think that if you, if you had to, if you had to be recommended it by a health care professional that it might be a bit counterintuitive, because. like, if I were to use it, I want to use it to see if I should go to healthcare professional.” (P8) If the University recommended it as well like. I say that would be really helpful, I mean, if, like, if you get recommended to

		that by like a professor you just you the same, it was safe, probably. (P8)
Barriers	Choice of language	Some structure of course. But I find a very rigid thing using language especially. I'm sure there's much research in this but I know personally you get to the point you missed too many days and it's too much guilt. No you don't want to go back. (P7)
	Cost	"Yeah, like a yearly plan for those apps it tends to push me off but if it's a one-time purchase app then I found it more appealing to me." (P6) "How much it would cost would be the only thing but Yeah. I dunno how much something like this would cost this. Yeah. If

		it's free, that would be very, yeah, I wouldn't see how you couldn't use it. That'd be great." (P3)
	Credibility	"I think with an app anyone can make an app really and I would be concerned whether it's just now I want to know where the information will come from. I would want to know whether it is sourced by medical professionals. I would want assurance." (P5) "let's say I'm just someone who know absolutely nothing and I found this app on the app store, I would really question about the liability of it. So I think it would be great if there is an official website, if it's on the official website, let's say they have some sort of certificate description or on app store or something and

		then they also put the same app on the website, it would be a better option.” (P6)
	Privacy (not really a barrier for this group / but anonymity is important)	Hmm, not really. I mean, I'll sort of, you know, conceited to the idea it's happening, like where everything's going on the internet and it's useful, you know, I think try not to be worried about the, you know, the, the privacy stuff we want to be share. It's the sharing isn't it. We want to share to learn and stuff. So I'd be cool with that. (P3) Yeah. I don't think, I don't think I'd have any worries. I mean it's not gonna be more than, you know, say let's say Instagram or, or Facebook have on you anyway and at least this is, is helpful and it's, it's going towards the betterment of, you know, not only yourself but you know, a whole group of people who,

		who are I guess, you know, living with these conditions as well. (P5) Well I think to me I don't have any concern using any digital apps. I would say well quite common thing is the privacy issues with anything downloaded to your phone at this time of the AI thing, technology thing era. (P4) Well, I guess I would assume that it was like not synonymous, but that the people who are on the app. A bound by the same law or doctors are where there's like, analyt, and they they they can tell anyone's names. I guess that would probably be quite important. (P8)

A hybrid model	A choice is always good. DHI as an alternative method during travel/busy schedules Acceptance of SM as an initial treatment Personal preference for SM versus seeking professional help for minor issues	I think a choice. A choice is always, it feels good to have that, you know, that choice because there's gonna be a lot of people that kind of wanna go through this on their own and log it on their own and then they can have the choice to maybe take it a little further. But yeah, I think, I think having it as you and the app and then having the choice to kind of, you know, make changes or whatever, I think is is cool. (P5) "I think, well, I think the best, the best thing is, uh, one-to-one in person. That, that's definitely, um, the best method. But if for any reason I can't, like, like you're saying, if, if, if I'm away, uh, and I don't know anyone in where I am, maybe a video call will be good also, um, be, because then, uh, just like showing what I'm doing and, uh, well, maybe they, they can't help me guide me better in that way. Uh, just explaining how

		I'm feeling, where I'm feeling the, the pain and, um, yeah. I, I think that that, that that can work." (P1) "I think personally going to consultant or physio is generally I would probably wouldn't do it unless I was really, really struggling with something. Normally I would probably just do stretches and I think general things. So I think if there's something really bad, I think it's worth going in physio. But overall with most small issues like aches and pains and so think having resources to help for that or make it easier would be very helpful." (P4) "I think when you go in a personal interaction that's I think said with the last resorts, you know start just looking up information and if things don't work eventually you'll work your way up to

		ask a professional. So I think if you're at that point to think having personal interactions very helpful. But the most general things I think it's not necessary and I think said the very start a lot of information that they might just tell you the same stuff that you find online." (P9) My concern is it (DHIs) lacks that physical touch..... Sometimes, just the Alexander teacher can place a hand on your shoulder can make all the difference in how you feel" (P10)
Larger code	Codes	Data

Points of access	Websites	Probably I feel like a website could be more intuitive. It's a really big thing on the app like to make. But I mean, if it was a really good that I give up. If not, I probably trust the website more, although only so far as you can. Just websites, it might give you more. (P8)

	Apps	An app is more personal (P4) “Yeah. I, I think, I think I would definitely, I think having a mobile app would be much more, I guess like you said, personal to you. And I think it would be much more accessible. You just open up your phone and you have it there. Um, but also the website would, you know, it's, it's everybody's go-to like how to do this, how to manage this. Do you know what I mean? Yeah. But I think definitely like a mobile app would be the one that I would go to. Just like a reminder where you can like, maybe like log what, you know, what you've gone through during the session that you've kind of learnt it so you can like, log it in there and then just bring it back up, if that makes sense.” (P4)

		“Yeah, cuz there's like, when it's just scattered on the internet, there's, there's so much, so yeah, if you had it like bookmarked in your app, what you could do” (P5) “No, no app can have all of that information on it. It would be impossible.....I think. Well, yeah, I think so. I think that app the app would have to also be quite well designed. because as soon as I get on to an app for a website and the something's off by the coding or the spelling, or just the visual design that would definitely be a big part it's still fake” (P8)

Simple, Targeted information	Type of medium: videos (between 15-30 sec), gifs, real person Animated videos/pictures Type of information affects the length of the video: stretches should be short and to the point Conciseness is important in delivering information.	- "Video demonstrations of exercises/anything that just shows the motion/prefer seeing it done by an actual person/ pictures/gifs could be used to show stretches/ if there is any exercises involving movements, then I will say video is going to be clearer" (p6) "I would say there are books about managing posture and reducing how the body works in general. That's information takes too long to digest if you were reading a book and maybe if there is a summary of it that someone has done and literally just points out what I have to do instead of explaining the reason behind it, then it'll be great." (P3)

		"I think both ideally (animated pictures and videos). But if I could only have one. I definitely put pictures." (P8)
		I guess. Yeah, maybe like it's, it's nice to have sort of a recommended idea of how often you should be doing things. So maybe like a guideline of of say from like when it's really bad to, you know, it's, it's guess it's just hard to have a metric of that, you know, like what point you are at and how much you need to do it. (P8)

		I think having something like a catalog maybe of, of, you know, like for example, if I have a flare up in my back and it's like you're saying it's really bad have kind of like something for that stage and then you can continue having something that is for managing, I guess like the whole thing. But little tiny, you know, exercises or something to help you on your journey, I think would be, would be really, really helpful. And I mean, I guess you could do something like on the duo lingo app, you have like placement tests almost. Like where are you? Are you intermediate? So maybe like questions or something that could help place you (P9)

Wellbeing features	Importance of psychological / mental support Positive affirmations Recovery stories Mood tracker	you know, what is the, the, the thing that's probably like what you were talking about at the start with the technology that's like really key. Yeah. and also something that's been really crazy in my head recently has been this whole like the, the mental side of it. Cuz with the voice, the voice thing, it's been like, it actually can be partially psychological. (P4) Like the pain can be psychological and, and I guess like, like I do lots of like, sort of meditations and things to try and help re re so like I know you are with physiology, but at the minute I'm, it's, it's really becoming so prevalent how like psychological things/spiritual things are are actually like linking to me. So I feel that, yeah. So I don't know if that's just something that you can almost have an essence to. (P5)

		That could be, that could be in those lines. And, and just like, honestly, it might be silly, but just maybe general notes of belief, like belief you will get better and things like that. It can be silly. You, you just might read something like a powerful message or, or like maybe an anecdote of something from someone that, that you like story, like when I hear a story about someone that can change my perspective like so quickly. Cause I just believe it. So like, inspirational quotes for example. (P6) Yeah, yeah, yeah. Maybe. I know, I dunno, I know it's like in there, but just something like if there's a particular injury. You

		are, someone's looking at these exercises for this injury and then they, there's an option just to hear about someone that recovered from it. Maybe it's someone notable, famous or or even just like someone like us or something. I don't know how you'd Yeah. But that could be really impactful, surprisingly. (P5) Yeah, I, I was gonna add like, the psychological thing of that definitely I, I've had something recently where I, something happened at a gig that I was playing at, and ever since then, sometimes I'll just choke up on stage. But I, it does, it does feel mental and a lot of it does feel spiritual and I think, you know, I've, I've got this app actually that gives me an affirmation every, every hour and it comes up on my phone. So I think something like that. And maybe building a

		community on these apps as well, you know, you do have, you know, like you have, I guess, you know, I'm into, you know, astrology and all of that. You have these apps where you have people in the community that can make. So maybe you have like different things. For example, you know, if you struggle with your wrist pain, you can have other people that can like add that to their, I guess, profile or something. So you have this community of people who are maybe posting updates. But yeah, something that can track your mood and track how you're feeling and maybe, yeah, little affirmations and little stories and I think that would definitely be a big help cuz it just gets in your mind, you know, it's in, you're in the habit of, of receiving this kind of positivity and this, this drive to keep going. (P5)

		I almost feel like it would be really accurate to sort of encourage the person to do like 10 minutes meditation and then do it like almost reset yourself, calm yourself or whatever and then, and then be like, what's going on with your body? (P4) But I think also the thing that that...said about being able to, you know, there, there's a prompt for you to take care of yourself, for example, with meditation or, or with mindfulness or something like that. Because I do think, you know, there is a big mental side to suffering with, with, with pains and aches, especially when it hinders your life. So yeah, maybe like a prompt or something before you go and do all of this to just, or anytime really in the app to just kind of ground yourself and be calm. (P4)

Appendix 17: Focus Group Reflexive Diary

After discussing the initial findings and transcript of the first focus group with my supervisors, we decided to modify the topic guide to align better with the research aims. To track and reflect on my approach, I started using a research diary. It helped me identify areas for improvement and summarise relevant points for my research objectives.

I wrote new entries after each focus group, noting the date, participant information, reflections, practical comments, and comments from supervision meetings. I also created a table in the diary to summarise the focus group findings. The table covered categories such as target audience, support areas, delivery methods, interaction styles, time requirements, HCP interaction, DHI access methods, and barriers and facilitators of DHI usage. This table served as a basis my field notes for data collection and also helped to summarise and discuss the focus group findings during my supervision meetings.

Below are examples from the research diary illustrating how it was used.

08/03/2023 Reflecting on my first supervision meeting

I had my meeting with Liba and Valerie today to discuss the findings of my first focus group with musicians which took place on 02/03/2023. We went through the plan I had prepared for the focus group, and I explained that although I tried several times to explore health technology to align with the aims of the focus group, participants kept going back to their experiences about how they managed their PRMDs. I felt that instead of discussing the potential of DHIs in helping them better manage their injuries, the results of the focus group were all about the barriers of using DHIs, which really does not address my objectives.

Throughout the focus group, I also felt that participants did not consider my position relevant to them because I do not play a musical instrument. I think they were looking for relatedness. This made me reflect on the power dynamics at play and how my role as a non-musician might have influenced their perceptions or responses. I discussed this with Liba and Valerie, and they mentioned that this is an expected finding, and it is also common with sports athletes, but it does not mean I am not qualified to discuss their issues. It is also not practical or realistic for them to consider that only professionals with a background in music can address their health issues.

Liba suggested that I change my approach to the focus group topic by using case studies so that it is more relevant to them. For example, I could ask, "If you were a musician experiencing pain in the middle of practice, how would you want to access information in a fast and efficient way?" She also mentioned that it is important for me to provide a summary of the survey results, highlighting the finding that the majority of participants indicated they could use DHIs to help them better manage their PRMDs. Additionally, I need to explain how DHIs have evolved over time so that they get an understanding of how it could help them, rather than feeling that I am imposing my ideas on them.

We then agreed that I would reflect on these comments and restructure the focus group topic guide and show it to them before doing the second focus group, which is supposed to be in a week's time, on 17/03.

I feel overwhelmed after this long meeting, which lasted around 1 and a half hours. I was writing so fast to make sure that I understood everything, and I also plan to send them an email summarising the points we discussed in the meeting. I think overall, their input and guidance are very useful, but I am also concerned that I am not doing it right. There are also many things I need to consider and rewrite before the next group, which is supposed to be next week. I considered rescheduling the focus group, but I do not think that would be a smart idea considering how difficult it is to get participants to talk about this.

