Run Healthy, Run Strong:

The development of a digital running-related injury prevention and self-management intervention.

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Publications and Poster Presentations

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List of Abbreviations

ADL	Activities of Daily Living
BMI	Body Mass Index
DHI	Digital healthcare intervention
CAQDAS	Computer-assisted qualitative data analysis software
FG	Focus Group
HCP	Health Care Professional
HCU	Health Care Utilisation
HRT	Hormone Replacement Therapy
GPS	Global Positioning System
GP	General Practitioner
GRF	Ground Reaction Force
ITBS	Iliotibial Band Syndrome
KM	kilometer
KTS	Knowledge Transfer Scheme
KW	Kathleen Walker
MTSS	Medial Tibial Stress Syndrome
NGB	National Governing Body
OSTRC	Oslo Sports Trauma Research Centre
PEU	Perceived Ease of Use
PF	Plantar Fasciitis
PFPS	Patellofemoral Pain Syndrome
PIS	Participant Information Sheet
PO	Participation Officer
PU	Perceived Usability
RA	Running Application

RE	Running Economy
REDS	Relative Energy Deficiency in Sport
RI	Running Intensity
RL	Run Leader
RV	Running Volume
RRI	Running-related Injury/Injuries
RCT	Randomised Controlled Trial
6SQuID	Steps for Quality Intervention Development
SDT	Self-determination Theory
S&C	Strength and Conditioning
TA	Thematic Analysis
TID	Training Intensity Distribution
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UK	United Kingdom
WHO	World Health Organisation

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Abstract

Running is a popular physical activity that has been shown to have benefits to both physical and mental health. However, with the increase in the popularity of running there has also been an increase in the number of running-related injuries (RRI). Therefore, it is important to develop interventions which can help runners prevent and self-manage their injuries, to prevent time off running and maintain health benefits gained from running.

Using guidance provided by the Medical Research Council (MRC) framework for the development and evaluation of complex interventions, this project aimed to develop a RRI prevention and self-management intervention for recreational runners. The project was split into phases:

Phase 1: a scoping review of the available evidence for existing RRI prevention and self-management interventions.

Phase 2: data collection from recreational runners in the form of a quantitative survey and qualitative focus groups to explore what runners want to see in the proposed intervention.

Phase 3: qualitative data collection from other stakeholders: focus groups with practitioners who advise recreational runners on RRI prevention and management and interviews with Run Leaders who lead running groups and interact with recreational runners, to explore their views on the proposed intervention.

The findings show that there is currently a lack of existing RRI prevention and self-management interventions developed using intervention development frameworks. Those that have been developed include very little involvement of stakeholders and potential end-users of the interventions. The findings show that all participants are in favour of the proposed intervention, with participants demonstrating preference for a smartphone-based application that can provide exercise programmes, advice on the most common injuries and advice on when to see a health care professional. Participants expressed concerns regarding risks of the intervention, such as misdiagnosis or misinterpretation of information. The development of any future intervention should consider these findings.

Chapter 1 Introduction

In the last four decades the sport of recreational running (also termed in literature as 'jogging') has become increasingly popular with numbers of participants continuing to rise. The creation of mass participation events such as half marathons and marathons and the inception of weekly parkrun events has seen numbers grow globally. Those taking part do not have to be elite or professional, they can be of any age and any skill set. It is seen as an accessible, entry level activity for those who are new to physical activity and running therefore attracts a lot of novices.

Traditionally running has taken place in running and athletics clubs under the guidance of qualified coaches but as running participation has evolved more people are choosing to run alone (Eime et al. 2015; Mayne et al. 2021; Linton et al. 2022). Data from the National Survey for Wales reported in 2019-2020 that adult running/jogging participation was 9%. In May 2020 this had risen to 14% and in March 2021 to 18% (Sport Wales 2021). The evolution of running participation has also seen the introduction of social running clubs which are organised by running leaders (Run Wales, 2022). Running participation has drifted away from the traditional athletics club/running club set up to being a more social sport, accessible to runners of all participation levels where the goal is not solely to enter races of compete but to experience community (Hindley 2022).

The World Health Organisation (WHO) has reported that ischaemic heart disease, stroke and chronic obstructive pulmonary disease as the top three causes of death globally (World Health Organisation, 2020). These incidences have all increased in the last decade. The global trend is reflected in the UK with more than 14 million people in England being reported to have a long-term condition (NIHR 2021) and 800,000 people in Wales reported to have a chronic condition such as heart disease, diabetes or Chronic Obstructive Pulmonary Disease (COPD) (Welsh government, 2019), providing a challenge for both health and social care. Running may be amongst possible solutions for improving health and reducing chronic disease as it has been proven to reduce the incidence of chronic health conditions (Pedisic et al. 2019) so increasing numbers of people engaging in running is positive for public health both globally and in the United Kingdom (UK).

While running has these positive effects at an individual and societal level running-related injuries (RRI) are a problem for recreational runners. These injuries can have a detrimental effect on running participation, resulting in runners having to take breaks from running and jogging and even leaving the sport all together. This cessation in running participation has the potential to have a negative effect on the physical and mental benefits that may come from running. This increase in RRI presents a problem as it can have an impact on physical activity levels, public health. It is of interest to public health both globally and in the UK and the health of individuals to address the problem and consequences of RRI. Running is a cheap, accessible activity that has the potential to have an impact on these measurements of health within all areas and the development of interventions to help runners to prevent and manage RRI is necessary, therefore involving recreational runners in this study is justified. Recreational runners are involved in this study in Chapter 5 (a survey study) and Chapter 6 (a focus group study).

Current interventions for the prevention and management of RRI include exercise prescription for specific muscles, stretching, graded training programmes and the mitigation of risk factors such as biomechanics (Bredeweg et al. 2010; Earl and Hoch 2010; Fields et al. 2010). These interventions have mixed success. The changing landscape in healthcare is being driven towards prevention and self-management away from hospital settings, via platforms such as social media and digital interventions, and new technologies allow for even greater personalisation of health services (Deloitte, 2019). The evidence base for current RRI prevention and self-management interventions is low with minimal application of developmental frameworks. With increasing moves towards prevention and self-management away from primary and secondary care settings, and the potential for digital platforms to facilitate prevention and self-management there is currently a gap for a systematically developed, evidence based digital RRI prevention and self-management intervention.

This thesis intends to address the issue of RRI and how RRI can be prevented and managed so that runners can continue to use running to prevent chronic disease alongside the long-term effect of reducing potential burden of chronic disease on local health services. Focus of this thesis is on populations in Wales as an excellent example of widely diverse population in terms of socio-economic status of people living in Wales as well as people living in hard-to-reach communities with limited access to healthcare and support. The main aim of this thesis is to develop the content of a proposed digital RRI prevention and self-management intervention using the MRC framework for the development and evaluation of complex interventions (Craig et al. 2008) later updated by (Skivington et al. 2021b).

The thesis is organised as follows:

Chapter 2 is a literature review which reviews the current literature around running, RRI, the impact of RRI, current interventions for RRI and the potential for digital platforms and interventions in prevention and self-management in healthcare. This review informed the overall aims and objectives for the study, detailed at the end of the chapter.

Chapter 3 discusses the methodology that formulated this study, the development stage of the MRC framework, the mixed-methods approach that was adopted and the chosen methods for each component of the larger study.

Chapter 4 describes a scoping review protocol which was chosen to evaluate the evidence for current digital interventions for the prevention and self-management of RRI. The development stage of the MRC framework calls for an identification of the relevant existing evidence base (Anderson 2008). **Chapter 4** reports the scoping review protocol and the subsequent findings.

Chapters 5 and 6 of this thesis focus on recreational runners in Wales. **Chapter 5** reports a retrospective survey of the recreational running population across Wales. This survey aimed to map characteristics of runners in Wales, their experiences of RRI, the types of RRI they were experiencing and the ways in which runners prevent and manage RRI. This survey also aimed to map runners' current use of digital technology such as watches and smartphone applications and runners' what runners would want to see in a proposed digital RRI prevention and self-management intervention. The survey was designed online and disseminated to runners throughout Wales via Run Wales.

Chapter 6 involved focus groups with a purposively selected sample of recreational runners who responded to the survey to explore runners' views on RRI prevention and self-management, their current approaches to RRI prevention and management, and to explore their views on a proposed RRI prevention and self-management intervention and their thoughts on the content that the intervention should include as well as the format the intervention should take. While the survey provided quantitative data on how runners prevented and managed RRI, the numbers of runners using digital technology and how many runners were interested in the proposed intervention, the aim of the focus groups were to obtain more in depth data about what recreational runners in Wales wanted from a proposed digital intervention while also seeking to gain data on how runners saw the intervention being presented as well as data on the possible unintended consequences of the proposed intervention.

Chapter 7 is focused on healthcare practitioners. It reports a focus groups study conducted with healthcare practitioners who are involved in the assessing, treating or managing recreational runners and are therefore key stakeholders in the development of any proposed digital intervention for the prevention and self-management of RRI. Participants included physiotherapists, strength and conditioning coaches and personal trainers. The focus groups were synchronous and again were conducted online.

Chapter 8 reports an interview study which was conducted with Run Leaders (RLs) from Run Wales. RLs are stakeholders as they are again involved with runners, in supporting runners to run, in helping novice runners and in teaching other RLs on the Leadership in Running Fitness (LiRF) course. The interviews were conducted online due to COVID restrictions with each interview being recorded, transcribed and thematically analysed. The themes and sub-themes and the supporting literature will be discussed in Chapter 8.

All findings were brought together into a discussion and conclusion (**chapter 9**) around how the findings achieve the aim and the objectives of this thesis, the elements that enhance the overall findings, the findings between studies that complement each other and the elements that challenge each other and may support the need for further research. Figure 1 provides a visual guide as to how the thesis is laid out. The phenomenon of running, RRIs, the causes and the current approaches to RRI prevention and management will be discussed in detail in the literature review that follows in Chapter 2.

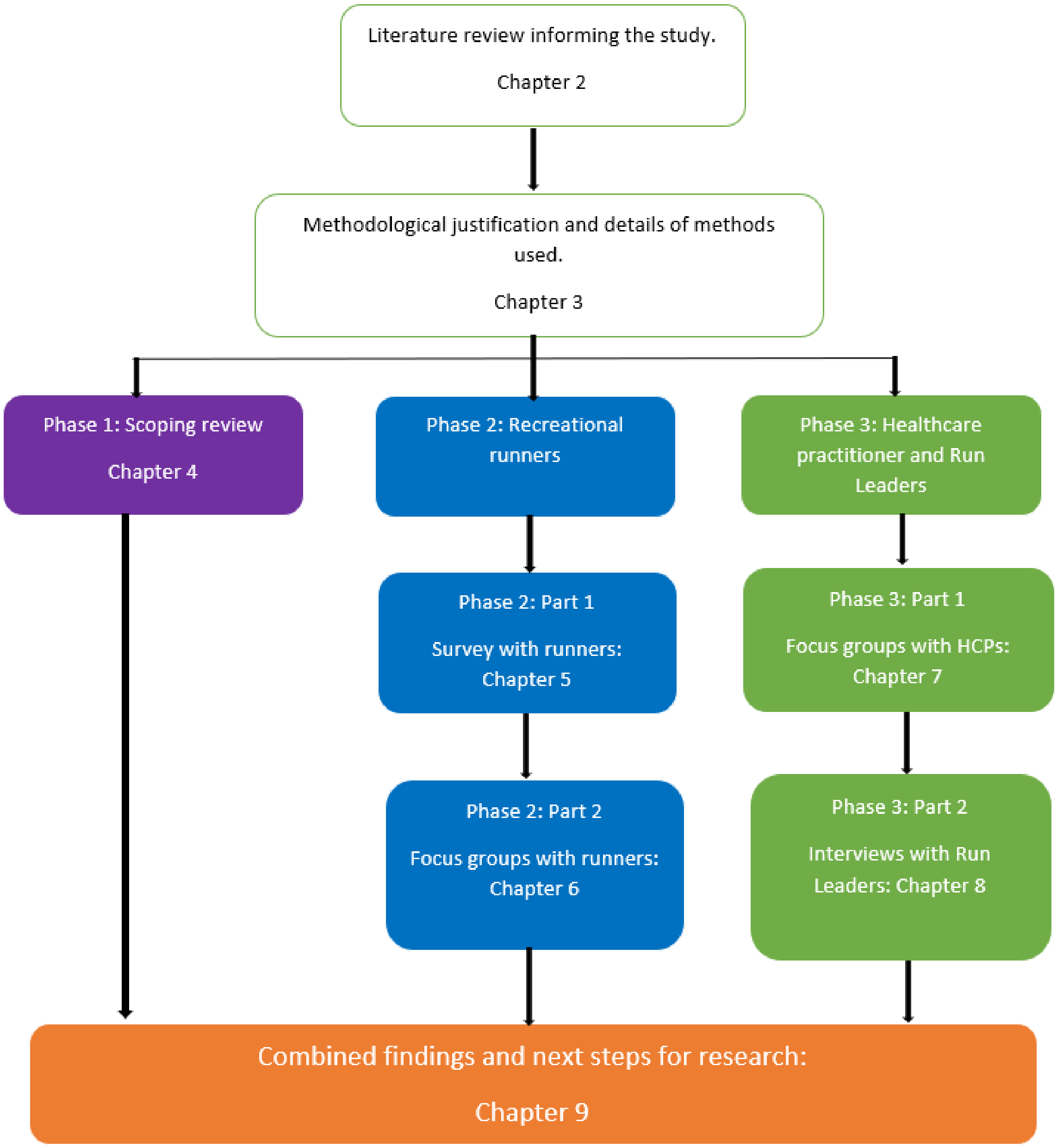


__Figure 1 Visual guide to thesis structure__

Chapter 2: Literature Review

2.1 Introduction

This chapter will review the literature relating to recreational running, running-related injuries (RRI), RRI injury prevention and self-management. The first section will discuss the phenomena of recreational running, the impact of running both on health and epidemiology of RRI. This will be followed by a discussion around digital technologies currently used for the prevention and management of injuries. The end of this chapter will then lay out the main aim of this study followed by the intended objectives.

2.2 Running phenomena and its impact on health.

The sport of running has seen major desportification and deinstitutionalisation, which means that it was no longer a sport only available to elites but a pastime that could be enjoyed by recreational runners and amateurs (Jeroen et al. 2015). Running is a simple, cheap form of exercise requiring very little skill set. It is not restricted to body type, nor is it only accessible to elite athletes. With the inception of community-based initiatives such as parkrun, running has become a global phenomenon, (parkrun.com, 2018) helping people achieve the recommended levels of physical activity. Running is known for its beneficial health effects on weight, the cardiovascular system and respiratory system (Van Gent et al. 2007; Hespanhol Junior et al. 2015). Those who have taken up running on a regular basis, report lifestyle changes such as improved eating habits, improved sleep patterns and a reduction in smoking and alcohol intake (Saragiotto et al. 2014b). With people in sedentary occupations, busy lifestyles with little time for leisure and a general trend towards inactivity, running with its accessibility to all sections of society, its simplicity and low cost is important to health and well-being (Shipway and Holloway 2010; Hespanhol Junior et al. 2015). With its health and emotional benefits, running can be a means to reduce economic burdens caused by physical inactivity and diseases (Hespanhol Junior et al. 2016b). The previously noted health benefits suggest that running as an activity has the potential to not only improve individual health but reduce burdens on health care provision and reduce work absenteeism due to chronic health conditions.

In the last decade there has been a global increase in running participation of 57%, with it being reported that 28.76% of runners having taken up the sport during the COVID-19 lockdowns (Rizzo, 2021). In the United Kingdom (UK) it is estimated that the running population is around 2.5 million, accounting for 5% of the population (Baxter, 2018). In Wales the National Survey for Wales (Sport Wales, 2021) found that in a sample of 12,000 people, adult participation in running/jogging was 9% in 2019-20 but increased in running/jogging with 14% participation in May 2020 increasing to 18% in March 2021. 82% of those adults ran alone, 18% ran with another person (Sport Wales, 2021). A limitation with the Sport Wales statistics is that the extent of running experience in this group or how often they run each week is not known, which are important insights into the behaviour of the running population. Comparison with the rest of the UK and globally is also a challenge, due to the varying nature of how the data is collected.

As an accessible sport running presents one potential solution to the burden of chronic disease throughout the UK and Wales. The number of people living with chronic illness is rising (NIHR Collection, 2021) with noncommunicable diseases accounting for 71% of global deaths (WHO, 2021). These diseases are driven by factors such as rapid urbanisation, unhealthy lifestyles and physical inactivity (WHO, 2021). In England one in four people live with one or two chronic conditions (NIHR Collection, 2021) It is estimated that 800,000 people in Wales suffer from a chronic disease such as diabetes, heart disease or COPD (Audit Wales 2014). Research has shown that moderate levels of running can reduce all-cause mortality and also reduce mortality from specific chronic diseases such as heart disease (Pedisic et al. 2019). The impact that running has on health means that as a physical activity it can be utilised to improve the health of those who are at risk of developing chronic disease. However, RRIs remain a problem within the running population, and this can mean that runners may end up leaving the sport and subsequently lose all the benefits that running has given their health (Fokkema et al. 2019d). If population health is to be improved via increasing physical activity with activities such as running, it is important to develop interventions that will help individuals to prevent and self-manage RRI, keep them running and ultimately prevent chronic disease. This fits with global initiatives that aim to reduce chronic/noncommunicable disease, and deaths caused by chronic disease, with it being estimated that preventing these diseases has the potential to save eight million lives by 2030 (WHO, 2018). This study is being conducted in Wales as the challenges of chronic disease are seen in Wales as a region, including the challenges faced by low- and middle-income populations and the issues around a lack of resources and opportunities relating to access to healthcare and self-management resources (Welsh Government, 2019).

Two epidemiologic terms which can provide information on the occurrence of RRI are prevalence and incidence: prevalence describes the number of runners within the recreational running population that have an RRI at a specific time. Incidence describes the number of new onsets of RRI within a group of recreational runners over a set period of time (Boling et al. 2010). Prevalence takes into account old and new occurrences at the same time. Therefore prevalence could potentially result in an overestimation because incidence will only take into account new instances of RRI (Boling et al. 2010). The true numbers of RRIs are difficult to identify due to studies using differing measures of association for incidence and prevalence (Videbaek et al. 2015).

Previously, authors designed a prospective cohort study where they aimed to describe the prevalence, incidence and course of lower extremity injuries in recreational runners during a twelve-month follow-up period following a running event which included races over five kilometers (km), ten km, 15km and 21km (van Poppel et al. 2014). In this study prevalence was calculated as the number of injuries per kilometers running distance per year which they subsequently found to be 46.3%. Incidence in the follow up period was defined as the percentage of runners who reported new injuries from the total number of runners who returned the follow up questionnaires at the relevant time points. The authors found that the mean three-month incidence of injury was 16.3%. Incidence of RRIs during the 12-month period was found to vary between 14.2% and 17.2%. The incidence of injuries in those who had run a longer distance event was 21.6% while the incidence of injury in those who ran short distances was 15.8%. However, this study experienced a low response rate at baseline and a high dropout rate during the follow-up period which could introduce bias within the results.

Another study used the definition of the numbers of new injuries reported per 1000 hours of running exposure to establish incidence of RRI within a cohort of runners preparing for a four-mile event (Buist et al. 2010). Exposure time was calculated from the time runners started the running programme until they reported an RRI or until the end of the programme if they remained uninjured. They established that the incidence of RRI within the 629 runners who participated in the training programme was 25.9% while they also found an overall incidence of thirty new injuries per 1000 hours of running time. They also found that of those who sustained a new injury, 39% did not restart running.

A systematic review used the same measure as Buist et al (2010), that is incidence of new injuries per 1000 hours of running (Videbaek et al 2015). They found that the incidence ranged from 7.7 injuries per 1000 hours of running in recreational runners to 17.8 injuries per 1000 hours of running in the novice running population (Videbaek et al. 2015). Prevalence and incidence of RRI was investigated in a group of runners training for a marathon (Van Middelkoop et al. 2008). Prevalence of RRI was found to be 54% in a one year period while incidence of new injuries in the month preceding the marathon was 15.6% (Van Middelkoop et al. 2008). These findings can only be attributed to those runners who are experienced runners training for marathons. The incidence of new RRI in an eight-week training period for a four-mile race was found to be 25.9% (Buist et al. 2010c) while the incidence of RRI for those training over 13 weeks for runners training for a ten km event was found to be 29.5%. Whilst experience levels weren't overtly described in these studies, it could be argued that newer runners are more likely to aim for these shorter distances.

A more recent systematic review found that the overall incidence of RRI was 40.2% while the overall prevalence of injury was 44.6% but that the reported incidence and prevalence varied greatly between the 42 studies that were included (Kakouris, Yener and Fong 2021). The authors acknowledge that the wide variance could be due to issues with reporting between studies as well as diagnosis of RRI, who is performing diagnosis and the definitions of RRI used between studies.

Research has also attempted to identify the prevalence and incidence of the location of RRIs. In a study to determine the risk factors for RRI among 550 runners, the most prevalent locations of RRI were the knee (25.7%), the lower leg (21.6%), foot and toes (15.5%) and hip and groin (12.9%). In the same study the most prevalent sub-locations for RRI were the anterior lower leg and the anterior lower leg (Hollander et al. 2020). This prevalence is similar to the findings of other studies which have also found the knee to be the most prevalent location for RRI (Middlekoop et al. 2008, van Poppel et al. 2014). A study of male marathon runners found the most prevalent RRI location to be the knee followed by the calf and foot (Middlekoop et al. 2008). The authors also looked at the incidence of RRI sustained before and after a marathon event and found the most frequent site of injury to be the calf, followed by the knee and the thigh (Middlekoop et al. 2008). However, it should be noted that this study was only conducted on the male population and therefore cannot be extrapolated to female runners. Those findings are also in contrast to a systematic review which found that the incidence of RRI was most common around the knee which was then followed by the lower leg (Achilles tendon, calf and heel), and the foot and upper leg (van Gent et al. 2007).

The different findings of incidence and prevalence of RRI between studies are likely due to the different definitions of RRI, runners' incidence and prevalence used between studies. Differences in incidence and prevalence findings can also be due to the different definitions of RRI used. This was highlighted by Buist et al. (2010), reporting that if they had used a different RRI definition in their study the incidence of RRI would have gone from 25.9% to 60.4%. Lack of consensus over a universal definition for RRI has meant that determining the true burden of RRI within the recreational running population remains problematic and rates of injury could be overestimated and underestimated due to use of different definitions (Yamato et al. 2015a, Kluitenberg et al. 2016). Broader definitions of RRI could result in higher incidence rates than more stringent definitions (Yamato et al. 2015a). Retrospective studies on RRI may also be affected by a 'healthy runner' effect in which injured runners stop running and are not included in study populations in retrospective studies, therefore biasing studies towards less injury prone runners (Wen 2007). However, with the reported rates of incidence and prevalence as they are it is of concern that there are runners who have to cease running and therefore lose the health, social and emotional benefits. Clearly RRI has a wider impact on sports participation, causing runners to potentially leave the sport and lose the health benefits that were gained. Addressing RRIs is important as failure to address the problem could potentially result in long term inactivity, placing individuals at risk of conditions related to inactivity such as cardiovascular problems and obesity (Baltich et al. 2017). The next section will discuss the impact of RRIs.

2.3 Running-related injuries

2.3.1 What are running-related injuries?

There are a variety of definitions of a running-related injury (RRI). For the purposes of this study, RRI is defined as 'any musculoskeletal complaint of the lower extremity or back causing a restriction of running for at least one week' (Buist et al. 2010a). Most RRIs are classed as overuse injuries which are defined as overload of the musculoskeletal system. The high forces through the lower limbs during running alongside risk factors such as training errors, previous injury, biomechanics, flexibility and tissue strengths of muscle and tendon are all thought to contribute to RRIs (Van Gent et al. 2007; Messier et al. 2018).

Studies on RRIs have found that the knee is the most common site of injury, followed by the foot, hip and ankle (Van Gent et al. 2007; Messier et al. 2018). Acute injuries such as sprains and strains still occur within the running population but the vast majority of injuries are chronic, overuse injuries (Wen 2007). Patellofemoral pain syndrome (PFPS) was reported to be the most common injury followed by iliotibial band syndrome (ITBS), plantar fasciitis (PF) and meniscal injuries. Tibial stress fractures and spinal injuries were more common in women (Taunton et al. 2002a). Tissues such as ligaments, tendons and cartilage are poorly perfused and seen to be more at risk of injury because they adapt more slowly to mechanical load than muscles (van der Worp et al. 2015b). A prospective study of 89 runners found that the main types of injuries were muscle injuries and tendinopathies (Hespanhol Junior et al. 2016a). Acute RRIs such as muscle injuries, sprains or skin lesions such as blisters are rare with 80% of RRI being overuse injuries (van der Worp et al. 2015a). Some of this variation could be linked to the differing populations studied, how injury was defined, how runners are defined and the age of those being studies, but this will be discussed in more detail later in this literature review.

Research has found that recovery times from RRI vary (Nielsen et al. 2014c; Mulvad et al. 2018.). In the novice running population the median recovery time to recovery from all types of RRI has been estimated to be between eight to ten weeks, with the time for specific injuries varying from 26 to 174 days. (Nielsen et al. 2014c; Fokkema et al. 2019a). A more recent study found that the median recovery time from an RRI was 56 days with recovery from medial tibial stress syndrome (MTSS) taking 70 days to recover (Mulvad et al. 2018). RRI recovery will subsequently have an impact on the health of runners (Paquette et al. 2018) therefore it is important to develop interventions which minimise the effects of RRI and reduce time off running due to RRI.

2.3.2 Running Related Injury risk factors.

In order to help runners better prevent and manage RRI it is important to understand the dominant contributors to RRI. This section presents research evidence for potential risk factors and potential predictors for RRI.

2.3.2.1 Previous Injury

Previous injury has been found to be a significant risk factor for developing a RRI (Van Gent et al. 2007; Saragiotto et al. 2013) with strong evidence reported for an association between previous injury and the development of a running injury of the lower limb (Van Gent et al. 2007). However, the history of injury could well be due to several factors that will be discussed in later sections, and the complexity of these interactions may well be why the numbers often seem higher. A one-year prospective study of recreational runners found that those with a previous injury were twice as likely to sustain an RRI as runners with no previous RRI (Desai et al. 2021). However, in participants preparing for a four-mile race, there was no association found between previous injury and the development of RRI (Buist et al. 2010b). Participants in this study were novice runners who may not have had the opportunity to be running long enough to develop a previous injury. There does seem to be evidence that previous injury is a risk factor for the development of RRI. It is suggested that those with a previous injury are likely to experience a further injury because the cause of the original injury was not addressed, the repaired tissues are less robust or the injury has not been able to heal completely (Taunton et al. 2002b). Going forward, interventions that are developed for the prevention and management of RRI may need to consider the previous injury profile of individual runners so that any issues related to previous injuries e.g. muscle weakness, flexibility, biomechanical issues, can be addressed (van der Worp et al. 2015b; Restrepo Villamizar et al. 2020). However, the challenges in using existing evidence to support such strategies are the differences in how the data is collected, follow-up time, recall bias for injuries as well as how injury risk has been calculated.

2.3.2.2 Running experience.

From a public health perspective running is an ideal entry sport for health and fitness due to its relative accessibility and simplicity. However, it is widely acknowledged within the literature that novice runners are more susceptible to RRI compared with more experienced runners (Buist et al. 2010b; Buist et al. 2010d; Linton and Valentin 2018a). The incidence of RRIs in novice runners was 17.8 RRIs per 1000 hours of running, compared with 7.7 in recreational runners (Videbæk et al. 2015). Novice runners who are using running to improve their health and lose weight can be limited in their running efforts by injuries or may become discouraged by injury and cease to run (Gingrich and Harrast 2015; Linton and Valentin 2018b). One of the main reasons for novice runners to discontinue running is sustaining an RRI (Fokkema et al. 2019f). Gingrich and Harrast (2015) suggest that novice runners are more at risk of injury because their load bearing tissue, such as tendons, bones, articular cartilage etc have not been conditioned and are therefore more likely to fail. It has been proposed that there is a 'healthy runner' phenomenon whereby more experienced runners listen to their body and have a greater knowledge of running which is a potential explanation for why novice runners are more likely to be injured than experienced runners (Taunton et al. 2002a; Tonoli et al. 2010). Experienced runners will get injured but from existing evidence, novice runners are more at risk of RRI and are more likely to drop out of running altogether. Therefore, any intervention developed for the prevention and management of RRI will need to address the issue around novice runners being more susceptible to injury and be designed to support both novice runners and experienced runners.

2.3.2.3 Body Mass Index

Within the literature, Body Mass Index (BMI) is discussed as a risk factor in the development of RRI. Research has found a linear dose-response relationship between BMI and the incidence of injury, and the risk of injury for novice runners also shows a proportionate relationship with BMI (Buist and Bredeweg 2011; Gingrich and Harrast 2015). Runners with a BMI over 25 had a 25% risk of RRI when compared with runners with a BMI under 25 whose risk of RRI was 15% (Buist and Bredeweg 2011). It has been suggested that the increased risk due to a higher BMI is due to increased axial loads being placed through the lower limb, stressing any existing intrinsic weaknesses more than a lighter runner would (Gingrich and Harrast 2015). Low BMI can also influence the development of RRI. A systematic review of 35 studies relating to the athletic population found that a low BMI increases injury risk in female runners (Amoako et al. 2017). Disordered eating and a lower calorific intake in female runners can lead to the development of bone stress injuries alongside other variables such as over training (Kraus et al. 2019). It is not only female runners that may suffer the effects of low BMI contributing to RRI. Male runners with low BMI alongside low Bone Mass Density can also be at increased risk of Bone Stress Injury (BSI) (Kraus et al. 2019). The female athletic population differs in risk factors from the male, novice population who have a high BMI but this shows that when considering BMI as a risk factor both ends of the spectrum need consideration (Amoako et al. 2017). Therefore, in the development of any prevention or self-management intervention, BMI may need to be considered to tailor interventions to the needs of the individual runner.

2.3.2.4 Sex

Research has been conducted to establish whether a runner's sex is a risk factor for RRI (Saragiotto et al. 2014c; Messier et al. 2018; Francis et al. 2019). One study found that being female had increased risk of developing RRIs, reporting that 73% of women sustained a first time overuse injury compared with 62% of men (Messier et al. 2018). This is in contrast with another study which found that male participants preparing for a four-mile race were more at risk of developing RRI than their female counterparts (Buist et al. 2010b). It should be noted that there are large differences in the cohorts being studied and the way data was collected in both these studies. The study by Messier et al. (2018) was a two-year prospective study which included runners who ran as little as five miles a week, whereas the study by Buist et al. (2010) followed runners over an eight-week period while they prepared for a four-mile race. The populations were also different with the study by Buist et al.

(2010b) focussing on novice runners. The sample sizes were also different with the Buist et al. (2010b) study having over double the number of participants of the study by Messier et al. (2018). These variations in study design, samples and the length of the studies may account for the difference in findings regarding sex as a risk factor for RRI.

Men and women have been found to have different RRI profiles and that even though both sexes developed similar injuries, the proportions of men and women developing specific injuries was different (Francis et al. 2019). The main differences were that women developed a larger number of knee injuries relative to men, while men sustained more ankle/foot injuries. The authors suggested that this was down to structural differences between males and females and differences in running biomechanics. However, a systematic review of prospective cohort studies did not find sex to be associated with running injuries in most of the studies reviewed, putting a question mark over whether sex is a risk factor for RRIs (Saragiotto et al. 2014a). However, this review included a wide range of running populations inclusive of recreational, elite and cross-country runners which may have introduced bias to the results as well as differences in statistical analyses between the studies which the authors reported to have prevented them from performing a meta-analysis. Therefore, sex may not be a key contributing factor to RRI but in the development of any future intervention to prevent and manage RRI, potential differences in biomechanics between male and females and the findings that males and females have a tendency towards developing certain injuries may need to be considered so that interventions could possibly be tailored.

2.3.2.5Muscle strength

Reduced muscle strength can be a risk factor in the development of RRI. It has been shown that hip abductor weakness can lead to increased movement in the frontal and transverse planes and could theoretically lead to overuse injuries (Earl and Hoch, 2011). It is hypothesised that reduced muscle strength reduces the ability to control movements at the joints involved in running, e.g. excessive hip adduction and internal rotation, resulting in more strain on the tissues which in turn leads to injury such as patellofemoral pain syndrome (PFPS) and medial tibial stress syndrome (MTSS) in runners (Becker et al. 2017). It has also been hypothesised that muscles can act to attenuate shock thereby reducing loads on the skeleton during running. Reducing loads through the skeleton potentially reduces bone strain and the reduces the likelihood of developing a bone stress injury (Warden et al. 2014)

With respect to the research evidence for these hypotheses, a systematic review on hip abductor strength and RRI concluded that there was a link between hip abductor weakness and RRI of the lower limb (Mucha et al. 2017). The same review also found that hip abductor weakness was associated with iliotibial band syndrome (ITBS) but was unclear whether it was significant in the development of other RRIs. However, this review only included 11 studies and differences in methods used to measure muscle strength raises questions over the validity of the findings and how they can be applied in practice. This review also concluded that methodological rigor varied between the studies reviewed, resulting in the authors calling for more studies with consistent methodology and inclusion of all distance running populations to determine the importance of hip abduction strength in the development of RRI.

From cross-sectional studies, gluteus maximus and gluteus medius activation has been found to be delayed or inhibited in females with PFPS (Snyder et al. 2009a; Willson et al. 2011). Delayed onset of Gluteus medius and maximus was found to be associated with increased hip adduction and increased hip internal rotation during running (Willson et al. 2011). Weakness or delay in the activity of these muscles is proposed to lead to altered biomechanics of the lower limb, including rear foot eversion, knee abduction, hip abduction and internal rotation, which in turn lead to the development of PFPS. This is supported by a systematic review that found a significant association between PFPS and increased hip internal rotation and contralateral hip drop (Neal et al. 2016). The same review also found that there was an association between delayed gluteus medius activity in female runners with PFPS. This is in contrast with the review by Mucha et al. (2017) who found that hip abduction weakness was not a significant factor in those with PFPS, however methodological rigor of the studies included in this review were questioned with questions over how participants were selected in some studies and running experience of the participants not being specified. These studies show that there is some evidence that reduced muscle strength has the potential to contribute to certain types of RRI. The development of any intervention to prevent and manage RRI, these findings should be taken into consideration as a contributing factor alongside other risk factors such as biomechanics and physiological factors (Napier and Willy 2021).

2.3.2.6 Biomechanics

The literature has identified several biomechanical abnormalities as potential risk factors to RRI at the foot, ankle, knee and the hip. These include rearfoot eversion and the rate at which loading was applied, (Napier et al. 2015), knee adduction and ankle eversion range of motion (Jungmalm et al. 2020). Hip and pelvis biomechanics in general have also been highlighted (Mokha and 2022). 2021). Abnormal biomechanics are suggested to lead to excessive compensatory movements of the lower limb, leading to stresses being transmitted through the leg, contributing to foot, ankle, knee, hip or low back pain in runners (Johnston et al. 2003). A number of studies have identified excessive foot pronation as a contributing factor to the development of RRI (Hreljac 2004b). A recent study investigated whether hip and pelvis biomechanics were associated with RRI in a group of college athletes (Mokha and 2022). 2021). Higher peak hip adduction was associated with an increased risk of RRI in college athletes, leading the authors to suggest that runners would benefit from motion analysis. However, this was a small study of only 12 participants so this limits extrapolation of the findings. In a larger but still not extensive population, a prospective cohort study of 89 recreational runners found that there was no significant associations between lower limb length discrepancy, Q-angle, subtalar angle and plantar arch index and the occurrence of RRI (Hespanhol Junior et al. 2016a). This is supported by a recent systematic review which found that evidence for biomechanical factors relating to increased RRI risk was ‘sparse and inconsistent’ (Ceyssens et al. 2019). The authors of this study reported that high quality research relating to biomechanics and RRI risk was lacking, partly affected by the variability in study methodologies, heterogeneity of the study populations and differences in outcome measures used between studies. Identifying differences between injured and non-injured runners can help to provide some information on possible risk factors but do not provide absolute measures of association when examining relationships between biomechanical characteristics and RRI (Jungmalm et al. 2020). This would suggest that in the development of an RRI prevention and management intervention, inclusion of biomechanics should be considered, but alongside the many other factors contributing to RRI.

2.3.2.7 Training factors

It has previously been stated that overuse injuries in runners are due to errors in training (Hreljac 2005). Training error is a broad term covering many variables within a training programme including volume, intensity and frequency (Nielsen et al. 2014b). Sudden increases in running distance are thought to overwhelm the musculoskeletal system and the ability for tissues to adapt and repair, thus resulting in the development of RRI (Hreljac 2005). When referring to training load in running several factors must be considered: training intensity distribution (TID), volume, frequency, intensity i.e., speed and additional capacity between runs. An increase in training loads whether that is attributed to TID, volume or intensity can exacerbate symptoms of a previous overuse injury which can be mistaken as a new injury. Injured runners can also adopt new movement strategies such as shortening their stride or adjusting the way their foot lands to protect the injured structure(s) when running leading to overload of musculoskeletal structures that previously had no issue, leading to new injury (Saragiotto et al. 2014a).

Excessive training volume has been suggested to be a risk factor in the development of RRI (Wen 2007). It is suggested that in the case of 60-70% of RRIs, excessive training volume is the main cause (Hreljac 2004; Nielsen et al. 2012; Nielsen et al. 2013a). Running volume has long been identified as a modifiable risk factor for habitual male runners (Macera et al. 1989). The authors suggested that men who ran more than 64 km per week would reduce their risk of RRI if they ran 48-64km a week instead. This study was conducted on habitual, experienced runners rather than the novice or recreational population so the results may not apply to these sub-populations Also sudden increases in volume will lead to injury as the increased exposure to stresses within the tissues exceeds the ability of the tissues to adapt and change accordingly (Damsted et al. 2018a).

When considering training volume, the ‘magic’ rule of 10% is regularly quoted anecdotally by runners and running websites as being the maximum volume that a runner should increase by each week. This concept was originally proposed in an article which summarized systematic reviews related to RRIs, with the authors recommending that to minimize the risk of injury, runners should increase training duration or intensity by no more than 10% per week (Johnston et al. 2003). However, this advice was based on what the authors referred to as level III evidence, defined as ‘expert opinion’, and not research trials or systematic reviews. In a study of novice runners there was found to be no differences in RRI prevalence between runners in a graded programme applying the 10% training volume rule and runners applying a standard training programme, with the rate of injury being 21% and 20% respectively (Buist et al. 2008). Total running volume per week has also been suggested to be a risk factor. However, a study retrospectively compared three groups of marathon runners who were categorized according to their weekly training volume (< 30km, 30-60km, above 60km) (Rasmussen et al. 2013). The risk of injury rose among runners who were running below 30km per week compared with those running above this volume, leading the authors to recommend that those wanting to complete a marathon should be running more than 30km per week in the lead up to their event. Despite excessive training volume being a potential cause for RRI there is also a cause for too little volume and therefore not enough ‘load’ as being a potential contributing factor to RRI. It is argued that the protective effects of training and exposure to load, e.g., volume, allows the body to tolerate load and subsequently training develops the physical qualities associated with a reduced injury risk e.g., strength, prolonged high intensity running, aerobic fitness (Gabbett 2020).

Running intensity (RI) refers to the speed at which a running session is performed. It has been proposed that volume and intensity lead to different types of RRI (Nielsen et al. 2013b). Ramskov et al. (2018) divided 839 recreational runners into two groups with two different training programmes: one focused on volume and the other focused on intensity. They found that there was no difference in risk of what were hypothesized to be intensity or volume specific injuries between the two groups. There is a question to be raised about the appropriateness of this study which the authors acknowledge. Exposing recreational runners to running schedules which may result in RRI seems inappropriate. There are large numbers of participants who were lost to follow up during this study which also limits its findings and questions over runners’ adherence to the running schedules.

Quantification of training in running is often built around weekly mileage but it is argued that this should not be the only metric and that other training load factors such as physiological and psychological efforts need to be taken into account (Paquette et al. 2020). Training load could be addressed in way to target specific RRIs, structures or group of runners where volume and or intensity is of critical importance e.g. Achilles tendon injuries in masters athletes (Napier and Willy 2021) however as discussed above there is limited evidence for this. Therefore, in the prevention and self-management of RRI external training loads such as mileage should be considered but perhaps not in isolation. Training loads should also be considered alongside other factors such as attributes of the individual runner, physiological stressors and psychological stressors (Napier and Willy 2021).

This section has discussed the varying risk factors that have been documented as having the potential to contribute to the development of RRI. RRI is multifactorial but there are some risk factors that have been found to be more strongly associated with RRI than other factors such as previous injury and being a novice runner (Saragiotto et al. 2013; Saragiotto et al. 2014c; Videbaek et al. 2015). There are many risk factors identified for RRI that could be addressed by active interventions and self-management. These potential interventions will be discussed in this chapter in the section on current approaches to prevention and management of RRI.

2.4 The impact of RRI

RRI has economic costs for runners such as requiring time off work to resolve an injury if it is severe enough that it impairs daily activity or the individual may incur health care costs through the pursuit of treatment for their injury (Hespanhol Junior et al. 2016b; Hespanhol Junior et al. 2016c; Hespanhol Junior et al. 2017). Withdrawal from running has also been found to influence mood, resulting in depression, anxiety and insomnia (Morris et al. 1990). For runners, other costs can include the costs of missing a race that they have been unable to participate in due to RRI (Sleeswijk Visser et al. 2021) but RRIs are not just a burden to the individual. Once an individual is injured it can have social, health and economic implications (Hespanhol Junior et al. 2016b; Hespanhol Junior et al. 2016c; Smits et al. 2016b; Sleeswijk Visser et al. 2021). RRI can result in healthcare utilisation (HCU) resulting in direct healthcare costs via face-to-face appointments and any investigations that are required (Hespanhol Junior et al. 2016d; Smits et al. 2016). In a group of injured novice runners, absenteeism from sport and HCU was investigated and found that 78% were absent from sports while 51% of the injured runners visiting health care professionals (HCPS) such as physiotherapists thus demonstrating high levels of HCU (Smits et al. 2016). Three to four visits to a private physiotherapist would incur an economic burden to the individual runner whereas in a publicly funded organisation such as the NHS, the burden is to health service resources. These findings are similar to another study which also found that RRIs had a high impact on sports and leisure activities, with 39% of runners visiting an HCP (Sleeswijk Visser et al. 2021). What is concerning from these studies is that runners seek high amounts of healthcare resources and require time out of the sport, subsequently losing the health benefits from running. Therefore, interventions that can reduce the burden on healthcare resources and keep runners within the sport to maintain their health are required.