In the next focus group, I think it is important for me to have a handle on how the conversation is going and explore their views, but also make sure that it is not straying too far away from the topic and actually addressing my research objectives. I also need to consider how I could use the focus group to come up with case studies that would be relevant to the participants and include questions about DHIs.

17/03/2023 Reflecting on my second supervision meeting

I had a meeting with Valerie to show her the changes I made to the focus group topic guide based on our previous meeting. Unfortunately, she was only available on Thursday morning at 11 am, which was also the day I planned to conduct my second focus group. Fortunately, the focus group was scheduled for later in the afternoon at 3 pm, so I had time to reflect on any changes needed.

To start the focus group, I divided the topic guide into several parts, first thanking the participants for taking part in the survey and highlighting the key findings and what DHIs are and how they can help. I prepared 5 A4 pages explaining how DHIs could be useful, which I planned to discuss during the meeting. When I met with Valerie, she suggested that I should try to get to the point quickly and not drag on, as this could cause participants to lose interest. I also showed her the PowerPoint presentation I plan to use. I included pictures from the internet and possible reward systems like progress bars and statistics.

17/03/2023 Reflecting on my second focus group

I was very nervous before the focus group. I felt a little out of my depth but relaxed a little once I got through the first few questions. It lasted 1 hour but seemed much shorter. One thing that didn't go as planned was that I was expecting four participants, but only three turned up. I had to email the participant after the focus group had started to remind them about it. Fortunately, one of them replied and joined straight away, but it was stressful not knowing what to do if participants didn't turn up.

Overall, I think the focus group went well. I don't think I was bias or leading the participants which is quite reassuring for me. I also made sure at the beginning that it is important for them to share their opinions freely and to not feel that they have to conform to the idea that DHIs are the only way or that they have to agree with what I am saying. I also made sure to mention that 25% of the survey respondents indicated that they did not consider that DHIs would help them better manage their PRMDs. However, the participants, who were all freelance musicians, were receptive to the idea of DHIs. They talked about their previous experiences, which I think is important to consider because it shapes their views on things like the kind of treatment they want and whether they want involvement from healthcare professionals. This is not part of my research objectives for the focus group, and I discussed this with my supervisors and they concerned that this might drag on and I end up going on details that are not entirely relevant to my study but considering how often this theme comes up, I think it would be interesting to include it in my project. It could provide explanations why they think certain things are barriers to DHIs or not, etc. I think I want to explore this again in more detail in my next meeting. They also wanted to know if the app would actually be developed, which reassured me that the project mattered to them and would be useful. One thing that I really liked in this focus group is that the participants got along and started exchanging details during the focus group. I had to interfere to ensure their anonymity is maintained. I think being of a similar age, similar music interests helped the conversation flow easier, compared to the first focus group where one participant was retired and the other one was in his thirties.

After listening to the audio record and filling in the table, I think while the participants had quite different stance on whether they wanted DHIs or not, both mentioned that they would appreciate peer support from musicians who had had similar injuries. This is not something that I had intended to explore as I was not sure how that could be integrated into DHIs, but one participant suggested having like an online forum of musicians to talk to each other about their injuries and how they decided to manage it. I think that would be interesting approach and could be away to break the culture of silence about musicians' injuries. I think this is something that I need to explore further in my next focus group.

25/03/2023 Reflecting on coding

I'm not really sure what I'm doing with my coding. My code ends up looking like sentences instead of actual code. I'm coding very slowly because I keep checking and rechecking my code to make sure I'm accurately capturing what the participants are saying. There's a lot of different information to consider, like the kind of information they want, the features, and how the DHI would actually work. One thing that stands out is that speed and accessibility are important, probably because the participants don't have much time. This group seems open to DHIs, maybe because they use YouTube to find exercises and NHS apps to quit smoking or control alcohol intake. Something interesting I noticed is how much participants understand about the impact of psychological well-being on their pain and the connection between their mind and body. I had thought about this before, but I wasn't sure how receptive they would be to that idea. I want to explore it more next time.

30/03/2023 Reflecting on coding using Nvivo

I have been reading through Braun and Clarke's book to ensure that I am doing it right. The book is simple and easy to read, and I am just trying to follow the steps mentioned. I also did a training on Nvivo which I think was interesting, but I am not sure how some of the features would help me in my analysis. Things like word counts seem too quantitative for me, and all the information about demographics would also not help that much. I think I agree with Braun and Clarke's approach in using a pen and paper for coding. That seems more engaging and real to me.

I followed the steps mentioned in the book using a table with the data and the codes on the side. I am not coding using sentences now, more like phrases. I think I am slowly getting it, but the data is a lot and things keep coming up. I am also unsure how all that would link to one story. I am also concerned about the contradictions between the participants, they all seem to want different things. I want to discuss this with Liba and Val in my next meeting.

25/04/2023 Reflecting on my third focus group

I had my third focus group. They were three music students from Cardiff University. I do not think there were any issues related to credibility of myself (i.e. whether I was a musician) or not. They were excited about the idea, but I also noticed that it did not seem that they had any major injuries before, and I think that affects their responses. They are more concerned with the practicality of the app and less about the content, which is okay, I think. But I think that uptake of people on this idea is affected by several things, not only their age but also the extent of their injuries. If they are not severe enough, then they are open to trying things on their own. I mean, comparing this with the first focus group where someone had to do a surgery and the concept of 'being too dangerous' to try things on their own, etc.

Participants preferred a website as they were concerned the app couldn't hold enough information. For them, this loses its purpose. I think this made me reflect on the design I thought would better suit musicians for example, an app would be more practical/personal to their lifestyle. I think I need to consider their feedback and also reflect on my position/beliefs when I am analysing the data. Another interesting point

was the kind of language that is used. The idea of using language like 'Get up/Move!' is a turn-off for participants. This makes them feel guilty, so it's important to consider in the design. Also, I tried exploring lifestyle factors and psychological well-being. Participants were okay with the idea, but they were concerned that too much information like that would make the app less specific to musicians and, therefore, off-topic. Maybe that's because they are still students and have more time, possibly less stressed about job prospects or their lifestyle has more of a rigid structure (e.g. going to university, rehearsals, studying, exams).

30/05/2023: Reflecting on coding

I managed to group the data into two main themes: one focusing on the content of DHIs and the other on optimisation. It's a good start, but I know I still have more work to do. In the meeting, we talked about the importance of not being biased when interpreting the findings. I need to make sure to mention that some people didn't want DHIs and explore their reasons for that. I think I need to approach the analysis with an open mind and to critically examine my own biases to ensure a balanced interpretation of the findings.

20/06/2023: Reflecting on writing

On re-reading the transcripts and codes I keep thinking that I need to explore the characteristics of participants as facilitators and barriers to using DHIs, but I do not think I had enough sample size to be talking about participants' characteristics in enough depth. I am also considering how to use the information from the focus group to generate the topic guide for the interviews with HCPs. It's a lot to consider, but it helps me stay focused on thinking about the data and how it can be useful, not just reporting it as is.

28/06/2023 Reflecting on writing

I am not entirely sure about the themes I have developed; I think some of the information could be combined to ensure there is enough depth in the analysis. Currently what I have is those three main themes: Navigating challenges in managing musicians' PRMDs, 2) Designing Effective SMIs for Musicians and 3) Exploring technology assisted SMIs for PRMDs.

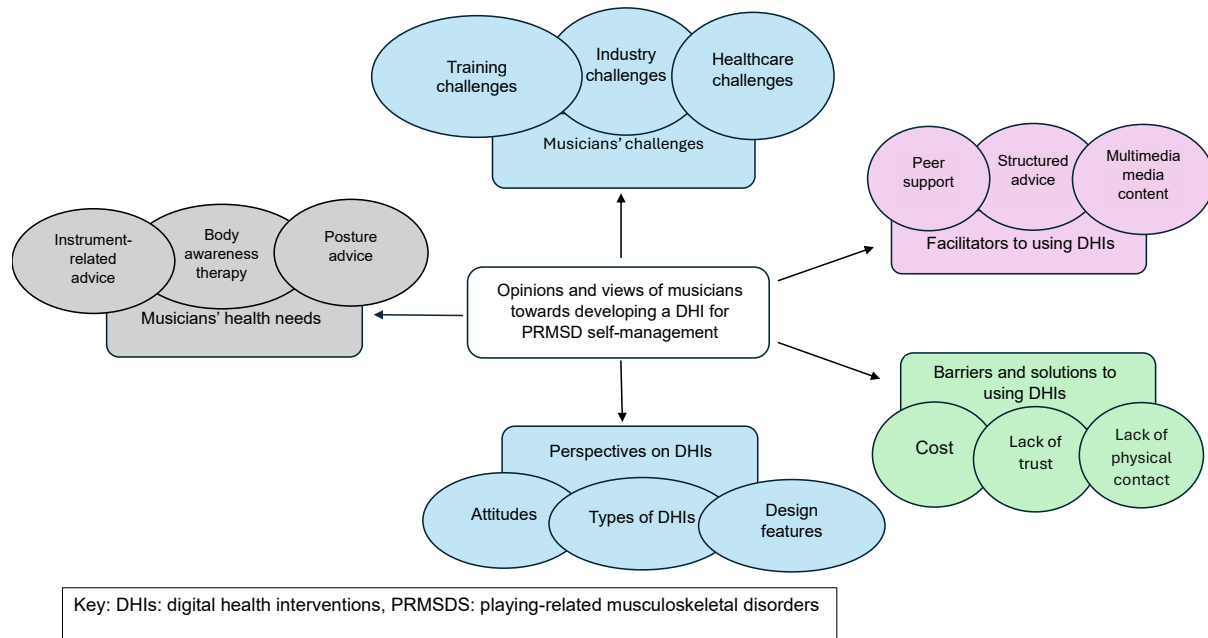
The first theme looks at participants' attitudes towards SM and the challenges in finding specialised care. I think this could be a part of the larger theme focused on "Exploring the integration of HT in MSD SM". This might help us dive deeper into the possibilities of using alternative treatments and ensure a balanced view, considering some participants still prefer having regular contact with healthcare professionals. As a thought, the subtheme could be called: "Attitudes' regarding the integration of health technology in MSD SM" and would be part of the larger theme: "Exploring the integration of HT in MSD SM".

I also introduced a subtheme called the "Hybrid Model," which discusses a gradual approach. Initially, individuals try self-management techniques and turn to professional help if they face severe injuries. I do not think a separate theme is needed to discuss this; this can all go under the above-mentioned subtheme.

So in summary, “Attitudes regarding the integration of health technology in MSD SM” will explore whether participants are accepting of technology or not, how their previous experiences might have influenced their decisions and if they are accepting technology, then what is the model they want and their points of access to technology.

Theme	Brief description
Navigating Challenges in Managing Musicians' MSDs	This theme explores musicians' previous experiences and challenges in accessing specialised care and their attitudes towards SM.
Designing Effective SMIs for Musicians	This theme explores the types of SM advice and interventions that musicians seek to enhance their ability to manage their MSDs.
Exploring the integration of DHIs in MSD SM	This theme explores how DHIs could be used to facilitate MSD SM, the facilitators, barriers, and model of integration.

Appendix 18: Initial Diagram of Themes and Subthemes (Focus Group Study)



Appendix 19: Interview recruitment poster



The poster features a dark blue background. On the left, a stylized guitar is formed by a vertical staff with musical notes and a cluster of colorful notes at the base. The Cardiff University logo is in the top left corner. The title 'Are you a Performing Arts Specialist?' is in yellow, flanked by horizontal lines. Below it, white text invites participation in research. A QR code is positioned below the text, with a label 'Scan the barcode for more information'. At the bottom, contact details for Noudy Eleryan are provided.

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

Are you a Performing Arts Specialist?

Participate in our research to help develop high-quality interventions for musicians.

Scan the barcode for more information



Contact information:
Noudy Eleryan (PhD candidate)
Email: eleryann@cardiff.ac.uk
Contact number: +44 07547 907786

Appendix 20: Participant Information Sheet

PARTICIPANT INFORMATION SHEET

Title of research project: Development of a digital self-management intervention for the prevention and self-management of playing-related musculoskeletal disorders in musicians

Name of researcher: Noudy Eleryan

You are being invited to take part in an interview study. Before you decide whether or not to take part, it is important for you to understand why the research is being undertaken and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish.