There is a wider socio-economic impact to RRI. Runners who sustain an injury, in particular novice runners, can leave the sport as a result and no longer participate (Napier et al. 2015). This results in the individual losing the benefits to overall health that would have been gained via running. However, at a societal level those losses to health can have an impact on wider services. As discussed previously, chronic disease is a challenge for health and social care in the UK (NIHR, 2021) and globally (Hajat and Stein 2018). The loss of the health benefits that runners had gained via running may result in more health care visits for other health reasons such as weight management, and as discussed previously, cardiovascular benefits and a reduction in all-cause mortality (Pedisic et al. 2019). Chronic health conditions place an economic burden on health services, which have the potential to be avoided if the running population is supported in preventing RRI. This highlights the need to prevent RRI in this population (Hespanhol Junior et al. 2017). Therefore, reliable RRI prevention and self-management interventions are needed for runners in Wales so that the economic costs of RRI to the individual and the wider health services are minimised.

2.5 Current approaches for the prevention of RRI

The following section will explore current approaches to the prevention of RRI and the evidence surrounding them.

2.5.1 Educational approaches for the prevention of RRI

Education is a common method used to prevent many musculoskeletal conditions including RRI (Esculier et al. 2018b) and has been adopted as part of online interventions which have been developed to prevent RRI among recreational runners (Adriaensens et al. 2014; Hespanhol et al. 2018b; Fokkema et al. 2019c; Hollman et al. 2019). One study found reported that their intervention, which included educational components, did not reduce the numbers of RRI (Fokkema et al. 2019c), while another study found that their intervention did reduce the number of reported RRIs (Hespanhol et al. 2018b). Other studies looked at whether the intervention enhanced runners' knowledge of RRI prevention behaviours (Adriaensens et al. 2014; Hollman et al. 2019). There is also variation between studies as to how much exposure participants were given to the interventions and how runners and RRIs were defined which again leads to heterogeneity between the studies. Interventions in these studies incorporate education as an element of their interventions however there is a great deal of variety between studies in the form that this education takes, and how long runners in the study are exposed to the educational element. These studies also demonstrate a variation in the effectiveness of online prevention interventions comprising an educational component but also shows how education as an approach itself, can vary. More research is needed to explore what education and learning should comprise of, how runners incorporate education into their running practices and the levels of adherence required to achieve effective RRI prevention and self-management education. If education is to be a component of any digital RRI prevention and management intervention, these issues need consideration.

2.5.2 Exercise based interventions for prevention of RRI.

Exercise-based interventions, such as stretching, and strength programmes are often used to help prevent injury in sport (Linton et al. 2022). Previous research has suggested that strengthening is superior to stretching in the prevention of sports injuries (Lauersen et al. 2014; Lauersen et al. 2018). One review concluded that strength training reduced overuse injuries by a third. However, this review didn't just include studies which looked at running, but at many different sports, therefore these results cannot solely be generalised to the sport of running.

A study by Baltich et al. (2017) evaluated the effectiveness of different exercise interventions in reducing the incidence of RRI in a groups of novice runners. They compared the injury incidence of novice runners who performed exercises for eight weeks in one of three groups: a strength programme, functional sport specific movement strength training or a stretching control programme. No difference in RRI incidence was found between groups which indicated that no approach in this study was superior in preventing RRI, however this study was subject to a high dropout rate which potentially contributed to Type II error. Reasons suggested by the authors for this drop-out rate were that the stretching exercises were too monotonous, a lack of belief that the intervention would be of help and a lack of enjoyment of the stretching intervention and the ease of the intervention. The reference to the ease of the intervention could be linked to the exercises performed by the strength and functional groups, for example the strength programme comprised of exercises using elastic bands. It could be called into question whether exercises using elastic bands were sufficient for a lower limb strength programme aimed at running. The reasons for drop out may also need to be considered for their potential impact on adherence of any future RRI prevention and self-management interventions.

Stretching has been identified by runners as helping to prevent injury (Saragiotto et al. 2014b; Linton and Valentin 2018; Linton and Valentin 2020). Stretching, whether passive or active, has been used by both elite and recreational athletes to reduce delayed onset muscle soreness, improve range of movement (ROM) and reducing injury risk (Baxter et al. 2017). Studies have investigated the effects of stretching on RRI. A study of the training habits of marathon runners found that those with greater training loads and with more running experience tended to use stretching as an RRI prevention strategy but did not find a significant difference in the numbers of injuries reported by those who stretched and those who did not (Piekorz et al. 2021). However, the study did not discern between active and passive stretching, or whether runners used other injury prevention strategies alongside stretching. A systematic review which focused on static stretching found that it did not provide a significant advantage to endurance runners and that it did not reduce injury risk (Baxter et al. 2017). However, many of the studies in this review involved the elite or sub-elite population so may not be fully attributed to the recreational running population. A systematic review which concluded that that the data did not support the use of stretching for injury prevention purposes before or after exercise, only included two studies on stretching, and neither was on the recreational running population (Lauersen et al. 2014). An alternative view comes from a review of the effects on stretching on injury reduction risk and balance which found that pre-exercise and chronic stretching can reduce musculotendinous injury incidence in running-based sports (Behm et al. 2021). They argue that this could be due to increased force available at longer muscle lengths (altered force-length relationship) or reduced active musculotendinous stiffness. More research is needed in the recreational running population on the benefits of stretching for RRI prevention and management, alongside studies which could look at a combination of approaches.

2.5.3 Training Load Management

A graded approach to increasing running distance has already been identified as being key to preventing RRI. It is suggested that to minimise RRI, the duration or intensity of running should be increased by no more than 10% a week (Johnston et al. 2003). An RCT investigated whether a training programme for novices based on the 10% rule would have an effect on the incidence of RRI (Buist et al. 2008b). Novice runners in this prospective study, were split between a 13-week training group and an 8-week training group. There were no significant differences found in injury incidence between either of the training groups with these findings potentially disputing the effectiveness of the '10% rule' in reducing the incidence of RRI. Training load monitoring was found to help prevent injury in novice runners susceptible to RRI (Buist et al. 2010a). Research on novice runners as a population group is reported as lacking but what has been found is that there are patterns in the novice running group which can help identify those at risk e.g. BMI, previous injury and running experience (Gingrich and Harrast 2015). So far graded loading programmes have not been found to reduce the incidence of RRI among the novice running population (Buist et al. 2007; Buist et al. 2008a; Bredeweg et al. 2012). Therefore, interventions need to be developed which target novice runners in helping them prevent RRI but also aiding their return to running when they sustain an RRI, so that the gains in health and fitness that were made via running are not lost.

2.5.4 Footwear

The type of running shoe selected by runners for training is a modifiable factor that can be used to reduce the risk of RRI (Malisoux et al. 2020). Shoes with different levels of cushioning and shoes which control excessive foot movement have been developed to attenuate the forces that are transmitted through the lower limb during running (Malisoux et al. 2016a; Malisoux et al. 2020). Running shoe manufacturers will argue that their shoes will protect against injury (Theisen et al. 2016) which ties in with the idea that excessive pronation or supination can be a contributing factor to RRI. Running shoes are typically tested in the laboratory to establish their injury prevention qualities such as motion control, however these shoes are tested on healthy subjects in the lab, limiting application of these findings to runners experiencing RRI (Theisen et al. 2016; Malisoux and Theisen 2020). An RCT looked at whether motion control shoes modified injury risk in a group of recreational runners and found that the risk of injury was lower in those who wore the motion control shoes, with the study also finding that in a subgroup of runners with pronated feet, the rate of injury was significantly lower among runners who used the motion control shoes (Malisoux et al. 2016a). These findings are in contrast to a previous study which questioned the belief that pronation is a risk factor for injury in a cohort of novice runners (Nielsen et al. 2014a).

Shoes with shock absorption properties can also be used by runners to help prevent RRI. A large RCT involving 848 runners investigated whether the amount of shoe cushioning would influence the injury risk in recreational runners (Malisoux et al. 2020). Injury risk was found to be greater in runners who wore the harder shoe type compared to those using the softer shoe type. A secondary finding of this study was that lighter runners were at a higher risk of RRI in a harder, less cushioned shoe. Another study looked at the influence of different shoe heel drops on injury risk, comparing three groups of recreational runners who used shoes with different heel to toe drops (10mm, 6mm and 0mm) (Malisoux et al. 2016b). The authors found that shoe drop was not linked to injury risk but did find that regular runners were more at risk of injury in low drop shoes. One reason suggested for this was that regular runners had to transition from their usual shoes to the minimal drop shoes and that maybe the transition was too quick for these runners.

The evidence suggests that the choice of shoe type is a preventive strategy for the prevention and management of RRI (Malisoux et al. 2016a; Malisoux and Theisen 2020). Choosing a shoe according to a runner’s needs may be one way in helping to prevent injury however RRI is multifactorial and from the research it appears that the type of shoe selected will still be dependent on other risk factors such as BMI, foot type and running experience. Therefore, in developing a digital intervention for the prevention and management of RRI, footwear could be a strategy that is included but will need consideration alongside other factors that can contribute towards RRI, rather than shoes being considered a prevention strategy in isolation.

2.6 Current approaches for the management of RRI

2.6.1 Exercise approaches for the management of RRI

Within the running population, studies have suggested that strength training of the hip and the knee can have a beneficial effect on the pain experienced from PFPS (Tyler et al. 2006; Earl and Hoch 2011; Peters and Tyson 2013; Ferber et al. 2015). Heterogeneity between studies regarding the types of exercises used and the multi-joint effect of some of the exercises means that the effectiveness of the interventions cannot be isolated to one muscle group. Small numbers of participants in some of these studies also means that extrapolation of findings to the wider running population is limited (Tyler et al. 2006, Earl and Hoch 2011).

In the treatment of Achilles tendinopathy, exercise therapy is consistently supported by evidence (Silbarnagel and Crossley 2015). A systematic review found that heavy eccentric training was superior to a wait-and-see approach but was inferior to other exercise interventions such as slow resistance training (Murphy et al 2019). A more recent systematic review supported the use of eccentric exercises in the management of Achilles tendinopathy, however they concluded that more appropriately powered RCTs are needed to allow grouping together of studies for a meta-analysis (Prudêncio, Maffulli and Migliorini et al 2023). Both reviews called for higher quality research in this area (Prudêncio, Maffulli and Migliorini et al 2023, Silbarnagel and Crossley 2015).

Despite conflicting evidence there is some indication that strength exercises may be beneficial for recreational runners, however methods used in strength training for runners need consideration. Previous studies have demonstrated that eccentric strength training has the potential to help runners absorb force and provide lower limb stability allowing for better running economy (RE) (Sundby and Gorelick 2014, Li et al. 2021). When considering strength training interventions for recreational runners to improve RE and potentially prevent injury, eccentric strength and lower limb stiffness should also be included alongside maximal muscle strength programmes (Li et al. 2021)

In summary, there is clearly some evidence for the benefits of strength training for the prevention and management of RRI however there is no consensus over what strength training for recreational runners should consist of in terms of specificity, function or both. There is also a lack of high-level studies comparing strength training versus stretch training solely in the recreational running population, who are a very different population to the younger, athletic populations often included in studies. Therefore, any future digital intervention for the prevention and management of RRI should consider incorporating both strength and stretching exercises.

2.6.2 Gait and running re-training.

Gait re-training is an approach used to help runners return to running or as a management strategy for injury. Movement retraining is a process by which a motor program is changed with the aim of reducing pain or injury risk (Davis et al. 2020). In the development of some RRIs such as PFP, biomechanical stresses are a factor in development of pain and dysfunction, as well as reduced muscle capacity (Davis et al. 2020). Previous research has found that despite strengthening programmes, pain does not improve and neither do movement patterns such as hip internal rotation and hip adduction which have been connected to the development of PFP (Willy and Davis 2014). Therefore, movement retraining is proposed to change the way a person moves and as a way to reduce pain.

Running re-training for injured runners is the implementation of strategies to alter a runner's running technique (Barton 2018). These strategies can include encouraging runners to increase their step rate, transitioning runners from a rearfoot strike to a non-rearfoot strike or giving runners cues to run softer, widen their stance or 'engage' muscles (Barton 2018). Running re-training methods have been investigated for RRIs including anterior exertional lower leg pain and PFP (Diebal et al. 2012, Breen et al. 2015, Barton et al. 2016, Esculier et al. 2018c). A case series investigated whether transitioning runners from a rear foot strike to a fore foot strike would benefit the symptoms and running performance of females with PFP (Cheung and Davis 2011). They found that ground reaction forces were reduced when runners transitioned to forefoot running and found that there were improvements in pain and running distance. However, this case series was only in three female runners so despite the promising findings, extrapolation of the data is limited to other running populations and other RRIs. A systematic review of the evidence for interventions for runners with PFP and altered biomechanics reported that there was limited evidence for running re-training, arguing the need for more prospective studies with control groups and longer follow-up periods (Neal et al. 2016). Subsequently, an RCT by Esculier et al (2018c) found that gait re-training was of benefit to the symptoms and function of runners with PFP, but that running re-training interventions were not superior to education alone. However, this study did not include a control group and did not extend follow-up beyond the eight-week intervention period.

Case series studies have investigated the effect of running re-training in runners who experiencing running related exertional leg pain (Diebal et al. 2012, Breen et al. 2015). Diebal et al (2012) investigated whether adopting forefoot running technique would result in reduced symptoms associated with chronic exertional compartment syndrome (CECS). After a six-week intervention to transition runners to fore foot running they reported that runners had significant reduction in pain, improved their running distances and avoided surgical intervention. Another study gave ten runners a six-week intervention of gait re-training which included verbal cues to increase hip flexion, increase cadence, to maintaining an upright torso, and to achieve a midfoot strike pattern (Breen 2015). Following the intervention, the runners reported significant improvements in pain and running distance, with 70% of the runners reporting that they were running pain free. The results of both case series studies show some promise for running re-training in this small sample of runners and for the treatment of exertional pain syndromes of the lower leg, but they cannot be extrapolated beyond this small case series or to other RRIs.

A mixed methods study combined a review of the evidence alongside expert opinion to guide clinicians who want to implement running retraining in the treatment of lower limb injuries (Barton et al. 2016). There was limited evidence for increasing step rate or altering proximal mechanics in individuals with anterior exertional lower leg pain. Evidence for visual and verbal cues to reduce hip adduction in females with PFP was also limited. In addition, evidence for transitioning runners from rear foot to fore foot stride was limited. However, experts who were interviewed for this study felt that running re-training methods had a role to play in the treatment of conditions such as plantar fasciopathy, Achilles tendinopathy, ITBS and patellar tendinopathy. It is suggested that running re-training may have a part to play in rehabilitation of RRI but should be used in combination with other approaches such as exercises and education. More research is required with larger cohorts and as Barton et al (2016) conclude they should be part of a package of treatment such as education.

2.6.3 Education for management of RRI

Education is reported to have a role in the management of RRI. Education around training load management and modification of training according to symptoms is a management approach that has been utilised for the management of PFP (Esculier et al. 2018c) and Achilles tendinopathy (Silbarnagel, Hanlon and Sprague 2020). In the management of Achilles tendinopathy patient education is described as being vital for successful outcomes and compliance (Silbarnagel, Hanlon and Sprague 2020). It is argued that patients require understanding of the purpose of exercises, the use of the pain-monitoring models, load management and expected prognosis (Silbarnagel, Hanlon and Sprague 2020). An RCT on runners with PFP assigned runners to three rehabilitation groups: (1) education on symptoms management and training modifications (education), (2) exercise programme in addition to education (exercises), (3) gait retraining in addition to education (gait retraining) (Escalier et al 2018c). Despite the addition of exercises and gait re-training to education, the additional interventions did not provide more benefit to pain and function over education alone, leading the authors to conclude that education on training loads and symptom management should be the primary component of treatment for PFP (Esculier et al 2018c). This study was for a duration of eight weeks and there was no reported follow up period, so there is no indication whether the results of this study were carried over after the intervention had been completed.

A review of interventions for the management of RRIs found limited evidence for education as an intervention (Alexander et al. 2022). The authors reported that there are no RCTs supporting it as a management approach when compared with a control group or wait and see approach. A review of by Goff et al. (2021) aimed to establish whether patient education was effective as a standalone intervention or when combined with other interventions for people with knee osteoarthritis. They concluded that patient education should not be used as a standalone treatment but should be used in addition to other approaches such as exercises, but the findings are only applicable to patients with knee osteoarthritis. Overall, there is some evidence for the role of education in the treatment of musculoskeletal disorders such as RRI. More research is needed to establish how effective education is as an intervention for management of RRIs, whether it should be a stand-alone treatment or part of a package of treatment approaches.

2.6.4 Summary

Section 2.5 and 2.6 discussed the approaches and interventions that can be considered when preventing and managing RRI. Interventions that show promise have short-term effects or the studies do not include long-term follow-up to establish long term effects of interventions or long-term adherence to interventions. There is a need for accessible interventions which combine RRI prevention approaches, such as graded training and strength training, as well as interventions that aim to help runners self-manage RRI, facilitating return to running post injury, empowering runners and providing insights into how they can actively mitigate injury risks. With the rates of RRI among recreational runners, healthcare services have the potential to be impacted, therefore self-management of RRI is critical and cannot be ignored in favour of purely preventive measures for RRI. The next section will look at self-management and digital interventions as a growing method of delivery for healthcare interventions.

2.7 Digital interventions for the prevention and management of RRI

Self-management interventions are recommended on a global level as a way to improve health and well-being by enabling individuals to improve their own health, prevent disease and cope with any illness or disability without the direct support of an HCP (WHO, 2022). The Welsh government's Healthier Wales plan envisages a shift of services from hospitals and back into home and communities, with people being supported to be active and independent at home for as long as possible (Welsh Government, 2021). One of the design principles to drive forward the vision for A Healthier Wales is to support people in the self-management of their own health conditions (Welsh Government 2021). RRI is a condition that has the potential to fit into one of the health conditions that individuals in Wales could self-manage, minimising the need to see an HCP initially. Optimizing self-management for runners would empower them, enhance their autonomy when making decisions about self-management and subsequently reduce the need for NHS services.

. The Healthier Wales document acknowledges that although some individuals will continue to prefer face-to-face contact with an HCP, digital technologies have the potential to deliver services, such as self-management information to people in Wales (Welsh Government 2021).

In 2018 the World Health Assembly acknowledged that digital technologies have the potential to play a major part in improving public health (WHO, 2018). E-Health has been defined as the use of information and communications technology (ICT) to support HCPs and patients (Crico et al. 2018). Mobile health (mHealth) is a subset of e-Health which involves application of mobile technology to provide health services, share information and collect data. M-Health has the potential to offer fast diagnosis, a way to provide treatment and rehabilitation, in the form of self-management, to promote and enable people to adopt healthy behaviours (Crico et al. 2018). Evidence for the use of digital technologies in the self-management of musculoskeletal conditions is mixed. A review of digital technologies in the self-management of osteoarthritis (OA) found that digital self-management programs may result in improvement in pain and physical function for people with hip and knee OA (Safari et al. 2020). However, a review on digital technologies for low back pain (LBP) found that evidence for digital interventions for the support of self-management of LBP was weak (Nicholl et al. 2017). An online training programme undertaken by community coaches has been shown to have a significant impact on coaches' understanding of how to prevent and manage sports concussion (Glang et al. 2010b) however the sample size of this study was small, which limits extrapolation to the wider population and its findings are limited to youth sports, but it shows promise in how digital technology can upskill coaches. In running, an online tool for prevention of exercise related collapse in marathon runners was found to have no real effect with no significant difference found between runners who viewed an intervention video and those who did not (Worley et al. 2020). Runners in the intervention group were only sent the video two weeks prior to the marathon so it could be argued that the runners had no time to adjust their behaviours before the race.

Runners are already avid users of digital technologies and able to select from a wide range of GPS applications which can help support their running activities and training. One study found that 54% of runners used a running application for every training session (Kemler et al. 2018). Strava can help runners to be more active and achieve better fitness, but it is thought that it might not be suitable for novice runners (West 2015). It is also thought that because of the competitive nature of Strava in particular, risk-taking behaviours could be increased, which could in turn lead to injury (West 2015). Despite there being no current link identified between monitoring apps and RRI, it has been highlighted that runners may not always use these apps appropriately and that engagement of runners in predefined challenges may affect training behaviours, resulting in risky training behaviours, which in turn can lead to RRI (Shei 2018). From an RRI self-management and return to running perspective, it is suggested that digital technologies could provide a way for runners to monitor their training loads and identify whether the amount of running is suitable for their return to running from RRI (Willy 2018), therefore having the potential to help runners self-manage their RRIs and their return to running. The following section introduces current digital interventions for RRI prevention and management.

2.7.1 Digital/online interventions for RRI prevention and management

Within the running population, an online intervention tool tailored for runners was found to have a positive effect on the determinants of RRI behaviour such as knowledge, attitude, intention, and actual preventive behaviour (Adriaensens et al. 2014). The intervention in this study aimed to increase positive behaviour towards the prevention of RRI such as buying new running shoes more often, performing a warm-up and performing a proper workout routine. Recreational runners were invited to visit the study website for 30 minutes and instructed to study the section on the website specific to runners but were free to scroll through the other parts of the website which were specific to other sports. A control group were given magazines to read for 30 minutes that contained no RRI or running specific information. The study found positive effects on targeted behaviours described above but did not find that the intervention resulted in a reduction in the numbers of RRIs. However, the effectiveness of behaviours being measured in reducing RRI, such as buying new shoes and performing a warm-up, can be questioned. Evidence for the association of running shoes with RRI remains inconclusive (Theisen et al. 2016; Napier and Willy 2018) as does the evidence for warm up and the association with RRI (Hulme et al. 2017). So, while the study by Adriaensens et al (2014) found a positive trend towards performing behaviours such as buying shoes and performing a warm-up it can be argued that their intervention did not target key risk factors for RRI which include being a novice runner (Buist et al. 2010b; Videbaek et al. 2015) and previous injury (Hulme et al. 2017)

Hespanhol et al. (2018) evaluated the effectiveness of a tailored online intervention advice tool on the prevention of RRIs and the promotion of preventive behaviour in trail runners. They found that online tailored advice did not have a significant effect on preventive behaviours, but they did find that online tailored advice was effective for the prevention of injuries after six months. Hespanhol et al. (2018) felt that six-month follow up may not have been long enough to yield changes in behaviour. This study also focussed on trail runners who may not be fully representative of the general recreational running population. A strength of this study is that it used a framework for the development of the intervention, the Knowledge Transfer Scheme (KTS) which involved stakeholders, including runners. This study demonstrated that an online intervention has a significant preventive effect on the incidence of RRIs which supports its implementation in practice.

Hollman et al (2019) explored whether biweekly online tailored advice for the prevention of RRIs was more effective than general advice for enhancing prevention knowledge and behaviours in runners. The intervention used in this study had previously been developed in a previous study (Hespanhol et al. 2018). The authors found that runners who were exposed to the online intervention gave more correct answers regarding prevention and behaviours than the control group. There was no data available on whether the intervention had any effect on RRIs in the intervention group compared with the control group, just that they were better at answering the questions. There was low attrition in this study but there was no follow up after the intervention had finished to establish long term effects of the intervention and whether runners maintained their knowledge of prevention and behaviours regarding RRI prevention.

Another study investigated whether an online multifactorial prevention programme would affect the number of RRIs among a cohort of recreational runners (Fokkema et al. 2019c). The authors of this study implemented an intervention that was developed via an extensive literature search and aimed to modify risk factors for RRI. Runners were given access to the intervention via a website. They found that the intervention did not reduce the overall number of RRIs among recreational runners. The study by Fokkema et al (2019c) had large participation numbers with 1196 runners allocated to the intervention group and 1182 to a control group, but one of the limitations identified by the authors was that there was a low engagement rate with the intervention by runners in the intervention group indicating that the intervention used in this study may not have been acceptable or feasible to runners. The development of the intervention used in this study may therefore be questionable and provides an argument for interventions that are developed in a systematic way via scientific frameworks such as the MRC framework (Craig et al. 2008; Skivington et al. 2021).

So far it has been demonstrated that there is a small body of evidence for online interventions for the prevention and management of RRI with all the current studies focussing on website interventions and no studies aimed at RRI using smartphone platforms. Smartphone applications (apps) are criticised for being simplistic and for only containing very basic information, as well as there being little evidence that the development process involves health professionals or the end users (Edwards et al. 2016). There are in existence injury prevention and medical diagnosis apps available to consumers however the evidence used to inform these apps has been found to be lacking (van Mechelen et al. 2014; Buechi et al. 2017). A systematic review of the content of available sports and physical activity-related injury prevention apps found that out of 18 applications, only four contained information that was evidence based (van Mechelen et al. 2014.) Five of the applications contained information regarding RRI prevention with suggested strategies including use of proper running shoes, warming-up and stretching, cool downs and strengthening exercises. Within the literature only the strategy of the implementation of strength exercises has been found to reduce sports injury (Lauersen et al. 2014b). Any RRI prevention application needs to be evidence based but also needs to have ease of use, while the developers of such an application may need a better understanding of commercial development and appeal, especially as van Mechelen et al. (2014) found that the applications with an evidence base had lower user ratings than those lacking a supporting evidence base.

The literature review above demonstrates that there are very few studies investigating digital interventions for the prevention and management of RRIs, with commercially available interventions found to be lacking in any scientific basis for their content (van Mechelen et al. 2014). The studies reviewed here focus on prevention and do not address self-management of RRI. There is wide variation in how interventions are developed, with only one study using a development framework and only one study involved running stakeholders in the development of their intervention (Adriaensens et al. 2014; Hespanhol et al. 2018; Fokkema et al. 2019c). The involvement of stakeholders such as HCPs, runners and other stakeholders such as National Governing Bodies (NBG) are clearly lacking. Involvement of NGBs is justified as all those who may be impacted by interventions or have a role in promoting interventions become stakeholders. The involvement of all stakeholders in the development of complex interventions is vitally important and this is discussed throughout the Medical Research Council's (MRC) guidance for the development and evaluation of complex interventions (Skivington et al. 2021) which will be discussed in more detail in Chapter 3. This lack of evidence for online interventions for prevention of RRI and the fact that there are no studies on digital self-management interventions for RRIs demonstrates a gap in the literature and justifies the current thesis.

2.8 Summary

This literature review has demonstrated that running is a popular activity but as running has increased in popularity, so has the increase in RRI (Videbaek et al. 2015). There is a need to address the increase in RRI as the consequences of RRI are that runners, particularly novice runners, will leave the sport altogether (Gingrich and Harrast 2015) or lose the benefits that running has given them such as weight loss, cardiovascular fitness, reduction in all-cause mortality (Pedisic et al. 2019) and the social benefits of being a runner (Shipway and Holloway 2010; Grunseit et al. 2017)

The risk factors most associated with RRI are previous injury (Saragiotto et al. 2013; Saragiotto et al. 2014a) and being a novice runner (Videbaek et al. 2015) . Research studies discussed above in the current approaches to injury risk assessment, prevention and management of RRI include graded training programmes (Buist et al. 2007; Buist et al. 2008), pre-conditioning (Bredeweg et al. 2012) or specific exercise programmes for the management of specific RRIs (Earl and Hoch 2011). There is a lack of evidence for interventions that are designed to help runners self-manage RRI. The evidence is mixed and there is no conclusive evidence for any of these approaches on their impact on the rate of RRI or whether they successfully prevent or manage RRI. RRI is multifactorial and there does not appear to be a 'one size fits all' in the heterogenous group that makes up the recreational running population.

Alongside the growth of the running population so has the development of technology that runners use to monitor and track their training (Kemler et al. 2018). Digital technologies have a potential to offer fast diagnosis and provide information on treatment and prevention (Crico et al. 2018) leading to RRI prevention and self-management information. There are studies which have investigated the effectiveness of online interventions for the prevention of RRI but the results are mixed, there is variability in the targets of the interventions and the way the interventions are designed with none of the studies including self-management for RRI in their intervention designs (Adriaensens et al. 2014; Hespanhol et al. 2018; Fokkema et al. 2019c; Hollman et al. 2019) . Importantly, the current literature indicated clear gap in how these interventions are developed, rarely involving stakeholders at all levels of the sport of running in the development of the interventions. It is argued that combining digital technology with interventions for the prevention and self-management of RRI could have the potential to impact rates of RRI within the recreational running community. In consideration of the literature reviewed the main aim and objectives of the study are detailed in the section below.

2.9 Aims and objectives of the study.

The main aim of this study is to fully engage with all relevant stakeholders (runners, clinicians and NGBs) as the first stage towards development of a digital personalised RRI prevention and self-management intervention for recreational runners.

In accordance with the recently updated MRC complex intervention development framework (Skivington et al. 2021). The objectives of the study are as follows:

1. Conduct a scoping review to evaluate the randomised controlled trials which develop and evaluate current digital RRI prevention and self-management platforms available to runners.

2. Map the RRI experiences of recreational runners and their use of digital technology, establishing possible associations between sub-groups of runners, RRI, use of digital technology and preferences for the content of a proposed digital intervention.

3. Explore the views of recreational runners regarding the content and possible platforms for a proposed RRI prevention and self-management intervention, using the findings to establish approaches to inform development of the digital intervention.
4. Explore the views of other stakeholders (e.g., health practitioners, coaches and Run Leaders from the National Governing Body (NGB) of Welsh Athletics) regarding the content and possible platforms for a proposed digital RRI prevention and management intervention, using these findings to help develop the approaches that should be used in development of the intervention.

Figure 2 presents a skeleton of a Logic Model which will be completed at the end of the thesis once findings have been collated and reported. This logic model will present a summary of how the intervention will work via inputs, outputs and implementations, short-, medium- and long-term goals, potential impact and the relationships between them (Gov.UK, 2018). The inputs show the resources that are required for data collection and development of the proposed intervention. Outputs will present the findings of the thesis. Implementations refers to how the intervention will be delivered in practice as well as what will be delivered. Outcomes refers to the changes that the intervention aims to achieve, and the mechanisms used to achieve them. The logic model provides a simplified picture at the end of the thesis of the resources and inputs that were invested, the activities that took place and the potential benefits and outcomes (University of Wisconsin-Madison, 2023)

The next chapter details the methodology underpinning the selected approach and describes methods to achieve the objectives of this study.

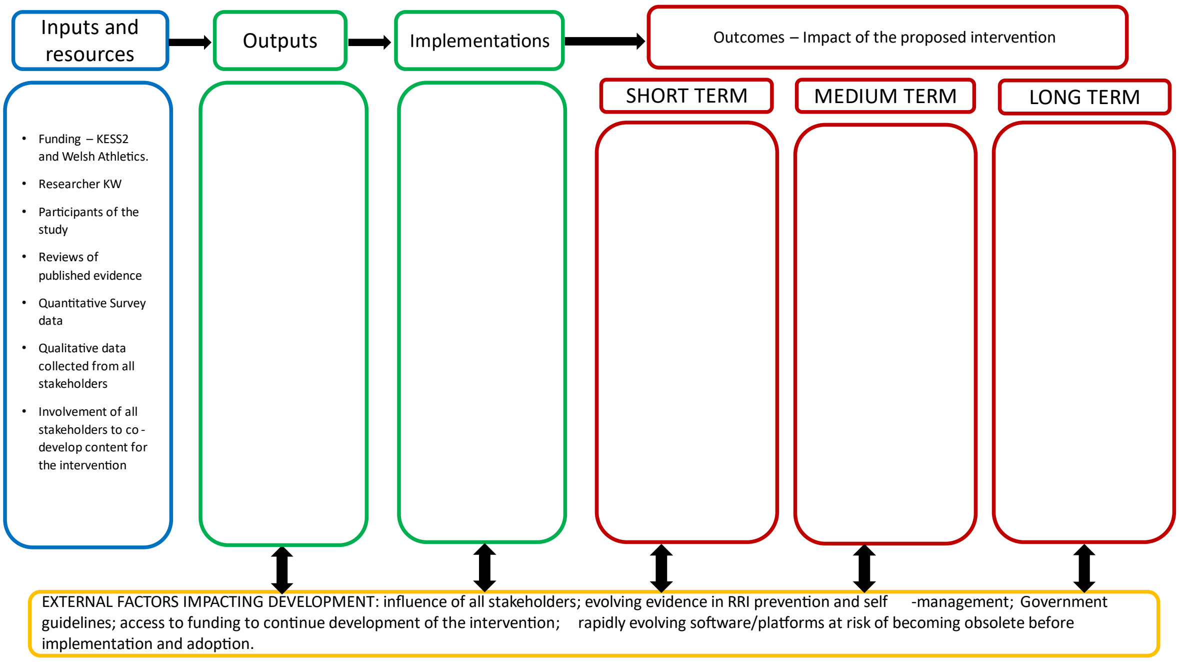


Figure 2 Logic model prior to data collection and reporting of findings

Chapter 3: Methodology

3.1 Introduction

Methodology refers to the choices made about what is being studied, data gathering methods and forms of data analysis in planning and conducting a research study (Silverman 2004). This section will focus on the methodology chosen, beginning with a discussion of the frameworks currently used for the development of complex interventions followed by the methodological approach chosen for this study, the design, and the methods.

3.2 Research paradigms and approaches

All research has a philosophical foundation for conducting research. When conducting research all researchers tend to make assumptions about gaining knowledge during the process, which can both the process and the conduct of inquiry (Creswell and Plano Clark 2017). These philosophical assumptions can be seen as worldviews, or paradigms (Creswell and Plano Clark 2017). The original use of the term paradigm by Thomas Kuhn defines it as 'a set of generalisations, beliefs, and values of a community of specialists' (Creswell Plano Clark 2017 p. 39). Each branch of scientific inquiry is based on a set of paradigms, which are important as they provide frameworks and perspectives for conducting research and interpreting observations (Bowling 2002). Varying paradigms lead different researchers to interpret the same reality differently, therefore all researchers should be aware of their theoretical perspectives and assumptions about the research topic, report them honestly when analysing findings (Bowling 2002).

Research methodology relies on ontology and epistemology. **Ontology** refers to the nature of reality and what is real and the nature of existence (Crotty, 2020, Cresswell and Plano Clark 2017). E**pistemology** is how we gain that knowledge and the relationship between researcher and the subject being researched (Creswell and Plano Clark 2017). Ontological positions specify the relationship between the world and our interpretations of the world and determines whether or not we think reality exists separately from human understandings or whether we think they cannot be separated (Braun and Clark 2013). Believing that reality is independent of human understandings is **realism** (Crotty, 2020), while the view that reality is dependent on human interpretation and knowledge is known as **relativism** (Braun and Clark 2013). Realism is the ontology that informs quantitative research and assumes a world that is comprehensible via research, where what is observed mirrors truthfully what is there (Braun and Clark 2013). At the other end of the continuum, relativism argues that there are multiple constructed realities rather than one single truth and that what is 'true' differs across time and context. Relativist ontology is underpinned by qualitative approaches. In between relativism and realism sits **critical realism**, this position suggests that some authentic reality needs to exist to produce knowledge that might make a difference and people's feelings provide a foundation for knowledge. Critical realism underpins some versions of thematic analysis and grounded theory (Braun and Clark 2013).

The main concern of epistemology is the theory of knowledge and considers 'What is Knowledge?' and 'What can we know?' (Greco and Sosa 2017). It is about the nature of knowledge, what counts as knowledge and determines how useful knowledge can be generated (Braun and Clark 2013). This theory of knowledge becomes embedded in the theoretical perspectives and therefore influences research methodology (Crotty, 2020). Like ontology it can be realist or relativist: a realist position assumes that is possible to obtain a single truth, whereas a relativist epistemological stance states that a singular, absolute truth is impossible due to knowledge always being perspective (Braun and Clark 2013). Epistemological positions of positivism, constructivism and pragmatism will now be explored.

The methods used by a researcher will be informed by the researcher's ideas and assumptions about society (Bowling, 2002). **Positivism** is a method of investigation that has its research methods drawn from natural sciences (Bowling, 2002). It aims to discover laws via quantitative methods (Bowling 2002; Creswell and Plano Clark 2017), assuming that there is one single objective reality that can be tested subject to the laws of the scientific method (Bowling 2002, Crotty 2020). In social sciences positivism assumes that human behaviour is a result of external stimuli (Bowling 2002). Popular tools used within the positive paradigm include surveys, experimental methods and statistical analysis. In health and social care interviews will be standardized to reduce the influence of the instrument used and the interviewer on participants (Bowling 2002).

Constructivism is associated with more qualitative methods and works from a different world view based on understanding phenomena. Meanings are constructed by our engagement with the world we are trying to interpret (Crotty, 2020) and participants and their subjective views subsequently make up the world view. The data provided by participants via constructivism methods is shaped by their social interactions and their personal histories. This research leads to broad understanding and the generation of theories about phenomena (Creswell and Plano Clark 2017).

Pragmatism is a world view that is associated with mixed methods research. The focus is on the consequences of the research rather than the methods. Multiple methods of data collection inform problems that are being studied and are focused on what will work in practice (Creswell and Plano Clark 2017). Whereas positivism will view reality as singular and constructivism will view reality as multiple, pragmatism will view reality as both singular e.g., there may be one explanatory theory for a phenomenon, and as multiple e.g., it is important to assess individual input into a phenomenon (Creswell and Plano Clark 2017). From an epistemological view, pragmatism enables research to steer away from debates on truth and reality and focus on understanding real world problems (Kelly and Cordeiro 2020).

Epistemologically, pragmatism is premised on the idea that research can steer clear of metaphysical debates about the nature of truth and reality and focus instead on 'practical understandings' of concrete, real-world issues. The worldview that is seen as 'best' for mixed methods is a pragmatic approach as it uses diverse approaches, valuing both objective and subjective knowledge. A pragmatist approach has been linked to mixed methods research. The research question is seen as of primary importance rather than the method or the philosophy and both quantitative and qualitative methods can be used in a single study (Creswell and Plano Clark 2017). Therefore, pragmatist epistemology underpins the approach to this mixed methods study. As for the overall approach to this study, an **inductive** approach was taken to enable observations to be taken across the data, building patterns and ideas that can be developed into hypotheses for further testing (Bowling, 2002).

3.3 Development of Complex Interventions

There are various models of intervention development including the Knowledge Transfer Scheme (KTS), (Verhagen et al. 2014a), Six Steps in Quality Intervention development (6SQuID) (Wight et al. 2016) and the Medical Research Council (MRC) guidance on developing and evaluating complex interventions (Skivington et al. 2021a).

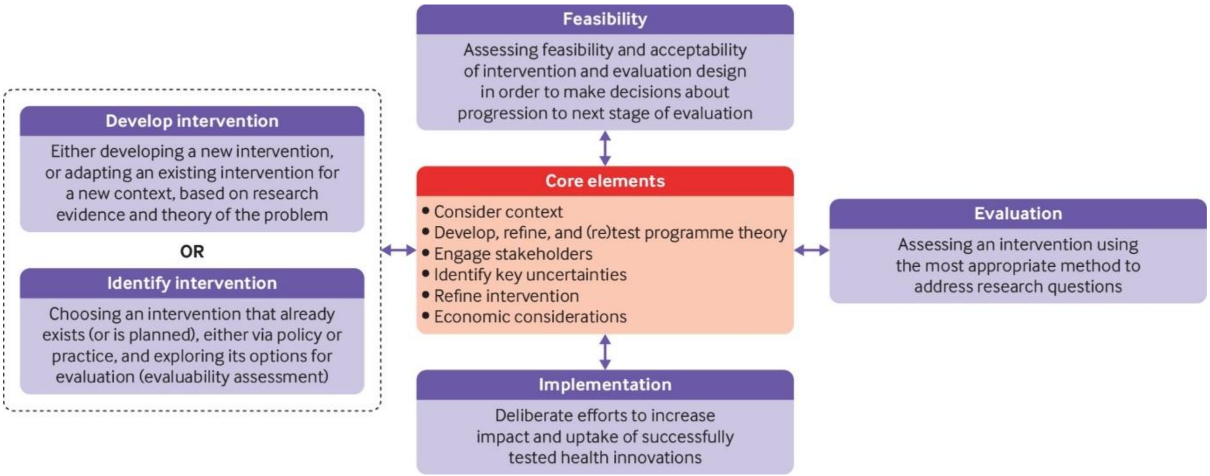
The KTS is a five-step programme which involves identification of the problem, evidence synthesis of the problem, usually in the form of a systematic review, a Knowledge Transfer Group (KTG) involving all stakeholders affected by the problem, intervention development ending with evaluation of the product so that translatability and feasibility of the developed intervention can be established (Verhagen et al. 2014a). The KTS has previously been used to develop a tennis-specific injury prevention programme (Pas et al. 2018) and an online RRI prevention intervention (Hespanhol et al. 2018). This development process requires synthesis of existing evidence and information that has been gathered via primary data collection (Verhagen et al. 2014a). The KTS is loosely based in Intervention Mapping, however it aims to seek existing effective interventions that fit the problem in a population (Verhagen et al. 2014a). Therefore, the KTS is not suited to the current study as the current study aims to develop a new intervention for an existing problem: a digital RRI prevention and self-management intervention for recreational runners.

The Six Steps for Quality Intervention Development (6SQuID) is a framework utilised for the development of public health interventions (Wight et al. 2016). The 6SQuID framework is similar to the KTS and has been developed to maximize effectiveness of interventions (Pringle et al. 2018). In a similar way to the KTS, 6SQuID defines the problem, but then goes on to clarify the causal and contextual factors that can be changed by the intervention. 6SQuID then identifies the mechanism of change, how to deliver change, tests it and then establishes effectiveness. The 6SQuID framework has previously been used to develop interventions to support positive behaviours in adolescents (Pringle et al. 2018). As well as synthesis of the current evidence to define and understand the problem, co-production with key stakeholders is central to the intervention development process outlined by the 6SQuID framework with thought given to the health problem at hand and the context (Pringle et al. 2018). A systematic review explored which frameworks have been used to guide the development of rehabilitation interventions for older adults (Booth et al. 2019). They concluded that the 6SQuid framework was more suited to public health interventions over complex rehabilitation interventions (Booth et al. 2019). Therefore, the 6SQuID framework is less suited to the development of the proposed RRI prevention and self-management intervention as the proposed intervention intends to be developed to include self-management/rehabilitation.

In 2006 the Medical Research Council (MRC) published guidance on the development and evaluation of complex interventions with the aim of helping researchers to recognise and adopt appropriate methods to improve the quality of research to develop and evaluate complex interventions (Craig et al. 2008; Skivington et al. 2021a). This guidance was updated in 2021 to reflect developments in the field of intervention research (Skivington et al. 2021a; Skivington et al. 2021b). The updated framework still includes the four phases of development, feasibility, evaluation and implementation as described in the 2006 guidance, however the 2021 updated framework defines a complex intervention as both the content and the context in which it is conducted, more emphasis on health services delivery and policy changes and the identification of six core elements to be addressed throughout the research process: theory refinement and testing; stakeholder involvement; identification of key uncertainties; intervention refinement; and economic considerations.