Thank you for reading this.

1. What is the purpose of this research project?

It is estimated that 86-89% of musicians experience musculoskeletal disorders each year that interfere with their ability to play their instruments and participate in music performances. Current recommendations for treatment include taking breaks, exercise programmes and ergonomic equipment but these have not been successful in alleviating the severity or incidence of musculoskeletal disorders. There is evidence suggesting that educating people about how to independently manage symptoms can help reduce the risk and severity of musculoskeletal disorders; however, there is a lack of evidence-based well developed self-management intervention (SMI) for musicians. The aim of the study is to explore healthcare professionals' insights on the management and prevention of musculoskeletal disorders in musicians. This information will be used to develop a SMI for musicians using health technology.

2. Why have I been invited to take part?

You have been invited because you are a healthcare professional (doctor, nurse, occupational therapist, physiotherapist, ergonomist, health coach/teacher) who has an experience in treating musicians' musculoskeletal disorders.

3. Do I have to take part?

No, your participation in this research project is entirely voluntary and it is up to you to decide whether or not to take part. If you decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. If you decide not to take part, you are free to withdraw your consent to participate in the research project at any time, without giving a reason, even after signing the consent form. In addition, you can ask for your data to be removed at any time, even after participating in the interview. A decision to withdraw at any time, or a decision not to take part, will not affect the standard of care you receive.

4. What will taking part involve?

First, the researcher will contact you by phone or email to explain the research and answer any questions you might have. If you are still interested in participating in the study, you will be asked to sign and send an electronic consent form via email. Once you consent to participate in the study, you will receive a Zoom invite email and an email reminder one day before the interview.

The interview will be held online via Zoom using audio and possibly video technology if you are happy to do so. The interview will last approximately 30-45 minutes. The researcher will present topic guides for the discussion and you will be expected to share your opinion.

With your permission, the conversation will be audiotaped to accurately record the discussion. The audio-recording will be transcribed anonymously and then destroyed. To verify the accuracy of the information, you will be asked to check a copy of the transcript.

5. Will I be paid for taking part?

No, there will be no payments for participating in this study.

6. What are the possible benefits of taking part?

There will be no direct benefits for any participant who will take part in this study. However, your participation in this study and the outcomes of it will contribute to research directed programme for developing a SMI for musicians.

7. What are the possible risks of taking part?

Participating in the research is not anticipated to cause you any disadvantages or discomfort. There are limited expected risks involved with this research. However, you may withdraw from the study at any time and this will not affect your legal or medical right.

8. Will my taking part in this research project be kept confidential?

All information collected from or about you during the research project will be kept confidential and any personal information you provide will be managed in accordance with data protection legislation.

To minimise the risk of confidentiality, only the workshop will be recorded and Zoom settings will be adjusted so that only authorised participants can join. Personal identifiable data such as name or contact details will not be part of the audio recording. You will be reminded before starting the interview that you should not disclose any information that could identify you during data collection e.g., full name, address or contact details. If you accidentally do that, the information will not be included in the transcription.

The information collected will be transcribed anonymously. The results will be published in academic journals and will be included in the researcher's PhD dissertation, in both cases your anonymity will be ensured. It may be necessary to use your words in the presentation of the findings and your permission for this is included in the consent form.

9. What will happen to my Personal Data?

All data collected will be de-identified and coded so that you cannot be identified from the consent forms. The electronic data will be saved in a password protected folders in a locked computer with a passcode only known by the researcher. Cardiff University is the Data Controller and is committed to respecting and protecting your personal data in accordance with your expectations and Data Protection legislation. Further information about Data Protection, including:

- your rights
- the legal basis under which Cardiff University processes your personal data for research
- Cardiff University's Data Protection Policy
- how to contact the Cardiff University Data Protection Officer
- how to contact the Information Commissioner's Office

can be found at <https://www.cardiff.ac.uk/public-information/policies-andprocedures/data-protection>

After completion of the PhD, the research team will anonymise all the personal data it has collected from, or about, you in connection with this research project, except for your consent form. Your consent form will be retained for 15 years and may be accessed by members of the research team and, where necessary, by members of the University's governance and audit teams or by regulatory authorities. Anonymised information will be kept for a minimum of 15 years but may be published in support of the research project and/or retained indefinitely, where it is likely to have continuing value for research purposes.

If you want to withdraw from the project after completion of the PhD, it is not possible to withdraw your personal data after being anonymised already or published.

10. What happens to the data at the end of the research project?

The personal identifiable data will be destroyed on completion of the PhD project. The research data will be retained for a minimum period of 15 years after the end of the project or after publication of any findings based upon the data as mentioned in Section 2.9 ('Research Project Conduct') of the University's Research Records Retention Schedule.

11. What will happen to the results of the research project?

It is our intention to publish the results of this research project in academic journals and present findings at conferences. Participants will not be identified in any report, publication, or presentation.

12. What if there is a problem?

If you wish to complain or have grounds for concerns about any aspect of the manner in which you have been approached, please contact Noudy Eleryan on email: eleryann@cardiff.ac.uk or +44 (0) 7525047241. If your complaint is not managed to your satisfaction, please contact the Chair of the School Research Ethics Committee Dr Kate Button on email: ButtonK@cardiff.ac.uk or +44 (0)29 206 87734.

If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, you may have grounds for legal action, but you may have to pay for it.

13. Who is organising and funding this research project?

The research is organised by Cardiff University and the PhD student: Noudy Eleryan under the supervision of Dr Liba Sheeran, Dr Rebecca Hemming and Professor Valerie Sparkes at the School of Healthcare Science in Cardiff University.

14. Who has reviewed this research project?

This research project has been reviewed and given a favourable opinion by the Health Care School Research Ethics Committee, Cardiff University.

15. Further information and contact details

Should you have any questions relating to this research project, you may contact us during normal working hours:

Contact details:

Name: Noudy Eleryan

Address: Eastgate house, School of Healthcare Sciences, Cardiff university

Email eleryann@cardiff.ac.uk

Thank you for considering taking part in this research project. If you decide to participate, you will be given a copy of the Participant Information Sheet and a signed consent form to keep for your records.

Appendix 21: Email Invitation for Interviews Study

Dear [Participant's Name],

Thank you for your interest in the study.

I have attached the participant information sheet and consent form. Please take the time to read both documents carefully, and if you have any questions or need further clarification, don't hesitate to reach out to me.

As for the interview, it will be conducted in a semi-structured format. This means that the questions may vary based on the flow of our conversation, but the aim is to try to explore the following topics:

- Prevention and management of musicians' injuries
- Tailoring treatments to musicians' specific needs
- Advice on load management and rest for musicians
- Role of general wellbeing in managing musicians' injuries

Please let me know your availability over the next couple of weeks so we can schedule the interview.

Thanks again.

Kind regards,

Noudy

Appendix 22: Consent form

CONSENT FORM

Participant Identification number for this study:

Title of research project: Development of a digital self-management intervention for management of PRMDs in musicians

Name of researcher: Noudy Eleryan

Please Initial box

11-I confirm that I have read the information sheet dated for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

12-I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my legal rights being affected. ☐

13-I understand that all data recorded including audio record will be stored securely for a maximum of 15 years following the publication of the research. ☐

14-I agree to be audio recorded during the study.

15-I understand that these audio recordings will be used anonymously and that no individual respondent will be identified in such report. ☐

16-I understand that the findings and potentially secondary analysis of the findings and associated data from the study may be presented at conference and in scientific journals. I understand that these will be used anonymously and that no individual respondent will be identified in such report. ☐

17-I give consent for the use of verbatim anonymised quotes in publications and conference presentations. ☐

18-I agree to take part in the above study ☐

Name of Participant

Date

Signature

Name of Person taking
consent

Date

Signature

THANK YOU FOR PARTICIPATING IN OUR RESEARCH
YOU WILL BE GIVEN A COPY OF THIS CONSENT FORM TO KEEP

Appendix 23: Interview PowerPoint



School of
Healthcare Sciences
Ysgol y Gwyddorau
Gofal Iechyd

Phase 1:
Evidence review

Phase 2:
Consultations with
musicians

Phase 3:
Consultations with
HCPs

- Epidemiology and risk factors of PRMDs
- Current interventions: passive and active treatment, government's policies and organisations' support

- Survey study
- Focus group discussion

- Interviews
- Mapping process

[Graphical representation](#) of the UK Medical Research Council on developing complex interventions (Skivington et al., 2021).



School of
Healthcare Sciences
Ysgol y Gwyddorau
Gofal Iechyd

Aims of the survey

- 1) To determine the relevant contributing factors to musicians' MSDs.
- 2) To explore the management methods used by musicians, their perceived efficacy and preferences for better management.



BRITISH ASSOCIATION FOR
PERFORMING
ARTS MEDICINE



School of Music
Ysgol Cerdoriaeth



ROYAL WELSH COLLEGE
OF MUSIC & DRAMA
COLEG BRENNHINOL
CERDD A DRAMA CYMRU



Musicians'
Union



Royal
Academy
of Music



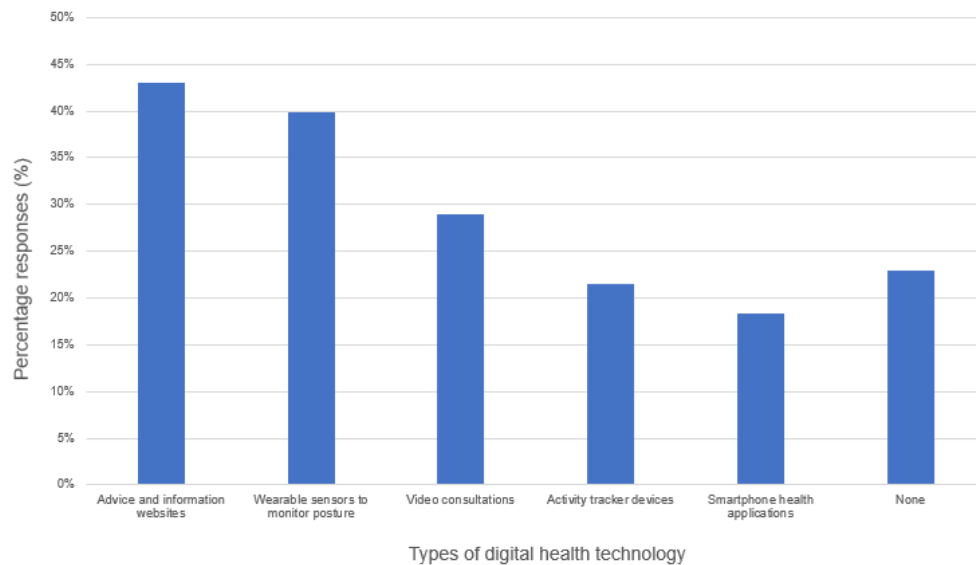
Key messages

1. 100 responses
2. Active strategies such as exercise and pacing playing were considered more effective

What kind of information would help you better manage your playing-related pains, aches and injuries?

1. Pain management and recovery information
2. Early prevention
3. More accessible information

Technology

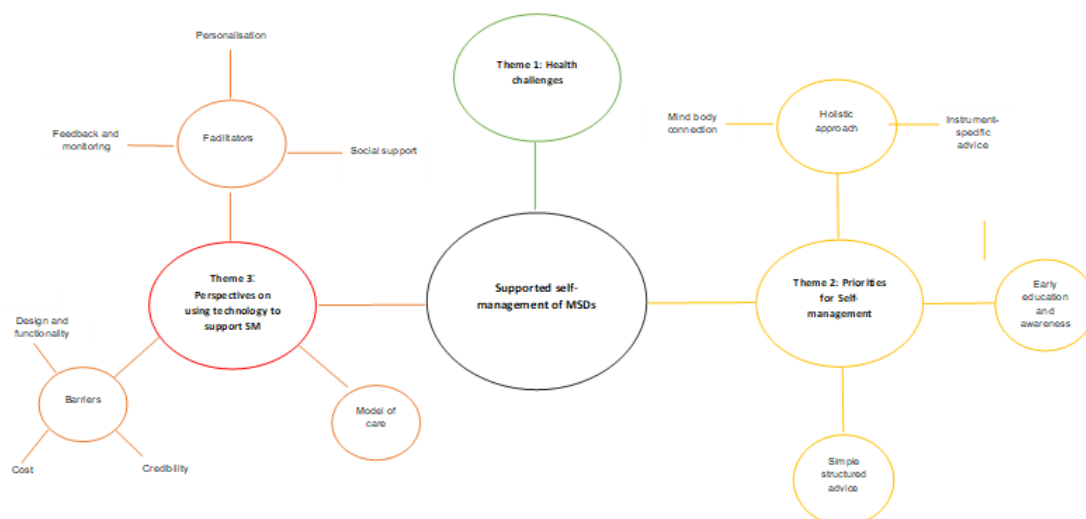


Digital health technologies



Focus groups

- 4 focus group discussions with 10 musicians:
(students, orchestra musicians, freelancers and retired musician)
- Main topic:
 - 1) Pain management
 - 2) Early prevention
 - 3) Personalisation



Aim of the interviews

1) Management of musicians' MSDs:

1. Advice for musicians dealing with pain and injuries.
2. The factors you consider important when tailoring treatment to musicians.
3. Guidance on load and rest for musicians.
4. The role of general wellbeing in managing musicians' pain and injuries.