What all the models have in common is that there are stages where current evidence needs to be appraised to establish the extent of the problem, current interventions need to be assessed for their effectiveness, the extent of the problem needs to be established with stakeholders, the best way to deliver the intervention needs to be established with stakeholders and unintended effects or consequences of using the intention need to be considered. The intervention development stage of the MRC framework (Skivington et al. 2021b) recommends a review of published research evidence to identify existing interventions and understand the evidence base, therefore Phase 1 of this project is a scoping review of the current evidence for digital interventions for the prevention and self-management of RRI.

The KTS aims to fit existing interventions with a current problem and the 6SQuID framework is itself based on the MRC framework, therefore it was felt that addressing the main aim of this thesis was better addressed by the updated MRC framework (Skivington et al. 2021a; Skivington et al. 2021b). The updated MRC framework also emphasises an iterative process that can require going back a step to repeat phases rather than automatic progression and linear progression and cut-offs recommended by the 6SQuID model (Wight et al. 2016; Skivington et al. 2021b). Following consideration of the other frameworks it was decided that the updated MRC framework for developing and evaluating complex interventions was the most appropriate framework for this thesis (Skivington et al. 2021a; Skivington et al. b). Figure 3 illustrates the stages of the updated MRC framework. This project focusses on the 'Develop Intervention' stage of the MRC framework which will achieve the main aim of this project to develop an RRI prevention and self-management intervention.



<u>Figure 2 Updated MRC framework (Skivington et al 2021)</u>

The development stage of the framework is seen as the design stage of the proposed intervention. The new MRC framework refers to the work by O'Cathain et al. (2019) in the developing intervention stage. Stages include planning the development process, involving all stakeholders who will use deliver, use and benefit from the intervention and reviewing published research evidence to understand the evidence base for the proposed intervention (O'Cathain et al. 2019). Planning the development process for this thesis means identifying the problem to be targeted which are the increasing RRIs impacting on recreational runners' abilities to run and therefore affecting their long-term health and at a wider level public health. The problem of RRI and the need to tackle this problem via an intervention was explored in Chapter 2. The MRC guidance for the development of complex interventions recommends a review to identify whether suitable interventions already exist prior to going on to develop any proposed interventions (Skivington et al. 2021a) therefore a review of the published evidence for current digital interventions for the prevention and self-management of RRI needs to be undertaken.

3.4 Research Methods

There are several different ways to collect and analyse data within the MRC framework described above. These include quantitative (mainly in the form of surveys), qualitative approaches, or a mixed method approach. Quantitative studies usually allow sampling of larger populations (Bowling 2002). Quantitative surveys have the ability to collects large amounts of data, leading to ease of data collection and analysis (Bowling 2002). Findings from quantitative research can be generalized to large groups and researcher bias is reduced (Creswell 2017). However, despite allowing sampling from larger populations the data collected often doesn't provide sufficient depth of information from which to develop a tool/intervention as there is a lack of understanding of the context or setting of the intervention (Creswell 2017).

Conversely, qualitative studies can provide rich information but often by their nature, from a much smaller sample. Qualitative methods in sport and exercise are becoming more widely used and respected for the value they bring in relation to the experiences of individuals and to provide voices to those involved in sport and exercise (Bekker et al. 2020). In the area of elite sport qualitative research is being used to provide insights into the meaning and understanding of the factors that can help understand what influences the uptake of injury prevention methods (Bonell Monsonís et al. 2021). For example, in efforts to understand the contextual factors and their interactions in sports injury prevention, semi-structured interviews were conducted with elite athletes to develop deeper insights that could be used to develop new theories (Bonell Monsonís et al. 2021). However, qualitative research can be seen as deficient because of interpretations made directly by the researcher, creating bias. Participant numbers are also limited which prevents findings being generalised to larger populations (Creswell 2017)

Mixed methods approaches are becoming increasingly popular in healthcare (Pizzari et al. 2002) and is recognized as a research approach (Johnson et al. 2007). Mixed methods combine quantitative and qualitative methods into a single program of inquiry (Johnson et al. 2007; Curry et al. 2013). The strengths of each approach can be complementary and characterise complex ideas more fully than using just one approach (Curry et al. 2013). In the development stages of a complex intervention the MRC framework (O'Cathain et al. 2019; Skivington et al. 2021c) recommends reviews of current evidence and new primary research to better develop proposed interventions. A mixed methods approach has the benefit of investigating contextual factors that may affect the proposed intervention (Zhang and Watanabe-Galloway 2014). Within the mixed methods paradigm there are different design procedures, data from quantitative and qualitative data can be collected sequentially or concurrently (Zhang and Watanabe-Galloway 2014). Mixed methods can also enhance the quality of a proposed health intervention and help understanding of barriers to the proposed intervention (Zhang and Watanabe-Galloway 2014). To develop the aim of this study via the updated MRC framework it was decided that a mixed methods approach was the most suitable methodology for this study. This would allow for sampling a larger population initially, then using that information to structure data collection of more in-depth themes arising from the quantitative phase.

Prior to conducting further research, the potential users/stakeholders of the proposed digital RRI prevention and self-management intervention needed to be identified. The MRC guidelines state that appropriate 'users' should be involved at all stages of the development, process and evaluation of a complex intervention (O'Cathain et al. 2019). For this development phase of the proposed RRI intervention, it was decided that all 'users' or stakeholders who could provide insights into the targeted problem i.e., RRI should be involved. These stakeholders include recreational runners who are directly affected by RRI, practitioners who are directly involved in aiding runners with preventing and managing RRI and those at the NGBs of Welsh Athletics and Run Wales who are involved in decision making around the sport of running.

All stakeholders in this study will have input into the development and any further evaluation of the proposed intervention. Stakeholders are those who will use the intervention, a practitioner who may recommend or deliver the intervention to patients/public and voluntary or third sector organisation and policy makers (Cathain et al. 2019). The involvement of stakeholders is necessary for the development of any complex intervention. To leave stakeholders out of development introduces a number of risks which include the resulting intervention failing to achieve its proposed effect or an effective intervention not being implemented or adopted by the target population (Skivington et al. 2021a). By working with runners, practitioners, and representatives from Run Wales from the development stage of the proposed digital RRI intervention, priorities for the intervention can be identified. Involving runners, practitioners and Run Wales representatives can also help identify solutions to problems and barriers that may make a difference to any future implementation of the intervention in the real world (Cathain et al. 2019). Following identification of the relevant stakeholders this study was designed to involve primary users of a proposed RRI intervention: recreational runners, practitioners who are involved in assessing, managing, and coaching runners and Run Leaders from Run Wales who help to support and facilitate social running groups. Subsequently the study was divided into phases:

- Phase 1: Review of the current evidence.
- Phase 2: Recreational runners:
    - Part 1: Survey of runners.
    - Part 2: Focus groups with runners.
- Phase 3: Other stakeholders
    - Part 1: Focus groups with practitioners.
    - Part 2: Interviews with Run Leaders from Run Wales.

The three phases of the project will now be discussed in more detail.

3.5 Phase 1: Review of the current evidence.

This Phase is designed to achieve the first objective of the larger study which was to establish the current evidence for digital RRI prevention and self-management interventions. There are several options available to investigate the available evidence. Whilst systematic reviews are typically used to collate evidence to support a specific practice or approach, with the aim of guiding decision-making, scoping reviews can be more useful in investigating available evidence on a topic an identifying knowledge gap (Munn et al 2018). For this study it was decided that a scoping review would be more appropriate. It was also more appropriate as the existing literature was heterogenous and not amenable to a more precise systematic review (Khalil et al. 2016). The scoping review method also uses a broader inclusion criterion that could be used to identify all studies of all methods involving digital interventions for the prevention and self-management of RRI, as well as their development and the theories used in the development of the interventions. It should be noted that there are limitations to a scoping review when compared with a systematic review: scoping reviews do not appraise the quality of the evidence or the rigor of the included studies, and they do not address synthesis of evidence (Arksey and O'Malley, 2005). Therefore, the scoping review provides more of a narrative account of the research in this area (Arksey and O'Malley, 2005).

This scoping review allowed identification of existing digital interventions for the prevention and self-management of RRI in recreational runners. A review of the evidence can also help to identify facilitators and barriers to implementing the proposed intervention while also identifying key uncertainties that can be addressed using primary data collection (Cathain et al. 2019). In the case of this study, the proposed intervention is a digital RRI prevention and self-management intervention. Therefore, a review was performed to identify the current evidence for digital or online RRI prevention and self-management interventions. The literature review discussed four RCT's which were identified to include digital interventions for the prevention of RRI. The inclusion criteria broadened criteria to include studies of different designs to review all research done in this area.

3.6 Phase 2: Recreational runners

The second objective of this study was addressed in Phase 2 of this study which was split into two parts:

Phase 2 Recreational runners:

- Part 1: A survey conducted on recreational runners. Quantitative data from this survey was collected and analysed to inform the qualitative stage of this Phase.

- Part 2: Focus groups of subsets of those surveyed (Zhang and Watanabe-Galloway 2014).

A survey allows data collection from a relatively large sample of people from a pre-determined population (Safdar et al. 2016). Other advantages to the online survey method are that they are cheaper than postal and telephone surveys (McPeake et al. 2014) and web-based survey packages can allow easy analysis of data providing accessible concurrent analysis (McPeake et al 2014). Due to the online nature of the survey respondents may also be more willing to share information (Safdar et al. 2016). A number of studies have used surveys for research on the recreational running population (Janssen et al. 2017; Linton and Valentin 2018; Fokkema et al. 2019b)

One benefit of conducting a retrospective cross-sectional survey is that potential associations can be identified between sets of data. For example, in previous studies on RRI, associations have been between factors and the incidence of RRI which include being an older woman (van der Worp et al. 2015), being male or a novice runner (Buist et al. 2010c; Linton and Valentin 2018), having a higher body mass index (Buist et al. 2010c) and previous injury (Hespanhol Junior et al. 2013; Saragiotto et al. 2014a; Dallinga et al. 2019). Conducting an online survey provided a different way of recruiting and sampling a wider range of participants and extended beyond participants who are regarded as typically taking part in survey research e.g., educated, middle class (Braun 2017). The online survey responses were followed by more in-depth qualitative approaches e.g., focus groups, interviews to add depth and obtain further information from participants (Safdar et al. 2016), which is another benefit of this approach.

Surveys conducted on recreational runners have been used for varying reasons, from establishing injury history and opinions on injury (Linton and Valentin 2018; Fokkema et al. 2019b) to establishing which technology recreational runners use (Janssen et al. 2017). Online questionnaires appeared to be the predominant method among survey research conducted on the recreational running population (Janssen et al. 2017; Linton and Valentin 2018; Fokkema et al. 2019b). There is therefore a very strong precedent for online questionnaires as a method used when conducting research on recreational runners. Online surveys allow comparison of results with previous surveys. They also allow comparison of results with studies involving different populations of runners e.g., trail runners, masters runners. The development of the survey is described in more detail in the methods section of Chapter 5 which reports the survey study. The findings of this survey informed the topic guide that was developed for use in the focus groups used in Phase 2: Part 2.

The method used for Phase 2: Part 2 part of the thesis was online synchronous focus groups (FGs). These FGs were designed to take place face-to-face but due to the COVID pandemic and restrictions around gatherings implemented by the Welsh Government an online method was adopted. Synchronous qualitative in-depth FGs were the method chosen both for FGs with runners and practitioners. Using FGs is a form of participatory research, involving stakeholders such as runners in the creation of evidence, identifying what matters most to runners regarding RRI prevention and self-management, allowing runners' voices to be prominent and enable them to work in partnership in the development of a proposed intervention that they could eventually use (Gregory 2010).

The approach being used for these focus groups is argued to be a narrative approach whereby the intention is to elicit firsthand experiences of a phenomenon firsthand (Gregory 2010), in this case runners' experiences, thoughts and ideas surrounding RRI prevention and management and the proposed intervention. The approach is a naturalist, realistic approach which is intended to bring out rich descriptions of the phenomenon being explored (Gregory 2010). This approach is appropriate to the research question as it establishes runners' direct experiences of RRI prevention and management. It could be argued that an ethnographic approach using observation could have been used but the research aims and objectives of this study are not to understand behaviour but to gather narrative experiences around RRI prevention and self-management. Focus groups enable the researcher to elicit discussion via a topic guide whereas in an observational study the researcher would have to wait for something to happen (Gibbs 1997).

3.7 Phase 3: Practitioners and Other stakeholders.

<u>Phase 3</u> aimed to tackle the final objective of this study which was to explore the experiences and opinions of other stakeholders (practitioners and Run Leaders) regarding

RRI prevention and self-management and their views on a proposed digital RRI prevention and self-management intervention. Phase 3 was also split into two parts:

- Part 1: Focus groups with practitioners who are involved in assessing, treating, managing and coaching recreational runners (clinicians, personal trainers, strength and conditioning coaches).
- Part 2: Interviews with Run Leaders who support recreational runners and lead social running groups to facilitate running.

3.7.1 Phase3: Part 1: Practitioners

The aim of Phase 3: Part 1 of the thesis was to map practitioner views and experiences of RRI prevention and self-management, their opinions on the proposed digital RRI prevention and self-management intervention and the unintended consequences that they perceived to the proposed intervention. Focus groups were used so that aspects of running and RRI could be identified that may not have been considered by the researcher even as a runner or as a physiotherapist, concentrating on the frames of reference of groups analysed, than on those of KW the researcher (Acocella 2012). Participants were also working in similar areas and had a similar interest in treating and managing runners, so could therefore be seen as being equal to each other, with differing opinions expressed (Acocella 2012). Other methods such as observation and examination of documents were not deemed to be feasible for this study due to time limitations and issues around ethics and confidentiality. It was also felt that FGs would be more suitable than interviews as a greater range of views and ideas would be able to be generated and that the rapport between participants would generate more discussion (Bowling 2002; Clarke and Braun 2013). The specific methods of the FGs such as the online method, the topic guide, recruitment, sampling, data collection and data analysis will be discussed in greater detail in chapter 7.

3.7.2 Phase 3: Part 2: Other stakeholders

Phase 3: Part2 of this study involved interviews with other stakeholders that may have a stake in the development of such an intervention. The local Run Leader (RL) population have direct contact with runners experiencing RRI in social groups and receive some education about RRI prevention and management on the Leadership in Running Fitness (LiRF) course.

One-to-one interviews were deemed most appropriate for the final part of Phase 3 in this study. It was felt that participants would be coming from a smaller pool of potential participants and that the numbers would not be sufficient to justify FGs. As the stakeholders were employed by, or volunteers, Welsh Athletics they would be able to speak more freely in one-to-one interviews. In-depth semi-structured interviews were the method chosen to engage stakeholders from Welsh Athletics for this study. Texts and documents were not something that were kept by participants regarding their interactions around RRI prevention and self-management. Observational studies of social running groups and their interactions could have been a possibility, however there was no guarantee that any runners would approach RLs to discuss RRI during these sessions. The objective of this data collection was not to fully understand RLs in an ethnographic manner (Silverman 2004), it was to explore RL's thoughts on RRI prevention and management and their views on the proposed RRI prevention and management intervention. The interview method, recruitment, sampling, data collection and data analysis will be discussed in more depth in Chapter 8.

3.8 Ethical Approval

Ethical approval for this study for all phases of this study was given by the Ethics Committee of the School of Healthcare, Cardiff University on 4 February 2020. Following methodological amendments for COVID, further approval was given on 5 May 2020. (SREC reference: REC701) (Approval letters can be found in Appendices 1 and 2).

3.9 Summary

This chapter has discussed the methodology behind the overall study for the development of an RRI prevention and self-management intervention using the MRC framework (Skivington et al. 2021a). The methodology adopted for this study is a mixed-methods methodology following a multiphase design (Creswell 2017). The subsequent chapters of this thesis will describe the methods and studies used to achieve the main aim of the study: a scoping review of the current evidence for digital interventions for the prevention and self-management of RRI, a survey study with recreational runners, FGs with recreational runners, FGs with practitioners and interviews with RLs. Following this mixed-methods approach which has been developed to follow the MRC framework for the development of complex interventions, data analysis from each section will be interpreted and applied to the overarching aim of the study: the development of a digital RRI prevention and self-management programme aimed at helping recreational runners to prevent and better self-manage RRIs.

Chapter 4: Phase 1: A Scoping Review of Current Evidence for RRI Digital RRI Prevention and Self-Management Interventions.

4.1 Introduction

This chapter will describe a scoping review protocol that was conducted to examine the current evidence for digital RRI prevention and self-management interventions for recreational runners.

4.2 Background

As discussed in the literature review there are several approaches to the prevention and management of RRI. Prevention and management strategies for RRI include education (Esculier et al. 2018b), exercise prescription in the form of strengthening exercises (Earl and Hoch 2011; Lauersen et al. 2014; Lauersen et al. 2018) and stretching (Alexander et al.) load management via appropriate training programmes (Johnston et al. 2003; Buist et al. 2008b) and the use of footwear to address biomechanical risk factors that may have been identified (Malisoux et al. 2016a; Damsted et al. 2017; Malisoux et al. 2020; Malisoux and Theisen 2020). With the increasing development of digital technologies there are new ways of disseminating RRI prevention and self-management information to larger numbers of recreational runners.

Digital technologies have been identified as having the potential to help individuals prevent health problems and manage existing health problems (WHO, 2018). They also have the potential to assist HCPs when managing patients (Crico et al. 2018). With the availability of the internet and the ability of smartphones to connect to digital interventions, RRI prevention and self-management has the potential to be revolutionized. 'E-health' refers to the practice of medicine supported by electronic processes and communication while 'mHealth' refers to 'eHealth' when it is accessed via a smartphone or mobile phone device (Verhagen et al. 2014b). Within sport there has also been an increase in the availability and use of technology to monitor sports activity (Dallinga et al. 2015). A study investigated the use of running apps and smartphone watches by recreational runners and found that out of 1995 runners, 86.2% used at least one monitoring device and over half of runners used smartphone apps (Janssen et al. 2017). This high use of smartphone apps and wearable technology means that runners have almost unlimited access to RRI prevention and management information (Verhagen et al. 2014b). For runners wanting to prevent or self-manage RRI, digital interventions such as websites or smartphone applications may provide a solution, but the quality of these interventions needs to be scrutinized. A review of the quality of sports injury prevention and self-management smartphone apps was performed found that out of 18 smartphone applications offering injury prevention information, only four contained evidence-based information and five contained false claims (van Mechelen et al. 2014). Five of the apps related to RRI but the review reported that advice within the app, such as using the correct shoes, stretching and reducing 'vertical bouncing while running' was not supported by any evidence. This review identified a lack of scientifically informed sports injury prevention apps and a clear need for development of apps that are informed by the evidence-base. Digital technologies for health and fitness are also reported to be lacking an emphasis on the involvement of HCPs (Higgins 2016). Therefore, highlighting that development of digital interventions for health need to reflect the evidence base but also involve HCPs.

As stated previously, digital interventions have the potential to provide recreational runners with information and content on prevention and management of RRI. However in the development of the proposed digital intervention, existing interventions need to be identified first as well as how these interventions have been developed and the theoretical frameworks that they use (O'Cathain et al. 2019). The MRC guidance for the development of complex interventions recommends a review of the literature to identify existing interventions, to understand the evidence base for components of the intervention and take into account evidence that may indicate the proposed intervention may not work in the way intended (O'Cathain et al. 2019; Skivington et al. 2021b). A scoping review is an ideal tool for this as it determines the body of literature about the topic at hand and gives an indication about the volume of literature and studies available (Munn et al. 2018). A systematic review may be used to establish quality of evidence, produce statements to guide decision making, clinical care and decision-making (Munn et al. 2018). A scoping review takes a broader view and aims to identify and map the available evidence, possible identifying a gap in the existing literature (Arksey and O'Malley 2005). The systematic review method will focus on a well-defined research question and identifies specific study designs for review, whereas a scoping review addressed broader topics where different designs may be utilised (Arksey and O'Malley 2005). Therefore, as the MRC guidance for development of complex interventions requires identification of the existing interventions, evidence for those interventions and identification of theoretical framework behind those interventions it was deemed that a scoping review would be the most appropriate method.

The primary aim of this scoping review was to identify current evidence for digital RRI prevention and self-management interventions for recreational runners, using the MRC framework as a basis for exploration:

The objectives were:

- Map the available evidence for digital RRI prevention and self-management interventions for RRI for recreational runners.
- Identify the modes of delivery of digital RRI prevention and self-management interventions.
- Explore theoretical frameworks which underpin digital interventions which support prevention and self-management of RRI in recreational runners.

4.2 Scoping review protocol

The framework used for this scoping review was proposed by Arksey and O'Malley (2005). The main goal for this scoping review was to identify current research findings for the intervention described i.e., digital RRI prevention and management interventions, identifying any gaps in the literature while also informing further research.

The framework used for this scoping review is as follows:

- Identify the research question.
- Identify relevant studies.
- Study selection.
- Charting the data
- Collating, summarizing and reporting the results.

4.2.1 The research question

'What is the current evidence on digital RRI prevention and self-management interventions for recreational runners?'

This research question is broad and needs further definition, therefore parameters were identified within the question to help guide the searching process (Levac et al. 2010). Providing a clearly defined scope of inquiry aimed to provide direction, focus and clarity to the broader research question (Levac et al. 2010). To clarify the focus of the scoping study and to establish an effective search strategy the concept, target population and health outcomes of interest were all defined (Levac et al. 2010). The Joanna Briggs Institute (JBI) recommends using Population, Concept and Context (PCC) (Aromatases E, Munn Z 2020). For the proposed research question the population refers to recreational runners, the concept refers to digital RRI prevention and management interventions, and context relates to mode of delivery e.g., frequency of the intervention, duration of the intervention, how the intervention was delivered, and theories underpinning the interventions.

4.2.2 Inclusion criteria

4.2.2.1 Population

Inclusion criteria were recreational runners of any running experience level including novices. The term recreational runner included novice runners, those who saw themselves as competitive and experienced runners but not runners who were in receipt of funding or who were deemed to be 'professional' (Thuany et al. 2020). Male and female participants over the age of eighteen were included to reflect the heterogenous population that is the recreational running population. Participants under the age of eighteen were excluded as these are considered young athletes and are a distinct clinical population with their own clinical needs. Elite and sponsored athletes were also excluded for the same reason.

4.2.2.2 Concept

Concept refers to digital RRI prevention and management interventions, but this requires further definition to aid the search strategy. The concepts of injury prevention and self-management were defined. For definitions and descriptions of these terms please refer to

Table 1. For this review digital interventions were defined as digital RRI injury prevention programmes, digital sports injury prevention programmes and digital RRI self-management programmes. Digital interventions were defined as interventions that were described as E-Health, M-health, remote, video based, online, app/application, web-based and mobile applications. This helped achieve the sub-aim of mapping the mode of delivery of the interventions being reviewed. The supervisory team assisted with developing the definitions and descriptions of these terms for the search strategy.

Table 1 Concept definitions for RRI prevention, self-management and digital interventions

Concept	Description
Injury prevention	Interventions designed to prevent running-related injury. Including the terms: • Injury prevention • Running injury prevention • Sports injury prevention • Strength and conditioning • Stretching • Training load • Orthotics • Running shoes • Running trainers • Warm-up • Exercise • Advice • Load management. • Gait retraining. • Education
Injury self-management	Interventions designed to assist with self-management of running-related injuries. Including the terms: • Self-management • Strength exercises

	• Stretching • Rehabilitation • Injury rehabilitation • Behaviour change • Attitude change • Load management. • Training loads • Education • Gait retraining. • Exercise
Digital interventions	Referring to interventions that are delivered via a digital platform to include: • Online • E-Health • M-Health • Mobile application • Application • App • Web-based • Remote • Video-based • Digital • Platform

4.2.2.3 Context

The context for this review included the theoretical concepts which underpin the study interventions e.g., theories of behaviour change such as Theory of Planned Behaviour (TPB) (Ajzen, 2011) and Self Determination Theory (SDT) (Chan and Hagger 2012) and intervention development frameworks. This context helped achieve the final sub-aim of this scoping review.

4.2.2.4 Types of evidence sources

A broad range of study designs were included in the inclusion criteria of both quantitative and qualitative methodologies, randomised controlled trials (RCT), non-RCTs, cohort studies and case studies. Broad eligibility criteria for the study designs were given to capture range of interventions developed and studied and reduce the possibility of relevant studies being missed during the search process.

No time limit was placed on the search and no limit on the years being searched. Due to time limitations the language was limited to studies that were published in the English language. Published literature and grey literature which includes unpublished papers and theses were included. There was no upper or lower limit for the follow-up periods of studies included in the review. The Eligibility criteria has been summarized in Table 2.

Table 2 Study eligibility criteria

Study participants	**Recreational runners** **Male and female** **Over age 18** **Any ability** **Excludes elite/professional athletes/runners.** **Excludes runners <18**
Study design	RCT, cohort studies. Quantitative and qualitative methodologies.
Time Frame	No limit
Years Considered	No limit
Language	English
Publication Status	Published literature, grey literature in the form of unpublished theses.
Follow-up period	No lower or upper limit
Exclusion criteria	Studies involving elite runners/athletes. Runners < 18 years of age Studies published in a language that is not English. Websites, blogs, policy papers, newsletters

4.3 Search strategy

The aim of the search strategy was to find studies which investigated digital interventions supporting prevention and self-management of RRI. The search strategy can be found in Appendix 5, providing an example of the search strategy was used in one of the databases used and how search terms were combined using AND and OR strategies. A librarian at Cardiff University assisted in determining and performing the search strategy and helped to identify the most relevant databases. The research supervisory team also assisted in identifying the search terms used for the search strategy.

The following databases were searched without date restriction and included AMED (via OVID), CINAHL (via EBSCO), Medline (via OVID), EMBASE (via OVID), PubMed.

Studies featuring recreational runners which met the inclusion criteria were identified.

The problem being investigated within the studies was any running-related injury (RRI). RRI was defined as a 'lower limb or spinal pain that restricts running for more than seven days or requires the runner to seek help from a medical or health professional' (Yamato et al. 2015b). Studies where runners were receiving treatment for an existing RRI were excluded.

The study intervention being investigated within the studies was RRI prevention and management programmes and interventions. Sports injury prevention programmes were also included to broaden the search so that studies describing sports injury prevention and self-management but including recreational runners were included within the search. Digital interventions which included websites and smartphone applications were included in the search strategy.

An initial search of the literature was performed, then key words for the search identified which included running injuries, running-related injuries, digital injury prevention, digital injury management, online injury prevention and online injury self-management (Appendix 5).

The literature described helped inform the next stage of the search with a broadening of terms so that as many papers as possible could be identified. For example, the concept 'running-related injury' was expanded to include variations on the phrase running-related injury (Appendix 5). Sports related injury was also included. Running-related injury was then broken down into the different diagnoses that can be defined as an RRI. This was so that any study that focused on a specific RRI e.g., plantar fasciitis, was not missed during the search process. The most commonly occurring RRIs were included (Table 3) (Taunton et al. 2002b) . Running injuries that were known by alternative names were also included in the search e.g., medial tibial stress syndrome and shin splints (Appendix 5). Truncation was used to identify alternative endings to any of the search terms so that these were not missed during the search process (Appendix 5).

Table 3 Most commonly occurring RRIs

Running related injuries (RRI)
Patellofemoral pain syndrome
Iliotibial band syndrome
Patellar tendinopathy
Plantar fasciitis
Achilles tendinopathy
Hamstring injuries
Medial tibial stress syndrome
Gluteus Medius injuries
Stress fracture.
Ankle inversion
Calf strain

For the following concepts, injury prevention and injury self-management, a similar approach was used. Each concept was searched but both concepts were broken down into the elements that could constitute both. The terms running-injury prevention and sports injury prevention were used to widen the search so that relevant studies were not missed. A similar approach was taken with the final concept which was digital.

For the first concept, ‘running-related injury’ each search term was searched individually, and a note made of how many articles were identified via that search term. Once this was done an ‘OR’ search was conducted to combine all the related terms relating to ‘running-related injury’ This resulted in a larger number of articles being identified. This approach was then repeated for the concepts of 'injury prevention', 'injury self-management' and 'digital'.

At the end of the search an 'AND' search was performed to combine the different concepts and retrieve the results where each concept was present. This narrowed down the results and made the search more specific. The searches that were performed via the databases were automated via the search terms that were used as described above.

4.4 Results

Figure 4 depicts a flow chart of the search process. Literature searches yielded 7,868 citations from all the databases that were searched (AMED, Medline, PubMed, CINAHL, EMBASE). Removal of duplicates resulted in 525 citations. The titles and abstracts were screened and a further 494 articles were excluded. Studies were excluded if they involved elite runners/athletes, involved runners under the age of 18 or were published in a language that was not English. Websites, blogs, policy papers, newsletters were also excluded.

This left 31 articles remaining which were then scrutinized further applying the inclusion/exclusion criteria. Reasons for ineligibility included study protocols, if they did not involve recreational runners and if they did not meet the criteria of this study. Two studies were excluded as they studied interventions specific to injuries that affect runners (ankle sprain and plantar fasciitis), but they were not included as they did not meet the inclusion criteria. Again, this is presented in Figure 4. All citations were imported to EndNote and any duplicates were removed by KW. Articles were screened by title, abstract and by full text according to the inclusion and exclusion criteria. After this process a total of four articles were deemed eligible for this review. Articles that had met the criteria via the search titles were excluded if the full text revealed that they were not eligible. Appendices 4-8 provide the searches conducted via each database.

The studies shown in Tables 4 were included because they met the inclusion/exclusion criteria of the review but also because they met the main aim of the study which was to identify the evidence for digital RRI prevention and self-management interventions for recreational runners. The tables give an overview of the authors, the intervention types, study population, sample size, duration of the interventions, aims of the studies, the methodologies used and the key findings. In this section a summary will be provided of the eligible studies.

All the included studies referred to RRI prevention. None of the included studies referred explicitly to management or self-management of RRI but some of the studies provided tailored advice to prevent sustained RRIs with the aim to prevent a non-substantial RRI becoming a substantial RRI (secondary prevention) and to prevent further consequences such as prolonged absence from running in those with substantial RRIs (tertiary prevention) (Hespanhol et al. 2018a). The website intervention provided by Adriaensens et al (2014) also contained education and advice which can be deemed to be a form of not just prevention but also self-management. In a similar manner the website intervention developed by Fokkema et al (2017) provided advice on training, equipment such as footwear and biomechanical advice on cadence and foot-strike which again can be seen as preventative advice but can also be used in the self-management of RRI. This study also provided information on orthotics which again can be seen as a form of self-management (Fokkema et al. 2019e)

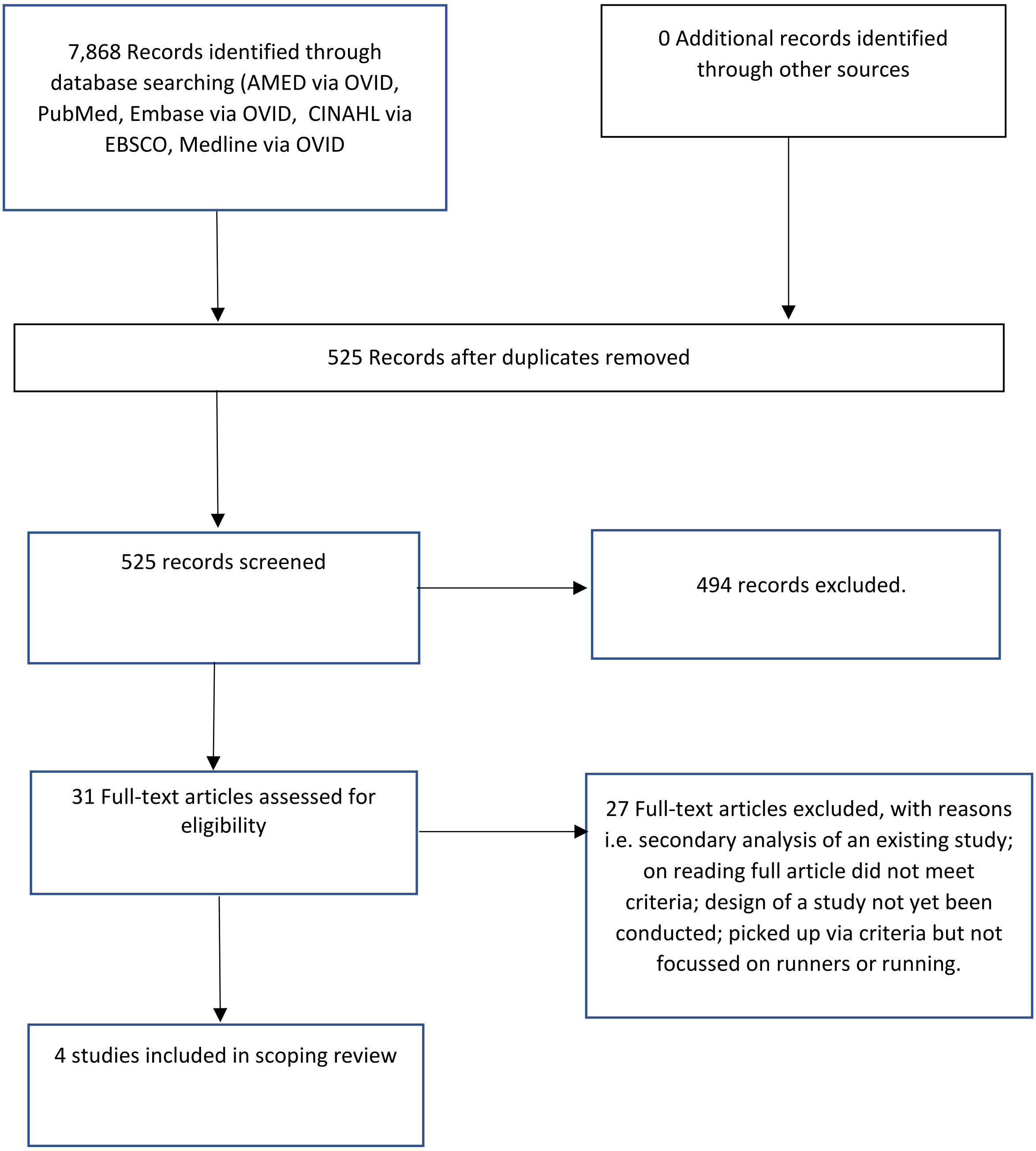


Figure 3 Flow chart of search strategy (modified by Moher et al 2009)

Table 4 Study characteristics

Study/Date published	Year	Methodology	Population	Sample size	Intervention		Comparator
Adriaensens et al	2014	RCT	Runners age 18-35	214	Online tailored intervention module on a website. .		Control group - read magazines that did not contain any information relevant to running, injuries or sports for 30 minutes.
Fokkema et al	2019	RCT	Adult recreational runners	2378	Online injury prevention programme aiming to modify evidence-based risk factors for RRIs. The intervention programme focused on four main topics: personal factors, training factors, equipment and biomechanics'.		Control group – followed usual prep for a running event, advised to train for running event as they normally would.
Hespanhol et al	2018	RCT	Adult runners over 18	232	TrailS Online Tailored Intervention. General advice provided at baseline. Following 2 weekly questionnaire advice provided based on whether runners had no injury (primary prevention) or had a non-substantial injury (secondary prevention) or had reported a substantial injury (tertiary prevention).		Control group who only received basic, general advice at baseline.
Hollman et al	2019	Secondary analysis of an RCT	Adults taking part in a running training programme.	51	Bi-weekly online tailored advice for prevention of RRI.		Control group who received general advice

Table 5 Study characteristics continued

Study	Outcomes	Length of follow up	Results	Conclusions
Adriaensens et al	Knowledge, risk perception, attitude and intention regards injury prevention measured via questionnaire.	4 months	Immediately post intervention there was an effect found for all measures in the intervention group. After three months the effect remained for intention to warm up pre-training and performing warm-up pre competition and the intention to buy new shoes more often. Effect was strongest immediately after the intervention. Effects remained 3 month post intervention.	Short term (3 month) positive effects of an online tailored intervention on determinants and performance of sports injury prevention behaviour. on knowledge, attitude, intention and actual preventive behaviour. The positive changes may be a positive predictor of a persistent behaviour change. Long term effects of the intervention need to be studied further. Plus, cost-effectiveness.
Fokina et al	Self-reported RRI between registration and 1 month after the running event.	Minimum follow up of 3 months. Mean follow up was 4.5 months.	Injury proportion for intervention group = 37.5%. Injury proportion for control group = 39.6%. No significant difference in injury proportion between groups. In both groups most injuries were to the knee, calf and foot. No significant in clustered injury locations between groups. No significant differences between groups when divided by distance of event, sex, running experience or injury in the 12 months prior to trial.	A multifactorial online injury prevention programme offered to recreational runners who registered for a running event was NOT effective in the prevention of RRIs. Was noted by authors that a third of the intervention group did not read any of the topics of the prevention programme.
Hespanhol et al	Determinants of performing the intervention (intention, attitude, subjective norm and	6 months	Very strong evidence (BF 194.3) supporting a significant (ARD -13.1%, 95% BCI – 23.3 to -3.1) preventive effect (NNT	Strong evidence for Online tailored advice having a preventive effect on RRI when

	perceived behavioural control. Via preventive behavioural questionnaire. Plus, questionnaire on RRI.		8, 95% BCI 3 TO 22) of adding online tailored advice on the prevention of RRIs after 6 months of follow up. Therefore, OTA may be used as a preventive component in RRI prevention programmes. No effect was observed on determinants and actual preventive behaviours towards RRI prevention.	compared with online general advice. No significant effect on changing individual preventive behaviours towards prevention of RRIs.
Hollman et al	RRI prevention knowledge and behaviours.	13 weeks	Increased knowledge in RRI prevention and a trend towards behaviours consistent with RRI prevention.	Delivering online RRI prevention programme results in positive changes in knowledge and behaviours towards RRI prevention.

Table 6 Study findings

Study	Exposure to intervention	Adherence to intervention
Adriaensens et al 2014	One off 30-minute exposure to the intervention. Instructed to study section specific to RRI but participants able to browse the rest of the website. Participants free to decide if they looked at the tailored section.	No clear adherence/compliance statistics collected.
Fokkema et al 2019	Potentially unlimited exposure but runners left to read website autonomously. This was not monitored.	Information collected via a follow-up questionnaire. 62.7% read at least one topic of the intervention. 38.8% read all 4 topics. 44.1% applied at least one topic to their running training.
Hespanhol, van Mechelen and Verhagen 2018	Every two weeks: 2 weekly questionnaire prompts participants to select advice most appropriate to their current RRI status.	Runners with no RRI demonstrated 66.6% adherence to one piece of advice compared with 90.1% adherence for runners with a substantial RRI. Based on the preventive behaviour questionnaire developed via a conceptual model of TPB.
Hollman et al 2019	Those in the intervention group received additional biweekly information tailored to their RRI status.	Not strictly adherence but 91% said there were no barriers to them performing the preventive behaviours recommended by the tailored intervention.

Table 7 Theoretical frameworks used by included studies.

Author	**Theoretical basis for intervention and outcomes**
Adriaensens et al 2014	Outcome measures were based upon the importance in several behaviour explanatory models, Theory of planned behaviour and health belief model. (Azjen 1988 and Abraham and Sheeran 2005 in Conner and Norman.)
Hespanhol, van Mechelen and Verhagen, 2018	Intervention developed using the Knowledge Transfer Scheme (KTS). KTS resulted in an intervention tailored towards RRI prevention. Information tailored by taking into account RRI profiles provided by Oslo Sports Trauma Research Centre (OSTRC) questionnaire. The Theory of Planned Behaviour used as the conceptual model of behaviour for this study
Fokkema et al 2019	The prevention programme was developed by the researchers via an extensive literature search aiming to modify evidence-based risk factors for RRIs. The intervention programme was focused on four main topics: personal factors, training factors, equipment and biomechanics.
Hollman et al 2019	Intervention used was developed by Hespanhol, Van Mechelen and Verhagen (2018), using KTS framework.

4.4.1 Study characteristics

4.4.1.1 Methodology

All studies were randomised controlled trials (RCT) with one study by Hollman et al (2019) being a secondary analysis of a previous RCT which sought to determine whether a tailored online intervention decreased RRI prevalence in runners with the secondary analysis focusing on whether an online intervention improved prevention knowledge among runners. The lead author of this RCT (Hollman et al 2019) was contacted for clarification of this point.

The aims of three of the included studies were similar in that they aimed to assess whether online interventions had an effect on the preventive behaviours of recreational runners (Adriaensens et al. 2014; Hespanhol et al. 2018; Hollman et al. 2019). One study aimed to examine the effect of the online intervention on the number of RRIs in recreational runners. The aim of the original RCT by Hollman et al. (2019) aimed to examine whether the biweekly online intervention decreased RRI prevalence in recreational runners while the secondary analysis focused on whether there was an increase in RRI prevention knowledge and behaviours. The authors of that RCT (Hollman et al. 2019) were contacted but the results of the original RCT were not published. A search online did not produce the original RCT. Therefore, the aims of the current evidence for online RRI prevention interventions seems to focus on the behaviours and knowledge of runners rather than on prevention of RRI itself. None of the included studies focused on self-management of RRI as aims.

4.4.1.2 Study population and sample sizes

Table 4 presents the population of interest and sample sizes of each study. Participants in all four studies were recreational runners over the age of 18, male and female. There is a variation in the male/female split between studies. Two of the studies had predominantly female participants with 71% female participants (Adriaensens et al. 2014) and 72% (Hollman et al. 2019). The study by Fokkema et al (2019c) had 52% male participants while the study by Hespenhol et al. (2018) had 67.6% male participation. One study capped their age limit at 35 (Adriaensens et al. 2014). Studies included runners of varying experience – those who were new to running, those who were not new to running but ran consistently and experienced runners. One study focused solely on trail runners (Hespanhol et al. 2018). Runners in the studies were training for varying distances ranging from five km up to marathon distance (42.195 km) (Fokkema et al. 2019c). Participants in the study by Hollman et al (2019) were all training for a ten km distance but were of varying ability. The study which focused on trail runners included runners who had registered for events that varied from 15km to 62 km. In contrast the participants in Adriaensens et al. (2014) were all runners who had run for at least 12 sessions in the last year for at least one hour a session. What these results show is that the included studies are heterogenous and that the study participants in these studies vary according to ability and experience. The study by Adriaensens et al (2014) refers to runners' who have had to take time off school but for clarification these participants were all aged eighteen or over, therefore the study still meets the inclusion criteria or the review. Study samples ranged from 51 participants up to 2378. The total sample from all four studies was 2875 participants.