1) Potential use of technology in supporting management of musicians' MSDs

Ground rules

- There are no right or wrong answers but rather differing points of view.
- Please share your point of view even if it differs from what is being said.
- We're recording what is said because we don't want to miss any comments.
- We will be on a first name basis today, and in our later reports no names will be attached to comments.
- Please be assured of complete confidentiality.

Appendix 24 Interviews Reflexive diary

10/07/23 Reflecting on writing and developing the topic guide for the interviews

I have been trying to use the data that of the focus group to develop the topic guide for the consultations with musicians. The themes that I came up with is commonalities in MSDs, instrument-specific advice, managing pain and tension, hybrid treatment models, and potential barriers and facilitators of using digital health interventions. I am just concerned about how to integrate the questions about DHIs in the conversations because if it's at the beginning of the conversation, I am concerned that it will take away from the time and we might delve into the topic of it won't work etc. I also do not think that I want to get into this conversation with participants. So what I am considering is that I explore the topics above and then at the end I explore the idea of DHIs and how that could be integrated into their scope of practice. I have put together a draft of the topic guide and sent will discuss it in my next meeting with Liba and Val.

17/07/2023 Reflection on my supervision meeting with Liba and Val

Long meeting. They did not quite like the idea of exploring the use of DHIs at the end because that would not really answer the questions, they might not like the idea but it is not the place to argue over it. The questions were also too much and too specific so that is something I need to work on make sure that it is concise enough with prompts used when needed. I need to try and make these changes and send it to them in a couple of days because Liba is going on holidays. They also comments that I need to give a bit of context to the question from the survey and focus groups so that they understand what I am referring to.

Another point that we talked to them is that I have been to several of BAPAM talks and they advice on a lot of information on posture, which is an element in MSDs management but not the whole story. I am just concerned that it will come up again when I speak with the HCPs and I do not want that to drag onto too much in the conversation. Liba and Val said that since musicians mentioned it in the survey it should be discussed, I just need to ensure that it is explored with other things.

I guess I need to be careful with my own biases when I am developing the topic guide so I will take their comments into considerations.

24/ 07/2023 Reflection on the interview topic guide

Finally after two more drafts, I managed to get the interview topic guide right. I started contacting the HCPs for the interview, recruitment is going better than expected, and almost everybody that I have contacted was interested in the study. I scheduled my first interview for the 10/08/2023. That will give my enough time to get more writing for the focus group so that I have a better understanding of what the musicians want and how to explore it with the HCPs. I also think that I will try to following the structure in the focus group so I will use a power point to explain what the project is what they survey was about, the result and the focus group. That will hopefully give a better flow to the conversation.

10/08/2023: Reflection on the pilot interview

Today I conducted my first pilot interview. The participant was an MSc Performing Arts graduate and has experience with acrobats, dancers and musicians. The interview was quite enjoyable and informative. I started off a bit nervous, as the participant was a bit late, and I worried about potential technical issues with the Zoom link. However, everything went smoothly once we started. I think I did a good job of introducing the context and purpose of the interview, and reassuring the participant that there were no right or wrong answers and that I wasn't there to evaluate her knowledge. I noticed that she was more relaxed and engaged as the interview progressed.

I was surprised by how receptive she was to my ideas about the use of technology. She seemed to be familiar and comfortable with using various apps and features for her own health and well-being, and for her clients. She said, "Oh, I already have an app for that" several times during the interview. This made me curious about how user characteristics, such as age, might influence the acceptance and adoption of digital health interventions. However, I'm not sure if this is relevant to my research question or objectives, or if I'm overemphasising it. But I think it is important to consider this when asking about demographics (i.e., Do you use technology for treating musicians/patients?).

I also learned some things that I need to improve or clarify for the next interview. For example, I realised that I don't have a clear answer to the question of cost, which she asked me at one point. How much would the intervention cost for the users, and who would pay for it? This is something I need to discuss with my supervisors. Another thing I noticed is that the question about exercise "What type of exercises do you find beneficial for musicians to prevent and manage their MSDs?" might not be appropriate or aligned with my aims or objectives. It seemed to be too broad and vague, and not focused on the theme of tailoring treatment. I think it should say whether there are different exercises for prevention and management of musicians' MSDs. This aligns better with the topic of tailoring exercises.

The pilot interview was a valuable experience for me. It helped me test my topic guide, gain some initial insights into the participant's views, and identify some areas for improvement and further exploration. It also boosted my confidence and interest in conducting more interviews. I look forward to the next one.

14/08/23 Reflection on my supervision meeting

Today I had a supervision meeting with Liba and Val to discuss my pilot interview

The meeting was quite long and intensive. Liba and Val gave me some formative critique on my topic guide and analysis. They pointed out that some of the questions were not well aligned with the themes I wanted to explore, such as the question about exercise "What type of exercises do you find beneficial for musicians to prevent and manage their MSDs?". They suggested that I should rephrase it to "Would different exercises be needed to prevent and manage MSDs?" to fit in with the theme of tailoring treatment. They also commented that I should delve deeper into the participants' responses and not take them at face value. For example, I missed some opportunities to probe why a reminder app would help participants in pacing their activity, or how watching musicians play their instrument would help in tailoring the treatment to musicians.

I found the feedback useful but also challenging. I realised that I need to improve my interviewing and analytic skills and be more critical and reflective of my own assumptions and interpretations. I also felt a bit overwhelmed by the amount of work I still need to do, and worried about the quality of my data. However, I also enjoyed hearing different perspectives and insights from Liba and Val and appreciated their support and guidance.

I will revise my topic guide based on their suggestions and try to use probing questions in the next interview. I will also consider discussing the solutions to the barriers that participants mentioned regarding the use of digital health interventions, such as cost, confidentiality, and functionality. Also, regarding cost, we do not really have enough information on this yet so if it comes up again, I will use this answer if I am asked again this time.

17/07/2023 Reflection on my second interview

After my second interview, I felt exhausted. The interviewee was an Alexander Technique specialist, and I had to listen closely to understand her perspective on how health technology could be used to implement the technique. Despite feeling tired, I think the interview went well. I was more confident this time and took notes to ensure that I didn't miss anything. At the beginning of the interview, the lady asked me about my knowledge of the Alexander Technique. I was glad that I had spent the previous night researching the technique and reading about her work so that my questions would be relevant. I told her that my understanding was basic and that I had never had a session before, but I admired the mind-body connection that we, as physiotherapists, don't always know how to implement.

Despite being older than the previous interviewee, the lady was receptive to the idea of SM and believed that people need to take responsibility for their health. She thought that using technology is the way forward for this generation. This made me realise that my assumption that only younger clinicians would want to use technology was wrong. She gave me examples of people she knew who had developed apps and mentioned that the institution she works at had recently bought a 1 billion-pound simulator. This gave me that I am not the only person trying to navigate the use of technology in this field.

One of the most surprising things was her answer to whether there were any barriers to using technology. Instead of mentioning common concerns such as cost and functionality, she was more worried about the lack of touch and how people might become more entrenched in their phones. There must be a way to maintain a connection with professionals while also encouraging people to get out and interact with the world around them. I really liked how she included the psychological aspect into the conversation, she really took it to the next level rather than just focusing on the physical pain. I was asked in my first interview about how this app could be different to any other app targeting musculoskeletal disorders in general people and from talking to the lady in this interview, I think that is what needs to be included to make it musicians specific. Building the connection between physical, emotional, and mental health especially when it comes to students at those elite institutions where the competition is fierce.

18/08/2023 Reflection on my second interview and familiarisation

It's been a very busy couple of days. I just did my third interview, which I believe is one of the best I have done so far. The participant was very articulate and proactively shared ideas on how technology could benefit musicians. She mentioned a couple of important points, such as the need to educate musicians about the impact of bad habits and ignoring pain. This was also mentioned in my second interview. Making this connection could help engage musicians in treatment, but I am not sure if using fear to promote adherence is ethical. I recall reading that this method has been used before, so I will need to explore this further in my supervision meeting. Overall, I am very pleased with the interviews. The results are becoming more tangible and the idea of a digital SMI is no longer abstract; it is slowly becoming a reality in my mind.

I spent the rest of the day familiarising myself with the two interviews I conducted. I listened to each recording three times along with the audio transcript. It's amusing how Zoom transcribes audio; most of the information doesn't make sense. I spent the day editing the transcripts using Braun and Clarke's book as a guide. I am cautious about adding punctuation because it can change the meaning, and I often get confused about when and where to use it. So, I think it's safer to leave it as is. This process is the least enjoyable and most tiring phase of the analysis, but I managed to complete two transcripts in about 10 hours.

Appendix 25: Example of Interview Data Analysis

Codes / subcodes	Data
Type and causes of injuries	“Generally the ones that I see often have a change in their activity of their training and then they lead to having pain as a result from that change in their training I'm just trying to see who I have seen recently so I've seen guitarists with a repetitive strain of forearm drummer repetitive strain of shoulder harpists repetitive strain so there's a chain is often related to change in how they play their instruments” (P1)
Repetitive Strain Injury	“There's a trend of when they suddenly practice a new repertoire when they start school, and they have a change in the training load and then as a result they get pain” (P11).
Neural tension issues	“Yeah, well I'd say RSI carpel tunnel you know musculoskeletal injuries generally I'd say you know kind of all sorts of injuries you know dystonia all sorts of from you know backache to you know immovability in terms of mobility issues sciatica it's just endless” (P12).
Tendinopathies	“The majority are overuse injuries, so tendonitis and muscle tension mainly in the upper limb, shoulders, wrists, hand. But the main trigger, possible a different section of your questions relates to a sudden increase in playing time. So, they've just set up a sort of cumulative pattern of overuse. Really, that's as that would say the main thing” (P4).
Instrument-specific injury patterns	

Psychosomatic pain cycles:	“Repetitive strain injury, a lot in the arms, hands, wrists, shoulders and sort of going into the back, with most musicians, whatever sort of instrument they play, but with variations on how that actually gets worked out in their bodies” (P6). “As you found out that the playing time of the musicians is actually the worst thing. That's the thing that causes the problems. And there are other things like coming back into term time without spending a couple of weeks getting the body back into musical mode. That's not great. You have a holiday and then day one you come back in for whatever reason, there's a six-hour orchestra rehearsal. That's purely bad time management of the school, not the problem of the student. But if the student knows that's going to happen, they probably do, then they should start working their body, warming it up, getting it ready for a couple of weeks before the first day of term. So that can bring on a specific injury possibly. But actually what I see is, I see overused injuries, overused condition, not even injuries, but overused conditions. They're overused in the whole of the shoulder musculature. They are just not fit enough to actually cope with the amount that they're asked to play. Actually, I don't think even if they were the fittest person in the world, they could possibly manage to play sometimes for 9, 10, 11, 12 hours a day..... I am looking at overuse, I am looking at fatigue, I am looking at muscles that are doing stuff that they are not fit enough for the amount of effort that they are being requested to do” (P6). “75% of them had what I call an instrument-related injuries, 25% of them that was very convenient, that it worked out that way, but it really was they had what I would call the same injuries that in the general population, but it was more complicated because they were musicians. So something like a broken wrist, or you know a fractured yeah thumb or de Quervain. Yeah, whatever. Or you know, they had something that is more commonly in in the general population and 75% of them were instrument related or instrument caused. And they generally fell into 3 categories which could overlap. So there's the overuse syndrome or cumulative trauma disorder...and there's the neural tension.. So, and there were lots of other bits and pieces, but of course all of them can occur with each other. So, there's a huge amount of overlap. So, you know, some of them were had a tendinopathy Obviously, lots of myofascial, you know, muscle issues, tension, posture, no proximal no proximal

	strength, no core stability at all, neural tension terrible. I mean the whole, the whole thing. And you have to just take it apart and rebuild it for them” (P7). Instrument-specific: Well, it depends, usually it's often with sort of violin. There's often a lower back issue and a shoulder and neck issue, with flute players. It's often, often a struggle for breath, actually, but that's accompanied with the, with their sort of rotation, and the shoulders, and so on, so they get can just get discomfort in the shoulders and the neck (P9). With, guitarists it's often, neck. I find, neck and shoulder. Pianists. It's often it's just feeling of fatigue. I think they're just all kind of too much effort. Yeah, don't often find that they they present with too much pain. Not the pianist I've worked with, anyway. And then sort of brass instruments. It's often just yeah. It's fatigue and pain and the shoulders and the arms. Yeah (P10) Psychosomatic problems: “I think 95% of the pain and discomfort that musicians have could be prevented, and many of them, many of them are actually living with discomfort. So it's not enough to stop them from playing, they just learn to live with it and then it becomes chronic. And then we've got we've got memory of pain, then we've got all sorts of problems because they expect the pain. They get the pain when they think about the instrument, they get the pain. Now, that is completely a psychosomatic problem, just a lot of problems. But it's real and that has to be treated here and here” (P6).