4.4.1.3 Intervention type and modes of delivery

Table 4 illustrates the type of intervention used in each study. The eligible studies used online interventions for RRI prevention in the form of websites. Two of the studies directed participants to a study website which they were directed to after completing an RRI questionnaire with the RRI prevention information being contained on the study website and participants guided towards the information that was relevant to them based on their responses to the questionnaire (Hespanhol et al. 2018; Hollman et al. 2019). One study invited participants to browse a sports injury prevention website which contained information about running alongside other sports (Adriaensens et al. 2014). The authors state that this information was tailored to runners after they completed a questionnaire with pre-defined answers which created a personal risk profile of each runner. Participants in the study by Fokkema et al. (2019c) were given access to a prevention programme which was presented on a website that only study participants had access to. The authors state that they provided information on four main topics (personal factors, training, biomechanics, and equipment) with different versions available for novice and experienced runners, indicating that there was some tailoring of the intervention.

The online intervention used by Adriaensens et al (2014) aimed to prevent RRI by modifying behaviour and increase positive injury prevention behaviour. The website used in this study had a section specifically designed for running via a needs assessment of the sport, with further tailored feedback provided to users following completion of a questionnaire with predefined questions which then provided a personal risk profile of the runner (Adriaensens et al. 2014). Fokkema et al's (2019c) online intervention focused on modifying running according to risk factors such as age, previous injury, training volume and biomechanics and provided tailored advice accordingly. Their intervention also provided different advice for novice runners and more experienced runners. Hespanhol et al's (2018) intervention required runners to complete a questionnaire on their RRI status and based on the outcome of this each runner was directed to the relevant part of the website whether that was no injury, a non-substantial RRI or a substantial RRI. This online intervention was claimed by the authors to be evidence-based and practice-based with advice in each section tailored to each of these categories. The authors state that the advice for RRI prevention was tailored after considering information provided by the Oslo Sports Trauma Research Centre Questionnaire (OSTRC) with advice such as being aware of 'doing too much too soon' and advice on general conditioning such as flexibility, muscle strengthening and balance exercises. Runners who were identified as being injured, either non-substantially or substantially, were advised to see health professionals with additional advice such as 'listening to your body' to prevent the injury from getting worse. The intervention used in the secondary analysis by Hollman et al. (2019) was biweekly online advice that was tailored to each runner's profile, in addition to general RRI prevention advice. The RCT by Hollman et al. (2019) is a secondary analysis of an RCT. The original RCT was not published so details of how the intervention was tailored to runners was not available, however the author did state that their intervention was based on the method and intervention developed by Hespanhol et al. (2018).

None of the interventions explicitly refer to management of self-management of RRI and the titles, abstract and text refer to prevention of RRI. However, the study interventions include sections on advice and one study referring to how to prevent a non-substantial RRI becoming a substantial RRI, using the terminology of secondary prevention and tertiary prevention (Hespanhol et al. 2018), which can be interpreted as self-management of RRI.

4.4.1.4 Duration of the Intervention

Table 4 presents the level of exposure to the online intervention that was found in each study. Large variability was found between studies as to how much exposure to the intervention participants were given. Exposure in one study was just a one off 31-minute session on an online tailored intervention website with a module designed for runners (Adriaensens et al. 2014). In another extreme Fokkema et al. (2019c) allowed for unlimited exposure to the online intervention's material. The intervention by Hollman et al (2019) lasted for 13-weeks and runners received the intervention bi-weekly. The final intervention in the group of studies provided initial advice at baseline and then provided further advice every two-weeks based on completion of an RRI questionnaire, which continued over six-months (Hespanhol et al. 2018) This demonstrates the heterogeneity of study design and interventions between currently available studies on this subject.

4.4.1.5 Follow-up periods

The follow-up periods of each study are presented in Table 5. There was wide variation in follow-up periods between studies. The shortest follow-ups were described by Fokkema et al. (2019c) and Hollman et al. (2019) who had follow-up periods as short as three-months but as long as four-and-a half-months, and 13-weeks respectively. Follow up periods for the Adriaensens et al. (2014), Hespanhol et al. (2018) studies were four-months and six-months respectively.

4.4.1.6 Comparators

Table 5 presents the comparators used by each study. All included studies had a control group with which the intervention group was compared. Two of the studies provided general RRI prevention advice to their control groups (Hespanhol et al. 2018; Hollman et al. 2019). One study advised their control group to read magazines that did not contain any information related to RRI and sport prevention (Adriaensens et al. 2014) while Fokkema et al (2019c) advised the control group to prepare for a running event as they normally would.

4.4.1.7 Definitions of runners and running-related injury (RRI)

The definition of what constituted a recreational runner varied widely between studies. Two of the studies identified runners as being individuals who were registered on a database

(Hespanhol et al. 2018) or as individuals who had signed up to a race or training programme (Hollman et al. 2019). Adriaensens et al (2014) defined a runner as an individual who had run for at least 12 sessions in the last 12 months. One study focused on a population of trail runners who were registered on a trail runners database (Hespanhol et al. 2018).

None of the studies used the same definition of RRI. For example one study defined RRI as a musculoskeletal complaint with one or more of the following consequences: participant 1) had to stop running and/or 2) could not fully participate in the next planned activity and/or 3) could not go to school (participants were over 18) the next day and/or 4) required medical attention (Adriaensens et al. 2014) whereas one study used a very broad definition of RRI (Hespanhol et al. 2018). The definition used for this study included musculoskeletal injuries but also injuries of the integumentary systems e.g., nail injuries, skin blisters, and concussion injuries that may have been sustained while running. The authors of this study used the outcome of effectiveness of the intervention of RRIs to evaluate the intervention. Their definition had the potential of increasing the numbers of reported RRIs, according to this very broad definition.

4.4.1.8 Theoretical frameworks underpinning interventions and outcomes in each study.

Table 7 presents the theoretical frameworks used by each study. Two studies used the Theory of Planned Behaviour (TPB) as the model for their intervention and outcomes (Adriaensens et al. 2014; Hespanhol et al. 2018a). The intervention used by Hespanhol et al. (2018) had been developed using the five step KTS (Verhagen et al. 2014a), resulting in an evidence based and practice based online intervention. Fokkema et al. (2019c) developed their intervention via extensive literature search and aimed to modify evidence based-risk factors for RRI but did not indicate a theoretical framework to underpin their intervention. The intervention developed by Hollman et al. (2018) was developed based on up-to-date research alongside the intervention developed by Hespanhol et al. (2018), which as has already been reported was developed via the KTS and TPB.

4.4.1.9 Outcome measures

Table 5 provided information related to the outcomes of each study. Three of the studies used outcomes related to behaviours change and knowledge of preventive behaviours related to RRI prevention (Adriaensens et al 2014*;* Hespanhol et al. 2018; Hollman et al 2019). Hespanhol et al's (2018) preventive behaviour questionnaire used the Theory of Planned Behaviour to develop a questionnaire that measured preventive behaviours via Likert scales which were used to establish the likelihood of runners performing each behaviour. This model had been used in previous research (de Brujin et al 2005) to establish determinants of bicycle use of adolescents. There was no indication that the conceptual model has been validated by the previous authors, but it was acknowledged that the model allowed for a limited set of variables and future research using the model should consider all relevant additional psychological and environmental factors to enhance the understanding of determinants of behaviours (de Bruijin et al 2005).

Two studies used clinical outcome measures to establish the occurrence of RRI (Hespanhol et al. 2018; Fokkema et al 2019). The study by Fokkema et al. (2019c) used self-reported occurrence of RRI as their primary outcome measure with the location of injury being a secondary outcome measure, with this measure being developed but it was acknowledged by the authors that using this as an outcome measure was a limitation of their study as the number and accuracy of RRIs being reported would have been influenced. The measure by Hespanhol et al. (2018) was based on the RRI classification generated by the OSTRC, a surveillance method that has been found to be sensitive and valid in documenting patterns of injury (Clarsen et al 2013).

What was noted was that there was no direct mention of the term 'self-management' in any of the study outcomes, with only primary prevention, secondary prevention and tertiary prevention being discussed in one study in relation to reducing the impact of non-substantial or substantial RRI (Hespanhol et al. 2018). There was no agreement between the studies using behaviour change based outcomes as to whether online tailored advice had a positive impact on RRI preventative behaviours, knowledge and compliance. Hespanhol et al. (2018) found that the online intervention had no significant effect on changing individual preventive behaviours towards RRI. In contrast, two of the studies (Adriaensens et al. 2014;

Hollman et al. 2019) found that there were positive changes towards adopting preventive behaviours and knowledge with regards to RRI.

4.4.1.10 Adherence

Table 6 contains details of the adherence of participants to the intervention in each study. Hespanhol et al. (2018) used the preventive behaviour questionnaire that they had developed to assess adherence. They found that the intention to continue to follow at least one advice was 66.6% for runners with no RRI and 90.1% for runners who had a substantial RRI. Fokkema et al (2019c) used a follow-up questionnaire to establish adherence to the intervention and found that 44.1% of the participants applied the RRI preventive behaviours to their training. Hollman et al (2019) did not report specifically on adherence but reported that 91% of participants felt that there were no barriers to them performing the RRI preventive behaviours. Adriaensens et al (2014) did not report specific compliance or adherence measures to their online tailored intervention.

4.4.1.11The effect of RRI prevention and management interventions

The conclusions of each study are presented in Table 5. Fokkema et al (2019c) found that an online tailored intervention did not reduce the total number of RRI's in a group of recreational runners one month after a running event. There was no significant difference found in the proportions of RRI between the intervention group and the control group who had been advised to train as they normally would for an event. There were also no significant differences found when groups were divided according to sex, running experience or RRI in the last twelve months. It was noted by the authors of this study that a third of the intervention group had not read any of the topics of the prevention programme. The findings of this study are in contrast with those of Hespanhol et al. (2018) who found that an online prevention intervention had a preventive effect when compared with general advice. However, this study did not find a significant effect on determinants and actual behaviours towards preventing RRI, which leads us to question the mechanism for the preventive effect of RRI in this study if it was not via behaviour change and attitude changes. Another notable difference in the study by Hespanhol et al. (2018) is that they refer to primary, secondary, and tertiary prevention. In reading deeper into the definitions, secondary prevention is advice provided to runners who reported a non-substantial RRI and tertiary prevention is advice provided to runners who have experienced a substantial RRI. Therefore, even though the terminology refers to 'prevention' it could be argued that this study is providing elements of RRI self-management to runners, even though the terminology of management or self-management is not used as an outcome term.

Adriaensens et al. (2016) reported that there was an immediate post intervention effect on all outcome measures in the intervention group (Table 5). At three-months follow up, the effect remained for intention to warm up pre-training and pre competition and the intention to buy new shoes more often. They concluded that there are short term (three-month) positive effects of an online tailored intervention on the determinants and performance of sports injury prevention behaviour in relation to knowledge, attitude, intention, and actual preventive behaviour. However, the authors acknowledged that the changes may only be a predictor of behaviour changes and that the longer-term effects of the intervention needed to be studied further alongside its cost-effectiveness. Similarly, Hollmann et al. (2019) found positive effects of an online tailored intervention on intentions to change behaviour. They found an Increased knowledge in RRI prevention in the intervention group and a trend towards behaviours consistent with RRI prevention, therefore concluding that delivering online RRI prevention programme results in positive changes in knowledge and behaviours towards RRI prevention.

4.4.1.12 Limitations within the studies

Low engagement with the intervention was noted in one study (Fokkema et al. 2019c). It was reported that only two thirds of the participants had read at least one topic of the online prevention programme with 44% indicating that they had applied it to their training. Hollman et al (2019) reported low study registration which resulted in fifty-one participants which can be considered to be much lower than participant numbers in the other studies (illustrated in Table 4). In the same study there was no follow up after the intervention so long-term effects of the intervention they implemented are not known. Low levels of participants also meant that the studies may not have been sufficiently powered to establish effectiveness of the interventions. Another limitation of one of the studies is the use of self-report of RRIs with authors of this study acknowledge that self-diagnosis was an issue and could have affected the accuracy of the injuries reported (Fokkema et al. 2019c).

4.5 Discussion

Following extraction of the data and analysis of the results the discussion is structured around the main objectives of this review which were outlined in section 4.2 of this chapter. The discussion of the results will center around three main themes: the evidence for digital RRI prevention and self-management interventions for RRI, the modes of delivery of the interventions and the theoretical frameworks used which underpin the digital interventions.

4.5.1 The evidence for digital RRI prevention and self-management interventions

Overall, there is no conclusive evidence for digital interventions for the prevention of RRI occurrence among runners but there is evidence for short term effects on RRI preventive behaviours or the intention to perform RRI preventive behaviours. This scoping review has also shown that there are no available studies which focus on online interventions for the self-management of RRI among recreational runners however one study referred to primary, secondary, and tertiary prevention in relation to helping runners who have reported non-substantial or substantial RRI (Hespanhol et al. 2018). The reporting of this study indicates that the information they provided via the online intervention to sub-groups of runners with non-substantial and substantial can be used to help runners to self-manage RRI and facilitate a faster return to running. In the information provided to injured runners the terminology ‘prevent this injury from getting worse’ is used rather than reference to self-management of injury. Results from the four studies were mixed but the findings could be interpreted as promising for prevention of RRI. Two studies found that after intervention there was a trend towards more positive behaviours and attitudes towards preventive RRI behaviours (Adriaensens et al. 2014; Hollman et al. 2019). In contrast, Hespanhol et al. (2018) did not find that online advice had an effect on determinants and actual preventive behaviour. Two of the studies looked at the number of RRIs as an outcome and there was disagreement between them as to whether the online intervention had a preventive effect on RRI with Hespanhol et al. (2018) finding that online tailored advice reduced RRI among Dutch trail runners and Fokkema et al. (2019c) finding that an online injury prevention programme did not decrease the total number of RRIs among running.

The lack of consensus on whether online interventions have an effect on the number of RRIs or on the preventive RRI behaviours by runners is likely due to several reasons. The lack of studies in this area is one but the heterogeneity in the studies is another. Reviewing these studies demonstrates the heterogeneity of the currently available evidence from the study participants to methods, to the interventions and the theories behind the interventions. It cannot be ascertained from these studies that online interventions for RRI prevention are effective or not due to the differences between the studies and the difference in findings between studies. There is no real consensus between these studies as to whether online tailored interventions are effective in preventing RRI or in changing behaviours and knowledge related to RRI prevention.

One of the main issues is the heterogeneity between studies in relation to the definitions of the study populations and the differing definitions of what an RRI is. It has previously been identified that the heterogeneity surrounding RRI research with regards to definitions of runners, what an injury is, injury classifications and diagnoses, there is not always a clear direction in the literature to help guide prevention and rehabilitation of RRI (Lopes et al. 2012). None of the studies used the same definition for RRI, with each definition using different qualifiers in relation to what an RRI is and how long an individual should have had an injury before it can be called an RRI. For example one study included injuries such as skin blisters and concussions (Hespanhol et al. 2018) while other studies only specified musculoskeletal injuries (Adriaensens et al. 2014) or musculoskeletal pains in the lower limbs (Hollman et al. 2019). A lack of standard concepts and definitions in research has previously been highlighted as a significant difficulty in comparing results between studies (Yamato et al. 2015b).

A systematic review attempted to establish the descriptors used to define RRI in 48 studies (Yamato et al. 2015a). This review found that similar words were used within definitions such as ‘symptom’, ‘pain’ and ‘problem’ but that there could be a wide variety of meanings. Definitions that included an ‘interruption’ of running were found to vary in time periods which then had an impact on RRI rates between studies with authors concluding that descriptors used for RRI varied between studies and therefore impacted the reporting of rates (Yamato et al. 2015a). These findings could have implications for two of the studies

(Hespanhol et al., 2018; Fokkema et al 2019c) in this review that looked at self-reported RRI an outcome.

Exposure to online interventions was variable between the included studies. One study approach allowed for runners to use the intervention autonomously (Fokkema et al. 2019c) whereas other studies initiated contact far more frequently to direct runners to the most appropriate section of the intervention (Hespanhol et al. 2018; Hollman et al. 2019). Where users are free to stop and start an intervention, and with the nature of the internet and the wealth of information available, this could potentially make it difficult to achieve sufficient levels of intervention use (Wanner et al. 2009). A working example of this can be seen in the study by Adriaensens et al (2014) where participants were able to visit other sections of the intervention website that were not specific to RRI prevention. This could have had the potential to reduce the uptake of RRI prevention information by runners in this study. Low exposure to an intervention could result in lower uptake of the information provided, resulting in preventive RRI behaviour uptake being less likely with the literature reporting that the use of internet interventions may not be optimal with regards to engagement and exposure (Brouwer et al. 2011; Yardley et al. 2016). A review of the outcomes of physical activity interventions found that better outcomes were identified if participants interacted with the intervention more than 5 times (Vandelanotte et al. 2007). Designs of two of the studies had contact with participants more than five times within the time period of the intervention which could account for the intervention effectiveness within these studies (Hespanhol et al. 2018; Hollman et al. 2019). Even though Fokkema et al (2019c) gave participants unlimited access to the intervention there was no measurement of the number of times participants visited the intervention or the time spent on the intervention. If as the literature suggests, there needs to be a degree of optimal exposure for better outcomes it is possible that findings of intervention ineffectiveness in studies could be due to suboptimal exposure (Brouwer et al. 2011).

A lack of engagement was reported in the study by Fokkema et al (2019c). This potentially affects the feasibility of the prevention programme they were testing during their study, thus highlighting the importance of establishing system usability prior to implementation of an intervention. If a system is not attractive to a user, then even if the information contained within it is accurate and evidence based it is not going to reach the user and change their behaviour (Hu et al. 1999; Mohammdi and Isanejad 2018). The platform that is used for an intervention may also affect uptake of its use, a factor that was acknowledged by Fokkema et al (2019c), commenting that runners may not engage as well with a website when smartphone applications have the potential to be more successful.

This review demonstrates heterogeneity in the follow up periods for each of the studies included. Only one study went up to six-months (Hespanhol et al. 2018) with other studies seeing follow up periods as short as three-months (Fokkema et al 2019c; Hollman et al. 2019). The studies included in this review were aiming to change determinants and intentions of behaviour in relation to RRI prevention via the online interventions. However, it is questioned whether the duration of the interventions and the subsequent follow-up periods were long enough to cause a change in habitual, less preventative running injury behaviours to intentional, planned RRI prevention behaviour. Research has found that habit formation can take between 18 and 254 days but that the new behaviour needs to be performed frequently and at least ten times (Lally et al, 2010). Some RRI prevention and self-management behaviours may be more automatic than other behaviours, therefore may take longer to develop as habit (Lally et al. 2010). Repetition can lead to some behaviours and habit becoming more automatic but the development of any future RRI prevention and self-management intervention will need to consider what the optimal exposure to the intervention and repetition of the suggested behaviours should be to change runner behaviour. Therefore, in the future development of interventions for RRI prevention and self-management, habit formation and the time it takes to start performing new behaviours habitually needs to be considered.

The studies included in this scoping review show mixed results with regards to RRI prevention but show some promising results in changing existing running behaviour to more preventative running behaviours. However, longer follow up periods with larger samples of recreational runners would help to establish the efficacy of any online tailored programme for RRI prevention in runners. Longer term randomised controlled trials with larger samples have been recommended to assess safety and efficacy of health and fitness apps (Higgins 2016), indicating that further research should consider this when developing and evaluating future interventions for the prevention and self-management of RRI.

4.5.2 Potential harmful effects of tailored online information

It is possible that online tailored interventions have the potential to cause harmful effects if advice is taken on board and not used in an optimal way by the user. As stated above, the study by Fokkema et al (2018c) found that a tailored multifactorial online injury prevention programme did not decrease the total number of injuries in runners, finding that runners in the intervention group showed a trend towards more injuries in the calf, Achilles tendon, ankle, and foot. The authors related this to information presented in a biomechanics section in their intervention, which provided information on forefoot strike and its effect on reducing impact forces and therefore reducing the chance of developing a knee injury (Fokkema et al. 2019c). The authors noted that a transition to forefoot running would increase loading on the lower leg and foot, potentially increasing injury risk to these areas. They therefore hypothesized that runners who had read the information on forefoot strike had gone on to change their stride pattern, resulting in injury. This example demonstrates the caution that developers of tailored online interventions need to take when considering the information they include, and whether such information may be better placed coming from an HCP or coach. It may also indicate a lack of tailoring of the information provided, as in the study by Fokkema et al (2019c) runners were able to extract information that was of interest to them, rather than information that was possibly more appropriate to them.

In reviewing these studies, none of the authors monitored the risk or potential harm of the intervention. For example, the study by Fokkema et al (2019c) reports the finding of the increase in calf and Achilles injuries and relates it to information being used by participants from one section of the website but this is not explicitly evaluated. Therefore, future studies need to build in safety factors or the ability to evaluate safety of a digital intervention to ensure no harm (Higgins 2016). There is a responsibility during the development phase of any future digital RRI prevention and management to ensure that any content included is safe for the target population and does not have the potential to do more harm than good.

4.5.3 Modes of delivery

The studies included in this review all used the same method of delivery for their interventions in the form of study websites. E-Health in the form of online websites is low cost, saves time and can hold a great deal of information in one place which can easily be adapted and edited when necessary. However, it relies on the individuals using the online intervention to be digitally literate. Digital literacy is a skill in which individuals can search, select, appraise, and apply online health information to their own situation (van der Varrt and Drossaert 2017). Studies have shown that these digital literacy skills are associated with healthy eating, exercise, sleep behaviour and self-management skills (Hsu, Chaing and Yang, 2014; Neter and Brainin, 2012).