	Confidence and Self-esteem: “I'd say the major problem that I see is lack of confidence and anxiety and a really good understanding of how the human nervous system and muscular skeletal systems interact that I would say that's the major problem is you know lack of understanding about how we work and also lack of self-confidence and self-esteem and you know being under a huge amount of pressure in elite institutions and the music industry you know is tricky” (P2).
Musicians' unique challenges Financial precarity Lack of safety nets Cultural resistance to help-seeking Pressure to maintain full functionality	“Time and if they have a show and if the musician have like music it's one of the job but if you have another job as well that still required so let's say my drummer he's a drummer but he's also a carer so when he's doing the caring wise really hard to not use his shoulders but when he's playing the drums he's able to like take breaks every 10 minutes sorry every half an hour rather than like playing the drum for 3 hours straight so yeah so I think the barrier would be time activity behaviour change is really difficult we all know that so it's yes I think that would be the main barriers” (P1) “I'd say in other performing artists it's still more kind of full body load mainly lower limb or back but with musicians again back yes but it's mainly upper body I've seen and in performing artists otherwise I think sometimes when you alter different steps that they do different choreographies they can still get away with it but when the musician you can't cause you have to hold your instrument maybe a little ups and downs the way you change your posture where you hold your hand the way you twist your body for the angle but there's not there's not a lot that you can change because your instrument remains the same and you have to hold your instrument in a certain way you have to perform in a certain way so I think that's the challenge when it comes to musicians as compared to other performing artists” (P3) “I suppose there is a similarity with perhaps with people that use computers. An awful lot. Big tendonitis but I think there's more of an urgency for musicians to keep going, even when

Intense rehearsal schedules	they're hurting and and people that have had tendonitis when they've, like one person I'm thinking of. She was office based, but she was being paid for to have lessons by her company, and they were very good at giving her ways to help herself, whereas musicians and have often have to keep going, because otherwise they don't earn any money. So there's more pressure on them to keep working, even if they're hurting" (P5). "And it gets worse because sometimes in the colleges, you'll get six-hour orchestra rehearsals. And then the kids think, Oh, my God, I've got lesson tomorrow. I've got to do some private practice. And it's not about playing. It's playing time. Not orchestral time, practice time. It's playing time. Because some of them say to them, How often do you practice? I only do a couple of hours a day. But actually you find out that they've done a two-hour rehearsal. They've done a two hour mark the door, they've done a lesson. It's absolutely ridiculous...They don't think about working in the gym to get themselves strong. They don't think about those aerobics to get their heart, lungs, really fit. They don't think about eating at the right time of the day. They don't think about what they need nutritionally. They don't think about actually watering their body and keeping hydrated. They don't think about all the things that elite sports people do. And these are elite musicians, and they don't. Yeah" (P6). "It's all about activity analysis, and the demand on a musician whether it be physical health, mental health, lifestyle social relationships. The temptation of drugs, alcohol. Yeah, poor sleep, or yeah, all of the this is completely different in the musician population to anyone else" (P7). "When they've got their problem and beating the culture of put up and shut up which is really terrible in music. You can't admit to anybody, particularly in orchestral music. You can't admit to anybody. There's a problem. And therefore, these muscular skeletal disorders just go on too long, and they become a mental health problem when they don't need to.

	Because I really believe that actually, that's what we should do and the Conservatoires are deeply at fault (P7). Along with these music schools, the secondary schools I know the Purcell, etc. where sport is treated with derision, and you know laughter and felt to be not important. Fitness is not important and even seen as a risk and the concept of looking after themselves is not there, and a conservatoire that the emphasis so much is on practise more. The only way you'll get better is to practise more". (P7). "So, there's this, there's this sense of having to return to full functionality that that maybe doesn't apply to some other groups. I mean, everybody would like it but it's not career ending, if it doesn't happen. It's a bit like an athlete who says well, this is my job. I need to keep doing it. I need to recover full functionality, even if I have to take some time off to do that" (P11). "I think quite a lot of the research shows that if they're in technically, if they're a labourer, thank you very much. If they're a labourer they can't stop. They have to go to the show. They will go through pain; they will go through discomfort. So then that element of they're an unusual breed, like the professional sports people, because they haven't got much choice. If anything, they're probably more akin to labourers, cause they're self-employed, they have to do it, whereas a footballer is professional or a Rugby player, professional gets paid if they're if they're injured or not injured, and almost there's a there's, there's a safety net for them, whereas I don't know if there's any safety net for musicians very few, those that are employed may get it, but there are so many out there that if you cannot do your job for long enough, there's the demand and the and the amount of talent out there, they can be replaced quite easily" (P12).
Self-management advice	"Well, first of all, if it's really severe, the pain is intolerable. And I cannot stand the, is it 1-10? I can't bear that. I just can't bear that. Because actually, you know, we all feel pain

Understand the injury and pain level	differently and I can't do it. So I said to them, you have a headache, you know what it's like, do you do well with pain or do you not do well with pain? What is your pain like? And then they'll come out with a really good description of their pain. They say things like, It's heavy and annoying. That's a great way to describe the pain, it's heavy and annoying. Or it comes in burst, it's short and sharp. They're all the attributes that they use to describe what they've got and where it is" (P3).
Mental practice techniques	
Warm-up/cool-down protocols:	
Graduated return to playing:	
Traffic light pain monitoring system:	"It's rest, warmth, massage. And I teach most students. I am teaching neural stretches because actually the neural stretch, especially the upper limb. They're in these horrible, contracted positions. Everything is flexed, every instrument is fecal. So they really need to be able to get the ulnar-radian-median nerve stretch, often during the day, often during the day, they need these lovely slow stretches for their nervous system". (P6). "So I kind of probably treat them like a professional sports person. Conditioning exercise if that's what they need, then yes, but if they don't need that. And endurance isn't a problem. But sensitization and pain is a problem. Then we focus a bit more on that". (P7).
Education	"I think that the most effective thing that I find is to educate them about the relationship between load and capacity, So once they understand that concept, they're able to then apply that to how much they play, taking breaks, understanding how we can increase their capacity with exercise, nutrition, hydration, sleep all those things. And really, if they, if they get that fundamental concept, then it everything just seems to fall into place with most of the people. So that when I'm when I have like a small window of time to add some education to a patient. That's where I'll normally go because as I said earlier, most of the injuries have been triggered by a sudden increase in playing and so effectively they've overloaded their current capacity. So, if they can understand why that's happened, the trigger, and then they can first of all work out how to increase their capacity. But then, in the future, if they do need to increase their play for whatever reason they can do it in a more conscious way to avoid those big hikes in load" (P4).
Load vs. capacity education	
Pain science education	

Body mapping Neuroscience-based approaches Video feedback Strengthening exercises / Targeted or not?	Pain education: “I will also go deep with them into the science of pain, the neuroscience. So that they can understand hypersensitisation, persistent pain. How that changes your behaviour, catastrophising, depression, anxiety and thought problems with anticipation of pain right up to management of suicidal ideology and despair” (P7).
Holistic health Nutrition and hydration needs	“I think pacing patient generally gets to what pacing is they understand that pacing it's like breaking down the activity taking more breaks adding structures and strengthening in between or having days off when they're not training and do something else” (P1). “Most musicians will not want to stop playing but they've got to re redirect their habits and they've got to find new wiring in their brain and you can't do that if you're overtired upset bored or any of those things you got to be very awake very rested in a you know in a really good state so performing arts is very different from a you know non performing artist of course we've got to be like athletes so you know we mentioned the Pomodoro technique

Sleep considerations	you know regular little rests I say 20 minutes but I find very few of them can bare that shortness of time because they're so used to thinking in hours but I think ideally any of us would involve in any task computer or anything we would take a little step back you know they say we can only really concentrate for 7 minutes so who knows but I think it's so it's really important to stop for a moment so I sort of teaching moments of stopping little you know. Play a thing stop so that you can regroup to spatial awareness your breathing your embodiment then chunking up to 20 minutes for 5-10 minute rest and then really not practicing more than about 2 hours in that framework I am very very keen for them to not the first thing they do when they stop is look at the phone you know that's the research so I'm very keen for them especially to look out look into you know 20 20 20 do you know that rule 20 minutes, 20 feet 20 seconds to really let their eyes and spatial awareness and vestibular system regroup to the space very very keen for them to notice oh have I been holding my breath you know have I been getting smaller and obviously as an Alexander teacher we recommend directed activities so maybe some lying down or having a movement sequence I'm very keen on movement sequences not so much exercises I would" (P2). "I'd say again optimal loading don't play in pain try to avoid playing in pain is all I can say because they wouldn't stop playing don't stop playing but maybe reduce the intensity. Duration take longer breaks or more frequent breaks, if possible, again try and alter the way you sit the way you move the way you hold your instrument in order to saying your pain limits or perform your day-to-day activities in your pain limits" (P3). "They need to continue playing as much as they are able to without be interfering in the healing process or making things worse. So I talk about kind of developing a strategy where they can work out what their current benchmark is in terms of how much they can comfortably play without exacerbating symptoms. Whether that's an hour or whether it's 5 minutes. And then we start to discuss how we can potentially build from that point, um you know, gradually increasing, playing load with this kind of monitoring the response to the increase in the dose and it's rare that there's a musician that cannot play even for 5 minutes. I mean, I have seen that a couple of times where literally, as soon as they pick
Cross-training recommendations	
Breathing techniques	
Breaking practice into manageable segments	
Flow state development	
Proprioceptive awareness training	

	up the instrument they're in severe pain, and that might be different, you know, that might that musician might need a period of rest it. It might be unavoidable, but the majority of them are able to play for short periods with lots of rest, periods in between, with a graduated progressive training load that can get them back up to where they need to be while they're doing their rehab, or whatever it is they need to do" (P4). "Depending on the severity of the pain, we'll either stop them completely and give them a break away. I mean, my things are, if they have actually torn some fibres, which sometimes does happen, and they've got any sort of swelling or if they've got any really deep pain, they will stop. They will just stop. Maybe for a week they don't like it, but we'll stop. And then we do a graduated return to play so that might be the first day, 10 minutes, the second day, 15 minutes, very, very gradual return to play, which they hate. But I'm very much into mental practice and therefore I say, you can still practice, it's just not going to be doing it physically. You can actually get into your head. You can go somewhere and say, you can actually learn a bit of music in your head and the mental practice is 95 % the same as physical practice. So basically, once you get into that, that's the way to practice in the future, not just when you have your injuries. Get them mentally practicing from the age of six, get them doing their practice on their scales in their heads very early on, then build it. Some people find it very easy, asome people find it less easy. But mental practice, when they are not able to play as much as they want to play, and certainly as much as I want them to play because I don't want them to play as much as I want them to play. So mental practice, rest, warm. I don't use ice at all. It's all warm, there are places for ice, but actually less and less. So keep in warm gloves. I suggest to my musician they wear gloves the whole time, really. Different types of gloves all through the year so they're actually maintaining a great deal of warmth and protection for their hands. This is their life so I teach them how to massage themselves. I actually teach them how to use the heel of the hands on their arms and talk to them about the discomfort they feel and it must be heavy and it shouldn't hurt. But it's just nice to move and get rid of any spasms or tightness in those muscles. So I teach them how to do" (P6).

Taking breaks Activity diary / self-monitoring	“Activity diary mapping out the whole week I have done that before with musicians and clients we can make a share document of like okay this is what you do this is when you play treating them a bit like a support athlete where they have a training timetable, and you just do the same for musicians” (P1) “So there's a really easy way to educate people with the traffic light system you know the red, amber and green so when you're kind of pain levels and amber that's fine but you don't want to push into the red say or sometimes you can do the fast scale like out of 10 it has 2 or 3 say okay and the other way it's kind of ask them to check in with themselves so what is your pain like before training what is your pain like during training what is your pain like after training so if after training the next day your pain has gone up significantly that means yesterday you overdoing it if you're over doing it yesterday how long you have been playing have you been playing for 2 hours okay can we cut that down to 1 hour hour or can you play slightly differently or do a different type of music piece see whether that would change like the intensity and the duration has on the body and then map it out accordingly so I guess in that regard an activity diary is really useful and helpful and providing they are quite self-aware and able to fill it in correctly sorry I speak so quickly, and I think I'm just” (P12). Potential for technology: “Ideally if there's an app that will help me do that and give patients the answer straight away that would be really easy but I guess the trouble is it takes you out of that clinical time zone and what you already have is quite limited time to clinical...I I personally would struggle to do like look through their activity diary every day and give the feedback there and then so they suppose you could say having a weekly or every 2-3 week catch up then you've got that boundary time that you're only doing that work with that patient at that moment in time whereas if I am constantly monitoring them I will not have time cuz I've got a lot of patients other than just one patient.” (P1)
Posture	“I wouldn't say there is a right posture but I would ask them to avoid static postures for a long time so every few minutes even if they are performing just a slight you know shrug or a fraction rather than maintaining static positions for a long time is something that I would recommend especially for people with long rehearsals or maybe bigger instruments move your foot up and down something like that to change or break the static position then I would

	say self management long term have a good healthy lifestyle which includes you know strengthening because you have to be strong in order to hold your instrument you have to have good endurance to play for such a long time so working on that self-management wise having good nutrition cause you're going to be on stage you're going to be performing for long hours you need proper hydration you need proper nutrition you need a good protein intake that and then taking care of your body" (P10).
Improving body awareness	"I think it takes time to really befriend oneself and look at oneself in a kind of third person way gentle befriending clarity but I do encourage video practice and videoing performance because there's just so much to learn about how we move how we breathe how we you know how we interact and often that's the big problem is understanding the difference between practicing and performing to really understand those 2 different states" (P2). "Obviously practicing is chunking information up disseminating and extrapolating what the problem is unpacking the problem seeing oh if I move like that it sounds like this if I move like that it hurts like this you know so that you're really having a clarity about how you practice and whether you're practice whether you're over practicing or whether you're pushing down or pulling up or whatever it might be and that um you practice to really solve problems actually performing is a completely different thing and so you need to practice practicing but you need to practice performing so that you get into a S a flow state you're not in it hopefully when you're performing you're not in an analytical state you're in a free communicating centred state and artists need to know the difference between those 2 things because you don't want to stand on stage practicing you want to stand on stage communicating and finding your charisma and tell the story you know you don't want to be thinking oh God I got that note wrong or whatever" (P2). "I'm encouraging people not to notice mistakes I'm notice I'm encouraging them to notice the prediction of mistake and how that actually creates the problem and um and that actually fussing too much about mistake you know musicians we need to be very good at concentrating we need to be very good at making mistakes we need to not make think

	mistakes exist even really there because that is you know a massive part of the of the startle fear reflexes and we need to be very good I think at some you know really understanding this in this moment now I'm communicating I'm not I'm communicating" (P11). "The biggest thing is to get them to take themselves seriously and to notice what's going on, and to look after themselves and think about things. It was interesting, because during Covid, I had to start teaching online, it's the only way I could do it. And to start with, I thought, this is going to be ridiculous. How can I do this work online? And I realised that actually, it was having a useful impact. And the really big reason was because I couldn't make themselves make them feel better by putting my hands on them and being there, they had to do the thinking. So, the ones that really took it on board and did the thinking and yeah, they we're sort of bringing about a lot of changes for themselves despite the distance learning so that it can happen" (P5). "Well, just remembering, just remembering to think about it is the first one to begin with so one little thing that I do with new pupils very often is just give them little red stickers to put up all around the place, so that when they see it they can be reminded to pause and think of freeing up. So, it's a little bit like so edging towards something you might do. We spend so much time getting sucked into the activity or suck getting sucked into being with the other person and losing awareness of what we're doing. So that's a huge bit of the work. And as an Alexander teacher, when we're training, that is enormous bit of the work that we do in the training. Because if I forget to think about myself when I put my hands on someone then I'm gonna mess myself up. But also, I'm not gonna be much use to them. So, I really have to. A lot of it is don't get sucked in, and only think about the pupil or the music, or the conductor, or whatever you know. Awareness goes out there, back to me out there, back to me all the time. So that and that I'm as important as that activity. Okay, that's a hard one for people to remember" (P12).

	It's starting to be aware of their whole bodies. So, actually getting a sense of, for example, getting a sense from the support of the ground, releasing the legs, even though they're sitting. It might be. For instance, a violinist is sitting, but her legs are tucked underneath her, and then she's kind of really sort of forward, honestly, Bones, and then she's arching her back and then she's squeezing in the shoulders. So, I would say, well, it's the whole, you know, really attend to yourself as a whole. My first of all sorts of really give them a sense of where can you get more of a sense of support. How about? You? Know you change the position of your feet. How about you? Get a sense of the support, the seat under your sitting bones? How about. you know? And of course, I'm working with them with my hands, too, you know, and as I'm talking to them, I'm sort of giving them useful verbal cues, that start that re coordination, that reorganisation of how much the sort of general overall muscular tone! So can they start getting more elasticity and adaptability and flexibility in their musculature. Whilst their skeleton is well organised, so the muscles don't have to overwork, and they're just stimulated to support the body. So I so so, yeah, so advice would be start thinking themselves as a whole, start getting a sense of where they are supported. Start to notice where they're excessively tightening and just start experimenting with. Oh, do I actually need to be gripping this amount? What do I actually need to be. yeah, wherever in there. Wherever they are, do I have to be gripping, and even if it's in their feet they might think their feet has got nothing to do with their neck, but of course it's all connected so, and I might give them a little, you know. Just demonstrate to them like, well, if you grip your feet, then I actually can't move your head. Very well. if you release your feet. Oh, actually, your neck releases. So, so I start to yeah give theme advice, we talk about the way they're using themselves, how they're using themselves as a whole really matters. And then my, you know, my advice would be I would actually start to, you know, work with them with the instrument, and start to see what particular patterns are stimulated. And so, my advice in there practicing would be when they start to become more aware of what we've identified in their lessons when you start having to play this particular passage, which is really challenging. Do you notice how your old habits of straining or tightening or pushing, or you know, whatever it is. And so really, in practising, I would get them to you know, literally stop to actually reorganise themselves and then start again and then stop. So put in lots of kind of stops to really stop that kind of firing of that whole neuromuscular pattern (P9).

	"My number one message in whatever I'm doing that you can learn. It's not the task that's hurting you necessarily although, of course, there is such a thing as overuse which we may talk about in a minute. So, there may be advice about workload rest periods so on. But but the main thing is to say if you Coordinate yourself better if you learn the skill, not only of playing music, but of how you work and you can develop an awareness of that whilst you're doing whatever it is that you do you will find yourself much stronger, much more successful much less prone to injury. So you don't have to stop what you're doing, but you have to learn to do it better" (P11).
Quick fixes / ergonomic advice	"I believe in more long term management and getting to the root cause of it but for musicians sometimes they were just helpless so I had to use something at least until they could get through their show such as taping that would last and then take it off and then again back to rehab so yeah a little more quick fixes with musicians that's it..It doesn't last I don't even believe in it but you know sometimes when a musician is really helpless like I have to perform today" (P3). "I think I have somebody with can't remember if it was rotator cuff because this was 2 years ago she she played the cello and her stool height was different as compared to the cello so she was in complete internal rotation all the time which was causing a lot of pain and she had her show so again we did some taping for her and I also gave her a gentle massage but on the upper back not really where the injury was because she was so tense and so much in spasm so we just taped a little bit we change the stool height but that was effective just for pain relief during the show but otherwise obviously didn't work she had to go through a full rehab plan to get better yeah but it just kind of I feel it helps them with their confidence while playing as well cause they know at least my pain has reduced by 10-20%" (P3).

	"I would say make sure the stool height is proper whatever they are sitting on or performing on make sure the instrument is the appropriate size for them if not appropriate size they could maybe angle their body in a certain way that they don't strain their body too much" (P3) how you're sitting are you twisting your body too much is the instrument too far from you too close to you're your posture with respect to the instruments for example that cello player almost completely rotated if she she could just change has to like little higher for her arm to be in a neutral position and still make sure she's hitting all the right notes and has a full range of movement (P9) I think in some ways that instrument is the least kind of important, unless it's you know that what you know, those asymmetrical instruments, the guitar, the violin, the flute those that you know. I think those are really worth kind of unpacking (P4) Absolutely, it's everything from how they bring it, how they carry it into the room, where they put it, how they handle it. Whether when I say, Okay, let's watch you play. Do they warm up? Or do they go straight to the instrument? Do they warm up on instrument, or do they just go straight to play? Where is they? Where do they put? I have a music stand. Where do they put the music? Stand? What height do they sit at? (P7) And you know, for example, yeah, the way that the harpists use their fingers nightmare, or even the way that they tension their strings is completely different to a violinist. They're both string instruments, but they're so different. I'll also look at the weight of the instrument I mean, particularly the bass guitars. The straps the same with the wind instruments with, with whether they use straps where they're sitting, where they're standing. How many of

	them you know, they practice sitting, but they perform standing like, why do you do that? Oh, I don't know. Okay, well, if you perform standing, let's watch you standing. Why don't you practise standing? And and there's a yeah, rigidity, rigidity and lack of movement is something that I find very, very commonly (P7) And so, for instance, you could have a pianist and a violinist that might have the same use pattern because that's how they generally hold themselves. Maybe they've got a very strong lordosis, or the you know they they habitually or they're very tall. They've got habitual stoop, or you know they've got their use pattern the way they move and breathe and are in the world. They'll take that to the instrument, and then it's usually then exacerbated by the weight of the instrument or the what the the position they're in. They they have to adopt or the the amount they have to play. So I work more with the individual, and then the challenges of what they have to do with whatever instrument. Okay, rather than kind of okay. Coming at it from the instrument with the ins with this instrument you're going to be twisted this way, your next can go that way. Your arms gonna be up this way a bit of that comes in. But it's more like, well, actually, let's start getting your support working better and your breathing working better, and your awareness, more heightened and your ability to change yourself. Let's get all of that working better. And now let's see what happens now with taking the weight of this instrument, or you know. So, I mean sometimes there's, I mean there's obvious there's things you know there's, I find there's common things for, for instance, with guitarists or were chalices, are often an over tendency to hunch over. There's an over tendency to kind of focus down. And in or violinist, there can often be a tendency to arch up or with. Let's see, yeah, with sort of heavy brass instruments, as often kind of an overuse of certain muscular. So, there's often the common things that so with those are again, it's just well. Maybe if we get get everything working better as a whole and start letting go of beliefs that you have to really over focus, or you have to start tightening more to play faster. Oh, actually what if you have more of a sense of that, your arms releasing out of your back, and you've got the space across here and also paying attention to where their attention is drawn, so often? Are they an over focuser, or can they still have a sense of space around them, or can they still take him what they're listening or attending to rather than so it's yeah, I'm saying. (P10)

	I mean the the only thing with something like video feedback, whatever as you'd, I think you'd have to. So, without Alexander work, it's about how we respond to a stimulus. So it would be, how then, would they respond? Or to the stimulus of technology? So, for example video or a mirror, as an outside objective, it can be used usefully in as much as you might be positioning or using yourself in a habitual way that you think. But oh, well, you know I'm, I you know I'm I'm not kind of. I'm not hunching my shoulders. And then you might look in the video or the mirror and go. Oh, actually, how I look is not how I feel so. Oh, actually, maybe if I release my shoulders, I release my shoulders and then they might think. oh, but surely now my shoulders are like this. So for for some and quite often, I'll say to students, do you mind if I take a photo of you. I'll delete it straight afterwards. But or they might think, or classic is, once they've stopped kind of arching their backs and pulling the chest up and trying to sit up straight and then play the violin, or whatever after we've actually got. You know the spine better aligned and working well in that springy way, and some deeper muscular waking up a bit, and they're all they're balanced, and they think they do literally think they're going on. Surely, I'm slumped now. and I go? No. And I take a photo, and I look at them. They go, oh, my God! So that's when and when video or mirror is a useful thing, because it then starts challenging their attachment to what they think they're doing in their bodies. But but if they use it as a stimulus to try and change themselves from the outside in rather than the inside out. It's not useful, cause they'll just start correcting themselves like I work with quite a lot of dancers, and they're so used to kind of correcting, trying to correct themselves in the mirror, correct their line. But they're doing it by just creating more tension rather than going. Oh, well, actually, maybe, if I just forget the mirror and think oh, what is it to sort of really think of length in my arm. Oh, there we go, and then you can check in the mirror. (P9) how might it be helpful to do things differently and hold the different side to make it really tailored I always understand how much um what's it what the training and performance schedule is like what instruments they play what size how they how they carry it and transport it if they can bring it in clinic great so the guitarist brought the guitar the clinic before and the drummer has played the drum on zoom call to me before or the harpists has

	show me videos of her performing a harp so on and so forth so I'll make it really tighter but understanding their instrumental needs and their training needs. (P10) I ask them to bring their instrument in or show me videos of them playing to make it really tailored. So I'll definitely 100% will watch the video of how they play because I don't play that instrument I wouldn't know how they hold it I wouldn't know the techniques and what's best for them but I can kind of from a physical lens we know how the body works we can advice around how the body works (P1) I think breath is really important and I might be very biased but when you're playing instrument if you are holding your breath your body gets tense everything's different so it's not gonna help with musculoskeletal conditions. (P1) Ehhh often usually light load exercises something that they can do it every day without needing to go to a gym so things like using shoulders just like having a third band with them like any see if anything easy to transport maybe because I do yoga therapy training so I do give them like kind of a yoga base kind of poses for posture work for breath work the strength endurance building and yeah I think breath is really important and I might be very biased but when you're playing instrument if you are holding your breath your body gets tense everything's different so it's not gonna help with musculoskeletal conditions. (P9) I know there's already that lots of physical tools online that they can use I think there's literally a website called physiotools that provide exercise so I really struggled to use those purely because I find it really hard to find specific movement pattern that I like so what I do is maybe a an app that can record the instead of like having everything ready made an app that can actually record the musician doing their exercise themselves and using that video

	of themselves as a practice or even an audio track of that recording I've done it before with mobility stuff I will record as a patient is doing this I would recall what I'm gonna say in terms of like the internal external queues and then the patient can just play the recording and then carry out the exercise as their own home training (P9)
Posture	I would use it as like a test if someone has quite a posture in terms of like if they do a guitar they only come forward to one side can we test by practicing let's say a door opening stretch by the side of the body test that out for a week see how the body reacts does it help with the posture because posture is another conversation of there's no bad or wrong like get a bad posture right or wrong posture it's just everyone has a tolerance see how long they can sustain and posture and how long? until they keep away from the pain barrier right so it's finding out which posture can I mean how how can they like have little breaks in between the posture so that they're not overloading a particular muscle group too much and giving like neck control the symptoms. (P10)

Appendix 26: Fourth Interview Transcript and Data Coding

Data	Code
Moderator: So I'll just start with more general questions, how long you've been treating musicians. How often do you see musicians? HCP 4: Okay, um, well, I've been a Physio for about 20 years, but I would say the last 10 years have been mainly exclusively with performing artists. Initially, mostly dancers. But then, when I completed the MSc in performing arts medicine it's um there was a shift. When I started working for BAPAM, and I now mainly see musicians. And, um, I I run a clinic for BAPAM once a week, which is an online clinic, um but I also see private clients at home in my home practice, and I also freelance in various different locations in the West End working with musical theatre. So, yeah, I mean 99% of my patients are now performers, mostly musicians. I would say. Moderator: So what percentages are musicians of your caseload? HCP 4: I would say, if we're including singers in in that, I would say, 80%. Moderator: Okay and what are the types of MSDs, that you typically see.	Demographics: 10years of experience with performing artists Workload: 80% are musicians and singers Type of MSDs: overuse injuries, tendonitis, muscle tension in the upper limb, shoulder, wrists and hand Main trigger: sudden increase in playing time – cumulative pattern of overuse Use of technology: Zoom, Physiotrack, Youtube

HCP 4: The majority are overuse injuries, so tendonitis and muscle tension mainly in the upper limb, shoulders, wrists, hand. But the main trigger, possible a different section of your questions relates to a sudden increase in playing time. So, they've just set up a sort of cumulative pattern of overuse. Really, that's as that would say the main thing. Moderator: And do you use any technology in your practice? HCP 4: Yeah, I use. Well, obviously, I'm using zoom for a lot of the consultations. I use a software called Physio-track, which also has an app which provides, you probably know it provides rehab exercises in video format or printed format, what else? I mean, I don't know if kind of Internet sort of video content from Youtube accounts. But I do direct people to certain videos education exercise videos on Youtube because I find the visual stuff really useful for for a large proportion of people who just need that visual kind of queueing. Um, that's probably about it, I think. Moderator: Do you think it works like directing them to videos and more the virtual things, I guess. HCP 4: Yeah, I mean, it depends on the patient but if you're a visual learner, you you need to see it demonstrated and modelled for you and so, yeah, I think that can be really effective and it's something that we're hoping to develop to develop at BAPAM actually is some instrument specific strengthening, stretches, videos for musicians to be able to access from their website. Because we think there is a need for that.	

Moderator: Okay, that's that's really nice and it fits nicely with my the research. Um, what kind of self-management advice do you give musicians? HCP 4: I think that the most effective thing that I find is to educate them about the relationship between load and capacity, So once they understand that concept, they're able to then apply that to how much they play, taking breaks, understanding how we can increase their capacity with exercise, nutrition, hydration, sleep all those things. And really, if they, if they get that fundamental concept, then it everything just seems to fall into place with with most of the people. So that when I'm when I have like a small window of time to to to add some education to a patient. That's where I'll normally go because as I said earlier, most of the injuries have been triggered by a sudden increase in playing and so effectively they've overloaded their current capacity. So if they can understand why that's happened, the trigger, and then they can first of all work out how to increase their capacity. But then, in the future, if they do need to increase their play for whatever reason they can do it in a more conscious way to avoid those big hikes in load. So yeah, I think that that for me is is a really key message. Was that the question? I can't remember the question. Moderator: Yeah, how do you think this could be delivered virtually. How do you think that would work? HCP 4: Yeah, it's difficult. I mean, we I deliver this message through workshops at BAPAM. We have regular kind of webinars where where anyone is. It's a free event over Zoom to join, and they're between one and 2 hours, and we go through some theory, and I do some practical stuff to illustrate some, you know some of the things and that from the data that we've got at BAPAM seems to be effective. They're well subscribed and get really good feedback.	Benefits for visual learning: - Demonstrating and modelling of exercise especially if you are a virtual learner

Moderator: I have been to a couple. HCP 4: Oh have you, oh, great, yeah. I mean. So I know that that they they are effective and I think, as I said earlier, we're trying to perhaps distil that into some short videos accessible at any time from the website, so that a violinist could sort of come on the website. Look at their instrument, specific advice on strengthening stretches, warm up, cool down and and information about, you know, injury prevention. So that but I mean we're not there yet, but we do have some fact sheets on the back on website which I know you see them, I know, are we're also reviewing that as well at the moment, updating those and adding to those, but they are quite well accessed. So I think that works, yeah Moderator: I mean it, it is worth mentioning, I've interviewed several musicians for my research, and not all of them know about BAPAM which was always very surprising for me. HCP 4: I know, do you know what that is one of the biggest things, I think and I don't know why it's not, you know, every Conservatoire, every music school should be in their first day, or even be, you know, in the documentation before they even start should should introduce them to BAPAM and and tell them about this service. Because one of the things that we were discussing in some of our meetings were you know, more proactive injury prevention stuff for Conservatoire. So having before they start in their first year to have some kind of education, because a large percentage of patients that I see in BAPAM clinics are in their first year of music school and they've suddenly increased their playing load and are struggling. And if they'd had some other education before they started college, a lot of that could have been prevented. So, yeah.	- Greater accessibility Self-management advice: - Load and capacity education - Potential effect of playing - Holistic management of capacity Lack of time in treatment session to facilitate this discussion in greater depth

Moderator: Yeah, okay so just building on what you were talking about in terms of load and capacity. So a lot, all musicians don't want to stop playing, and I'm sure that you you people have come and told you that. How do you manage this conversation? HCP 4: Yeah, well, first of all, I experience, a lot of patients who've been told that they should stop just stop playing or just rest and what I explained to them is that the research shows that that is not the best advice for musicians, both physically and psychologically. They need to continue playing as much as they are able to without be interfering in the healing process or making things worse. So I talk about kind of developing a strategy where they can work out what their current benchmark is in terms of how much they can comfortably play without exacerbating symptoms. Whether that's an hour or whether it's 5 minutes. And then we start to discuss how we can potentially build from that point, um you know, gradually increasing, playing load with this kind of monitoring the response to the increase in the dose and it's rare that there's a musician that cannot play even for 5 minutes. I mean, I have seen that a couple of times where literally, as soon as they pick up the instrument they're in severe pain, and that might be different, you know, that might that musician might need a period of rest it. It might be unavoidable, but the majority of them are able to play for short periods with lots of rest, periods in between, with a graduated progressive training load that can get them back up to where they need to be while they're doing their rehab, or whatever it is they need to do. So that's that's kind of how I sort of discuss it with them. Moderator: Do you think there is any potential for technology to help monitor their symptoms?	Building up conscious about load and capacity Potential role of technology: Webinars, videos, workshops

HCP 4: Yeah, I think there is actually because I mean it, it does need to be quite structured. So I always talk about okay, so let's say your benchmark is 10 minutes of playing that you can comfortably manage. Let's increase that by 10% for 2 or 3 days, and we monitor the symptoms, and if it's all fine, then we da, da, so it's quite structured. So I some kind of app where they can record their playing time and record their symptoms, their pain levels, or their fatigue levels, or their perceived exertion, or something like that, and then they can keep tracking um, their progress. And perhaps you know, the app could even detect if there if their VAS score goes above 6 or something that it can alert them, say, Okay, well, let's drop your, you know something like that which is has a response. I think that could actually work really well, because that is one thing that musicians struggle with is that kind of process. It's a difficult process, it needs really to be done under the guidance of a Physio. But for if they don't have that access and it's difficult for them to get that supervision. Then, having an app that, could, you know, help them with that monitoring, I think, would be great. Moderator: Do you think a physio would need to monitor the app? Moderator: Potentially, yeah, I think that could be that could be useful, but if that wasn't possible, I think, having kind of safety netting within the app to kind of alert them to say, okay, look I can see that your pain scored has increased, and I think you need to contact your physio something like that, having some kind of safeguarding in there. But I think it is possible, for you know, a fairly savvy aware musicians to be able to navigate that themselves, I think it is possible.	Content of workshops: theory and practical content Short videos for accessible learning Focus on instrument specific advice Importance of education Importance of targeting conservatoires / elite music schools Potential of prevention by ensuring early education

Moderator: Okay, great. So the next set of questions are about tailoring treatment. So we we talked about instrument specific advice, do you think it, is it only the instrument that we need to tailor the treatment for, or is it, do you consider other things when you're treating musicians? HCP 4: Um well, yeah, good question. I mean, it's not always the most important thing is, it's it's so multifactorial um, you know the age, the kind of expertise the level of training. What's going on the medical history, or there's so many things, I think in some ways that instrument is the least kind of important, unless it's you know that what you know, those asymmetrical instruments, the guitar, the violin, the flute those that you know. I think those are really worth kind of unpacking. But yeah, I wouldn't say it's the most important thing for me. The instrument I I think there's more important factors, unless, as I said, it's those specific instruments. I think it's worth looking much more closely, you know, or if they're if they're in the subjective, they're telling you about some specific interaction with the instrument ergonomically, you know, maybe a clarinettist with a thumb. And you know, it's an obvious interaction between the body part and the instrument, but yeah. Moderator: okay, so you mentioned expertise, what do you mean by that? HCP 4: Well, well, most professional musicians do have good training, but not all of them do. Some of you know I've seen musicians that are self taught and have had no lessons and you know that and especially singers and I don't know singers are part of your. Moderator: No	Balancing playing and healing: Developing a safe playing strategy: Monitoring response to load increase: Variability in musicians' conditions Graduated progressive load Potential need for rest periods:

HCP 4: No, um seeing technique is obviously really critical, but yeah, some some musicians are self-taught even at elite levels and that can have an impact on load because they may not be as efficient as they think they could maybe refine their technique, things do things that they're not aware of to reduce muscle, you know, loading and stuff like that. So yeah, I think that's what I mean by expertise is, is technical expertise. HCP 4: Okay, and do you think would be, or would we, need, different exercises or advice for prevention and management. HCP 4: Prevention and management. Yeah, I mean prevention, we're kind of yeah, I mean, I, I do specifically put together a preventative exercise programme for the patient that I'm seeing. A lot of that is quite the same and generic really focusing on, you know, shoulder, girdle and everything. But then I will put in some additional stuff specific to you know the musician that I've got in front of me, and if I've identified specific weaknesses, or maybe they have hypermobility or something else. I'll add in to that and obviously for the for the rehab. If I have an injury, then that will be very much focused on addressing a specific issue. I suppose I would still include some more general strengthening type stuff to kind of work on their overall capacity and resilience for the future. But that would probably be a bit further down the line in their recovery process, perhaps. Moderator: So if somebody doesn't have pain and somebody is coming with pain. How different would your advice be	Rehabilitation and performance alignment Structured approach to progression Use of Technology for Monitoring: - Structured approach to musicians - Real-time Monitoring and Alerts: "real-time monitoring of VAS score" "automatic alerts based on thresholds" "alerting for symptom escalation"

HCP 4: In terms of exercise, or just generally Moderator: More generally HCP 4: If someone was in pain, then the I would perhaps added more advice about pain, management strategies, bit of pain, education bit of advice on kind of better pacing load management, trying to identify potential risk, other risk factors that might be impacting their pain experience that kind of thing. And and with the musician that wasn't in pain, I think it would be you know encouragement education generally, looking at optimizing performance, looking at, you know, nutrition, hydration, you know all those things, talking about injury prevention, Yeah. Moderator: And do you think there's a potential for technology here, in terms of tailoring treatment for prevention for management, according to their expertise instruments or even muscle groups? HCP 4: Technology, um yeah, I mean, fact sheets and little, short videos and things. It's probably difficult to be more interactive here, because there's so many factors. I suppose, yeah, so I mean, I suppose, yeah, I hadn't thought about it. But guess things like, maybe there could be like a self assessment, a questionnaire, or something, or what? You go through a series of questions about their lifestyle and their diet and everything, and then perhaps, it could give you like a a score or a kind of pointers to, okay you're great at this this and this, but it looks as though your hydration is poor. Here's some information about hydration. Go off and do that kind of thing, I think that I think musicians would quite like that	"proactive feedback from the app" "adaptive response to symptom changes" - Addressing Musicians' Struggles: "challenges in load management process" "difficulties without professional guidance" "need for supervised load progression" "barriers to accessing physio guidance" "finding alternatives in absence of supervision" Safety measures:

because that would be quite personalized, and they would get like a I don't know a profile at the end of it. As to how you know what they could improve and what they're doing, well, that that could work. Moderator: Great, ok, so you mentioned Physio track, yeah, I know it and it's great but one of the professionals that I interviewed what she was talking about that, yes the exercise are there, but she doesn't always find it easy to to find the right movement sequence that she's looking for for musician. HCP 4: Yeah Moderator: Yeah, is your experience similar to that. HCP 4: Yeah, it is similar and also I find a lot of the descriptions really awful. I often have to edit them, which takes a long time, um, what I sometimes do if I'm in person is that I will video myself doing the exercises, or I will with the patient's phone video them doing the exercises with me, talking and explaining, I find that works really well because they've got that on the phone and they've always got access to that, um yeah. Moderator: so would there be a potential for technology to help you do that, so you could. Well, just giving you an idea. So you could if you could take the video like you were talking about, and you could be able to attach queues, external queues. So something spoken, what to do, what not to do? Would that help at all?	- Automated alerts based on pain scores Tailoring treatment: Medical history Instrument-specific mostly important for asymmetrical instruments

HCP 4: Yeah. yeah, definitely. I mean, if there if there was an exercise video library that you similar to Physiotrack, but you could rather than them, reading a script you could voice over, okay, this is this is exercise number one. I want you to make sure you, you know, lift your chin on this one. Yeah, that would be, that'd be great. Moderator: Right, so the next set of question are about general, well, well-being in self-management. So, I think the musicians that I interviewed were very keen on looking at certain factors, and their influence on their pain. So things like sleep, mood, some even talked about nutrition and hydration level, which is is really great. I think it's very forward thinking. So my question to you is, what factors do you monitor or what things do you consider important to monitor? HCP 4: So I always ask about 5 things, which is nutrition, and so I'm just looking at, you know. Do they have a generally healthy diet, with enough protein and all those things that they need, are they hydrated enough? Do they sleep well enough, and for long enough? Do they exercise enough? Have enough movement? Is there variety in there is there strengthening, as you know, have a look at that. And then I also ask about how they manage stress in their lives. What tools do they use when they're feeling stressed, overwhelmed, or anxious? And I sort of make an assessment as to how effective their strategies are, um or not, because for me, those are the 5 pillars of you know, homeostasis, tissue health. So if you've got, if they've got those 5 right, they're pretty much sorted, obviously, not always, but mostly	Subjective history Specific interaction with the instrument and body part Technical expertise

Moderator: Okay, so how about looking at correlation, so if there was a technology or any, wherever it's going to be, that would look at the correlation between their sleep, for example, and their pain level. HCP 4: Hmm, yeah, I mean, I know I've seen it work in other, you know the Royal ballet, they use those kind of tracking and they've been really effective. So yeah, absolutely, I think that would be great, similar to what we're talking about for being able to record and monitor those aspects. How well the sleeping! You know! What is your mood today? How much, and track all their, how much they're drinking and all that kind of thing. Moderator: And would you want look at the recorded data, or do you think it would be something more for the musicians? HCP 4: I think they would probably need some kind of guidance. And so, perhaps, you know, you know, thinking about some of the things we do at BAPAM, for example, we did over lockdown, we did what was called a community drop in where the musicians could drop in on on a Tuesday, and every week we talked about some different aspect of wellness and health. So something like, you know, you sign up for this program, maybe a couple of webinars introduction to this digital technology, how you can use it, some education around what we're monitoring and why, and then send them off to to do it, and then perhaps have check-in points every month, or something. And then a final sort of review of maybe after 3, 3 or 6 months. I think something like that would be really interesting, big, you know, great, great study. And I think that kind of combination of education and a little bit of supervision and monitoring, and then a kind of wrapping up at the end to consolidate what they might have learned, I think, could be really effective.	Potential implications of being a self-taught musicians: Load Efficiency technique Prevention: Encouragement and education

Moderator: Okay, so I'm in my last set of questions now. And it's all really about the barriers and solutions of using technology for self management. What do you think are the barriers of using technology? HCP 4: Barriers, well, I think for some of our older musicians they might struggle with some of those app-based stuff. Perhaps, safeguarding safety netting is going to be a key issue, making sure that you know you're not sending off someone off with kind of going to do some exercises that could injure them, or that they don't understand. So that I think that's a key factor. How do we safeguard them to use this technology safely, you know, and effectively. Moderator: So what monitoring here have a place, or would we need something else? HCP 4: When you say monitoring, do you mean like a health professional, is is it? Moderator: Yeah? HCP 4: I think. Yes, I think that if that that can be integrated, I think that would be really useful. For that, especially if you're if, if musicians that are injured or in pain are using this, you know, if it. If it's if it's healthy musicians who've got no injuries, then I think obviously there's less less of a need. But certainly, if you're dealing with musicians in pain. I think some kind of monitoring would be a good idea.	Generic exercises for shoulder girdle and the upper limbs Management: more strengthening exercises, more rehabilitation exercises More focused on addressing a specific issue

Moderator: What else? HCP 4: I suppose, making sure that the technology is up to date, because the evidence base is constantly shifting. And so that we need to be really reviewed on a regular basis, yeah, I think that's all I can think of Moderator: So going back to the age thing. Yes, I I mean yeah it is a barrier. Do you think there's any way we could facilitate older musicians to be able to use the app or the tool. HCP 4: Yeah, I think I think most older musicians are, You know, they're kind of up for it. They're they're willing. If they've got that extra support, then I think that will be the main, I mean, I there are a couple of patients that have had haven't got smart phones. They've only got old Ericson's and things that can't access apps. For example, though that is rare. It's very rare. Moderator: okay, I mean, so the way we're we're thinking about the project is that we'll have an app and a website. HCP 4: Great, yeah, that's something, yeah, the choice. If they haven't got more phone, they could still go on the website. Yeah.	Personalised approach through self-assessment Difficulties with current exercise applications: Bad descriptions Time-consuming for editing Potential for an exercise video library with voice overs

Moderator: Alright, so this is it really. I was just wanted to ask if you have anything to add, if you have any questions to me. HCP 4: No, it just. It sounds really interesting, and and you know, just it's great that this research is happening because we so need this kind of work. So that's great. I love. I love the idea of trying to, you know, push things toward and and introduce new technologies, that's great. Because, yeah, there, there is a there is a lack of specialized care for this particular group, you know, they they go to a a non-specialist, health care practitioner, and sometimes they can be given really quite awful advice, actually quite, shocking advice about you know how they should manage it. So the more accurate and evidence-based information out there, the better definitely Moderator: Do you think anything else needs to be covered in in this topic, anything that I've missed. HCP 4: No, I think I think you you were sort of thinking about that you did mention when when they need to seek help and when they canjust self-manage, so yeah, I mean, whatever whatever you're developing, I think making sure that there is that understanding of and confidence about what they're able to manage themselves, and what when they absolutely need to seek help from a professional.	General well-being: Nutrition Sleep Variety of exercises Stress management

Moderator: Okay, what things do you think they absolutely need to seek help for? HCP 4: Well, I mean in, in my kind of sessions, I I sort of talk about. Okay, if you're or first of all, if anything traumatic like a fall or a knock or an accident that you don't mess around, you always seek help for that straight away, but you know, just thinking about if if something is not getting better after a week or so, or it's getting worse, or you're getting neuroscience, or you know, it's severely affecting your function, then that is, you know, you do need to seek advice on that. But if it's just, you know some muscle tension or a bit of an ache, and that that goes when you just reduce your playing a bit. Then that's fine, yeah, so some clear clearer than what I've just described. Guidelines around that went, you know, maybe, like one of those flow charts where you know they can ask them questions, yes or no, and they go down the flow chop and a bit like I suppose it's the when you call 1 one. They go through the the kind of red flags and everything, and you get to the point where you see that go to a Ne or ring, or Gp, or whatever, yea	Potential for tracking these factors using technology Progressive guidance from professionals Structured programme for implementation:

	Educational webinars Monitoring and check in points Consolidation and review Barriers and solutions: Effective safeguarding – professional monitoring for injured musicians / flow chart to assess seriousness of injury Up-to-date: continuously update the evidence Age: some do not have smartphones – integration of an app and smart phones, extra support to show them how to use the app. A flowchart to visualise the seriousness of the condition

Appendix 27: Initial Diagram of Themes and Subthemes (Interview Study)