Even though the modes of delivery were the same there were differences in how the mode was utilised between studies. The study by Adriaensens et al. (2014) asked participants to browse a website containing a module aimed to prevent sports injuries by modifying determinants of preventive behaviour with participants asked to look at the information aimed at runners but were free to access other sections of the website. By asking participants to freely look at a website we are expecting them to be able to pick out the information that we would want them to pick out. It is also expected that participants will be able to appraise that information in the context of their own running behaviour while achieving this in 30-minutes. Participants could potentially have taken information from other sections of the website that were not relevant to running and could also have misinterpreted information from the website in a way that did not did not encourage RRI preventive behaviours. However, Adriaensens et al. (2014) did find that there were positive short-term effects of the online intervention on preventive behaviours among runners. Other studies in this review opted for a more tailored approach, using information from the participants to tailor prevention information to runners via a website (Hespanhol et al. 2018; Fokkema et al. 2019c; Hollman et al. 2019). However, these studies found mixed results. Fokkema et al (2019c) found their intervention which aimed to modify risk factors via personal information taken from participants did not decrease the total number of RRIs for recreational runners, whereas the study by Hespenhol et al. (2018) found that a tailored online intervention did prevent RRIs among runners. There are key differences in the way both these studies developed their interventions which could explain the difference in findings: Hespanhol et al. (2018) used an intervention development framework to develop their intervention while Fokkema et al (2018) was developed via an extensive literature search.

Interventions are more likely to be effective if they are tailored to the individual (Higgins 2016). However previous research on tailored online interventions has found mixed results. A tailored internet intervention for increasing physical activity among ethnically diverse women found that it had positive results on walking and moderate-to-vigorous physical activity among participants (Dunton and Robertson 2008). In contrast, a study which examined a tailored online physical activity intervention found that the intervention was ineffective in improving physical activity among office workers or determinants of physical activity behaviour (Slootmaker et al. 2009). Similarly, a study by Wanner et al (2009) found that a tailored intervention to stimulate physical activity was not more effective than a nontailored website in increasing physical activity among the general population. However, they acknowledged that their tailored intervention could be better utilised by prescribing the intervention to more specific populations such as those in primary care and workplace settings (Wanner et al. 2009). A tailored RRI online intervention is already 'tailored' to some extent as it is targeting a specific group with a specific need. Overall, though from this review the use of tailored online interventions is promising but in the development of any digital intervention for RRI prevention and self-management, how information is tailored to runners will need in depth consideration to enhance acceptability and feasibility. The tailored interventions are also only tailored to prevention of RRI, again demonstrating a gap for interventions targeted at self-management of RRI.

4.5.4 Theoretical frameworks used for the interventions.

Behaviour science is an integral part of injury prevention (Gielen and Sleet 2003) and health interventions are more likely to be effective if they are based on behaviour change theory models with attention to tailored feedback, goal- setting and progression (Higgins 2016). Adriaensens et al (2014) and Hespanhol et al. (2018) used TPB as the model for their intervention and outcomes (Ajzen 2011). A central factor of TBP is an individual's intention to perform a given behaviour such as injury preventive behaviours. The intentions indicate how hard people can be willing to try and how much effort they are willing to expend to perform a given behaviour. The stronger the intention to engage in the behaviour the more likely it is that the behaviour will be performed (Ajzen 2011). The studies above measured the strength of intentions to perform RRI prevention behaviour using Likert scales within their outcome measures.

However, the intention to perform a behaviour is also dependent on resources available to the individual e.g., time, skills, co-operation of others (Ajzen 2011). If a person has the relevant resources and intends to perform the behaviour, then it is more likely to be successful. Collectively all these factors will represent a person's actual control in performing a new behaviour. In the study by Hespanhol et al (2018), the intervention directs the runner to start performing conditioning exercises to help manage their non-substantial RRI. But it could be argued that simply directing a recreational runner to do conditioning exercises whether that's strength, balance or core stability exercises is not necessarily sufficient to lead to a change in behaviour. An individual runner, particularly a novice, may not be familiar with strength or core stability exercises. So, while intention can be high, if a runner is not confident in performing physical conditioning via strength training or core strength exercises, they will not be successful in performing the RRI prevention behaviour even though they have indicated that they intend to do it. Therefore, when developing an intervention for the prevention and management of RRI, the presentation and demonstration of information such as exercises needs to be considered. Development of such an intervention may also need to consider the different learning styles of runners using the intervention.

In planning for injury prevention there needs to be both passive/structural strategies and active (behavioural) strategies, with active strategies requiring individuals to take an active role in protecting themselves (Gielen and Sleet 2003). The online tailored interventions being reviewed here are providing active strategies to runners via the online interventions to empower them to change any injurious behaviours. Injury prevention cannot occur without an element of behaviour change and any change requires an adaptation by the individual (Gielen and Sleet 2003). In the case of recreational runners, that change might mean committing to a warm-up or cool down, regular conditioning sessions or monitoring their training volume more closely.

The average recreational runner may be unaware of how to prevent RRI and how certain strategies around training and conditioning can prevent injury. Previous research on injury prevention has found that the public can be unaware of the effectiveness of some policies in relation to reducing injury, highlighting that professionals need to do a better job of educating individuals and the public about injury prevention strategies and therefore making them an advocate for changing their behaviour (Gielen and Sleet 2003). In sport, research investigating online injury prevention found that education was key in helping a group of players or coaches to understand prevention of specific injuries (Glang et al. 2010). Therefore, an educational component is important to consider in the development of any intervention for the prevention and management of RRI.

The online interventions in question require active changes in behaviour by the individual runner and much of the sports injury prevention research focusses on the actions of the individual (Vriend et al. 2017). It is argued that in the context of sports injury prevention more is required than just a change in the actions and behaviours of individual runners but that broader support is needed from sports organisations and HCPs to help support runners in their injury prevention efforts (Vriend et al. 2017). It may be that more research is needed on how online interventions are embedded within the recreational running community i.e., via a running NGB, and whether involvement in injury prevention from the organizational levels of the sport contribute to a culture of injury prevention and education among recreational runners.

The process of changing health behaviours entails the tasks of both initiating and maintaining the behaviour change. In self-determination theory behaviour (SDT), change occurs when a person acquires the motivation for a new health behaviour and develops autonomy and competence in relation to the new behaviour leading to new behaviours being internalized and integrated which sustains the behaviour which is conducive to their health (Ryan et al. 2007). For the prevention of RRI this would mean a runner developing the motivation to change their current running behaviours and becoming competent in performing new running behaviours e.g., developing the motivation to perform injury prevention exercises, competence in performing the exercises followed by the runner integrating the new routine into their running behaviours but also sustaining that behaviour long-term. It is therefore argued that the development of the proposed digital RRI prevention and self-management programme needs to be embedded in behaviour change theories such as TPB or SDT to enhance motivations towards prevention/self-management behaviours and to improve self-efficacy towards these behaviours.

4.5.5 Lack of digital self-management interventions aimed at recreational runners.

One study used the terms primary, secondary and tertiary prevention, which were interpreted as a combination of prevention and self-management (Hespanhol et al. 2018). The authors used these terms when referring to RRI prevention for ‘non-substantial’ and ‘substantial’ RRIs. There were no studies identified that focused their terminology explicitly on interventions for self-management of RRIs. There were two studies which looked specifically at plantar fasciitis (PF) and ankle sprains. They were excluded from this scoping review as they did not meet the inclusion criteria. Therefore, this scoping review demonstrates that there is a currently a gap in the research regarding digital self-management interventions which are aimed at RRIs, and specific RRIs, within the recreational running population. Ways in which more experienced recreational runners are reported to self-manage include modifying their running practices, change running style and adjusting the terrain they run on while continuing to run through an injury (Linton and Valentin 2018). It is suggested that this is because experienced runners could have developed musculoskeletal adaptations to running making them more robust and less predisposed to injury (Rasmussen et al. 2013). Less experienced runners would not necessarily have the knowledge to self-manage their training load in this way to manage injury and again this demonstrates the gap on self-management of RRI in this area. Therefore, it is argued that novice runners who are documented within the literature as having a higher risk of RRI would not only benefit from an intervention that helped prevent RRI but would also benefit from a self-management intervention that could potentially reduce the time of cessation from running and return them to sport more quickly.

4.6 Limitations

A scoping review methodology was selected over a systematic review however the limitations of the scoping review methodology should be acknowledged. The scoping review question for this study was broad and intended only to map the current literature available on the area of research rather than appraising and synthesising research relating to a specific research question, as per a systematic review (Munn et al. 2018). Another limitation of the scoping review methodology is that the quality of evidence and bias within studies is not assessed, therefore the rigor of the studies has not been scrutinised in the way it would in a systematic review (Arksey and O'Malley, 2005; Munn et al. 2018). This scoping review only sought to identify current evidence in this area. In the future a systematic review would be able to confirm or refute whether current practice in this area follows research evidence, while also establishing the rigor and quality of that evidence (Munn et al. 2018).

4.7 Conclusion

This review has found that evidence for online tailored interventions for RRI prevention are limited to four studies. The existing studies for online interventions for RRI prevention have mixed results with regards to effectiveness on the number of RRIs and the determinants and performance of RRI preventive behaviours (Adriaensens et al. 2014; Hespanhol et al. 2018; Fokkema et al. 2019c; Hollman et al. 2019). There is also great heterogeneity with regards to the interventions, ranging from a one off 30 minute exposure to the intervention (Adriaensens et al. 2014) to advice received every two-weeks for six-months (Hespanhol et al. 2018) and the methods and definitions used within the studies. Better consensus regarding definitions of what a recreational runner is and what constitutes RRI are needed for consistency within RRI research. There was variation in the level of exposure to online interventions and the follow up periods between studies. Future development of interventions needs to be underpinned by theories of intervention effect with justification of intervention length and outcome measures which have been evaluated, so that the effectiveness of online interventions for RRI prevention can be established. There is also a clear gap for the development of a digital RRI self-management intervention.

Current studies are clearly underpinned by theoretical frameworks linked to behaviour change such as the Theory of Planned Behaviour (TPB) (Ajzen 1991; Ajzen 2011) and the Health Belief Model (HBM) (Gabriel et al.) but there is limited involvement of stakeholders across the sport of running. Research on what all stakeholders in running, including recreational runners, would want from an online intervention could enhance the implementation of future online interventions for RRI prevention and management and make any future interventions more likely acceptable and usable to recreational runners.

This review also demonstrates that only one online intervention for RRI prevention utilised an intervention development framework (Hespanhol et al. 2018). It is argued that there is a need for a digital RRI prevention AND self-management programme that has been developed in a systematic way using a development and evaluation framework that involves stakeholders int eh development process.

This scoping review has established the current evidence for RRI prevention and self-management. As per the MRC guidelines for the development of complex interventions the next two phases of this thesis target all stakeholders involved in running and who may be affected by RRI and any RRI prevention and management intervention. Involving stakeholders who have lived experience of the problem that the intervention aims to target will enhance the intervention but also dissemination and evaluation of the proposed intervention (Skivington et al. 2021a).

CHAPTER 5: Use of digital technology by runners and their views on a proposed RRI prevention and self-management intervention: An exploratory survey study.

5.1 Introduction

This chapter reports Phase 2: Part 1 of this thesis. The MRC guidelines described in Chapter 3 (Methodology) advise that the development of a complex intervention requires the involvement of all stakeholders including the end-users of the intended intervention. Phase 2 of the overall thesis therefore involves recreational runners who are the targeted users of the proposed intervention. Part 1 of Phase 2 is a retrospective survey with recreational runners followed by qualitative focus groups with recreational runners in Part 2.

5.2 Background

Progress gained in running fitness and ability may unfortunately falter when a recreational runner develops a running-related injury (RRI). A systematic review has previously found the incidence of RRI to be between 19.4 – 79.3% with the most common site of injury being the knee (van Gent et al. 2007). A potential consequence of injury is that novice runners could lose their motivation to return to running, which could subsequently lead to long-term inactivity (Baltich et al. 2017). A study of runners who participated in a Start-To-Run' programme found that the most common reason for discontinuation of running at 26 weeks follow up was a running injury (Fokkema et al. 2019d). Authors of this study concluded that RRI seemed to be a considerable problem amongst novice runners while also suggesting that more attention needs to be given to the prevention of RRI and the restarting of running following injury.

As discussed in Chapter 2, RRIs are multi-factorial and no effective prevention or self-management programmes has yet been identified, likely because most studies concentrate on single risk factors (Fokkema et al. 2019a). Running injury prevention programmes have been developed and effectiveness evaluated in randomized clinical trials (RCTs) (Adriaensens et al. 2014; Hespanhol et al. 2018; Fokkema et al. 2019c; Hollman et al. 2019) but the findings from these studies are mixed. One study found that an online injury prevention programme did not decrease the total number RRI among runners (Fokkema et al. 2019c) however, a similar study on the trail running population found that runners who used the online intervention experienced 13% fewer RRIs when compared with those in a control group (Hespanhol et al. 2018). Other studies have found that RRI prevention interventions delivered online have a positive impact on RRI prevention knowledge and behaviours (Adriaensens et al. 2014; Hollman et al. 2019). The research demonstrates mixed results regarding the effectiveness of online prevention programmes in terms of actual RRI prevention or the move towards RRI preventative behaviours. Interestingly, no studies focused on online interventions for RRI self-management. The interventions from most of these studies were also developed by practitioners and researchers without significant input from runners themselves. For more effective online or digital interventions they should be developed with insights from runners as to the barriers and facilitators experienced by runners when they are looking for RRI prevention and self-management advice.

As recreational running has seen a boom in participation in the last two decades there has also been a rise in the use of devices such as GPS watches and smart phones. Smartphones allow users to download applications (apps) on their phone as a way to monitor their health and fitness (Higgins 2016). Technology for GPS watches has developed so that devices can quantify time spent running, distance, pace as well as physiological and biomechanical metrics such as heart rate, cadence and running intensity (Nielsen et al. 2019). These devices can also provide advice on rest periods and offer means of monitoring and tracking runners' fitness telling them total mileage in a given time and running intensity of each run compared to previous runs. In conjunction with smartphone apps, a GPS watch can upload to a runner's chosen app and store their run history. Runners also have the option to share this information with the larger recreational running community in reward for 'likes' and 'kudos', a form of gamification within fitness apps which are designed to motivate the user.

The Strava app was launched in 2009 and in February 2020 more than 50-million users had joined since its launch with over 1-million users joining each month (Strava 2020). Strava also reported that the app had seen over 3-billion activities including runs, rides, walks and other activities had been uploaded (Strava 2020). Garmin watch users are also able to download the Garmin Connect app which enables watch users to download their fitness activities directly from the watch to the app. The Garmin connect app goes beyond the Strava app and monitors sleep patterns, stress levels, daily steps, fluid intake and menstrual cycle if the user opts to (Strava Support, 2022). For recreational runners of any level running is an easily accessible sport and has been made even more so by GPS devices and smartphone apps. Beginner programmes available to be downloaded, such as the free NHS Couch-to-5k app provides novice runners with an entry point to the sport. Apps and devices appeal as runners can track progress, see improvement and if the platform allows, connect with other runners in the running community for mutual support and encouragement. The literature shows that runners are avid users of digital technology, but it does not tell use how they use this technology in RRI prevention and self-management, how useful they find online sources to be for RRI prevention and self-management or what runners would want from a proposed intervention.

The main aim of this study is to map the use of digital platforms and smartphone apps by recreational runners in Wales and their experiences of RRI while also establishing relationships between sub-groups of runners, their use of digital technology and the content they would want to see within a proposed digital RRI prevention and self-management intervention.

5.3 Methods

5.3.1 Study design

The design of this study is a retrospective study design (Bowling 2002) using volunteers who are recreational runners in Wales. The survey is an exploratory survey questioning runners about their running habits, their experiences of RRI and their approaches to prevention and management of RRI.

5.3.2 The survey instrument

The survey was hosted online using Online Survey Builder (www.onlinesurvey.ac.uk) (license held by Cardiff University). The survey builder was accessible via username and password which were only known to the researcher KW.

Prior to questionnaire development, topics that were of interest for the project were identified. This involved scoping the literature for articles relevant to the topic of RRI. The survey aimed to collate basic demographic information such as age, sex, height and weight but also collect data in relation to recreational running.

Questions within the survey were designed to meet the aims of the study (Bowling 2002). Most of the survey questions were close ended with pre-defined answers from which the participant selected their answer. An initial survey was piloted with members of a running group, members of the academic faculty and fellow PhD researchers. Via the piloting of the initial version of the survey further questions were added to meet the aims of the study which included establishing what recreational runners would want to see in a digital RRI prevention and self-management programme. Wording that was felt to be ambiguous by the pilot testers was altered. Clarification about instructions within the survey was made clearer so that all respondents understood it. Pilot testers identified that there were issues with answering some questions and that some questions were not optional when they should have been. The logic within the survey was then modified.

An online survey reduced costs and removed the need for printing and postage with quick, easy distribution. Secondly it meant that the survey could be shared more widely among the recreational running community. An online link allowed runners to share access to the survey on social media and via email. The online format is also known to provide a high level of anonymity (Braun 2017). A further benefit of conducting online surveys is that they provide a different way of recruiting and sampling beyond self-identification and can extend beyond participants who are regarded as typically taking part in survey research e.g. educated, middle class (Braun 2017).

The survey was designed as a retrospective descriptive survey, taking a cross-section of the population (Bowling and Ebrahim 2005), in this case recreational runners. Retrospective surveys involve questioning participants about behaviour, past and present, attitudes and events. Runners in this survey were asked about their behaviour with regards running and training, their attitudes towards technology and the use of it during running training and their behaviour and attitudes regarding running injury and the management of RRI.

5.3.3 Consent and Eligibility

The first section of the survey screened for eligibility and obtained consent. Participants were asked to read a Participant Information Sheet (PIS) (Appendix 6). The PIS provided participants with information about the intentions of the study, the agencies involved in the study, reassurances regarding anonymity and protection of personal information and who to contact if they had questions about the study. Once they had read this and were happy to continue, they were given three options. The first option took them to the Consent page (Appendix 7), the second option took them to a screen out page if they had questions and wanted to speak to the author KW prior to participation. Potential participants clicked the third option if they did not want to complete the survey and were taken to a screen out page which thanked them for their interest in the project. Participants that clicked that they wanted to participate were taken to a list of consent statements which they were required to tick to indicate full consent for their participation in the study. There were also optional statements regarding participants being happy to be contacted further for potential participation in focus groups connected to second part of the larger study. Once participants had indicated their consent on the mandatory statements they clicked 'Next' and were taken to the first section of questions. The survey questions can be found in Appendix 12.

5.3.4 Survey Sections

The survey was divided into sections:

- About you
- About your running
- About your training
- Have you ever had a running injury?
- About your running injuries and how you manage them?
- The Ideal Running App

The sections were developed with assistance and feedback from supervisors. The first session 'About You' aimed to gain basic demographic data and parameters from the running population (Bowling and Ebrahim 2005) and included age, gender, height, weight and the geographical area. This would enable cross referencing and testing of any statistical hypotheses in relation to the running population (Bowling and Ebrahim 2005) to help identify any relationships within the data e.g. age and rate of RRI.

5.3.4.1 'About Your Running'

This section was designed to gain information about behaviour patterns and motivations of recreational runners in Wales. The intention for this section was to gain the overall experience levels of runners so that relationships between RRI rates and injury behaviour could be established through the data. Runners were asked about the distances they covered in miles per week, whether they trained to compete in mass participation events and races and how many of these races they had completed in the last 12 months. This was intended to help map behaviour patterns of recreational runners and identify possible relationships between RRI rates and injury behaviour. Runners were also asked if they practiced any other forms of training such as other endurance activities, gym classes or strength and conditioning. It was felt that this would be relevant so that it could be ascertained whether cross-training had an impact on injury rates and behaviour.

5.3.4.2 'About your training'

This section was designed to gain information regarding training behaviour patterns of recreational runners in Wales. Runners were asked if they monitored their training and how they did this i.e., via smartphone app, GPS watch or on paper. This was to help collect data on how many runners used digital means for monitoring their training. Runners were asked about the devices/apps that they used, what they used them for and whether they used them for training plans. Runners were also asked whether they tended to stick to training plans or would step outside what the plan recommended and if that meant they would run more often or faster. This data was collected to have a better understanding of training behaviour among runners in Wales and whether this had a relationship to RRI.

Following this section runners were directed to the next section which asked them if they had ever had an RRI. If runners had not had an RRI they could tick 'No' and be moved to the final section of the survey. If they answered 'Yes', they were moved to the next section.

5.3.4.3 'About Your Running Injuries and How You Manage Them'

This section aimed to establish the RRI rates of runners in Wales and behaviour around their injuries. Runners were provided with a definition of what an RRI was. This consensus definition was previously established via a Delphi approach (Yamato et al. 2015b). RRI was defined as 'a running-related (training or competition) musculoskeletal pain that causes a restriction or stoppage of running (distance, speed, duration or training) for at least seven days or three consecutive scheduled training sessions, or that requires the runner to seek medical attention'.

Runners were asked to share how many times they had been injured due to running and to identify their most recent RRI. Participants were given a list of the most common RRIs so they could indicate what their most recent injury was. This list of RRIs was partly informed by the study by (Taunton et al. 2002) in their retrospective case-control analysis of 2002 running injuries. The survey then asked runners how they managed their RRI: did they take time off, how much time they took off and the way in which they managed their injury e.g., physiotherapy, self-management, massage treatment. Runners were asked about what they had found most beneficial in managing their injury and whether they ever used digital/online resources to manage their RRI. Asking runners about whether they used digital resources would provide information about the possible intentions of runners regarding a digital RRI prevention and self-management programme.

5.3.4.4 'The Ideal Running-Related Injury Intervention'

In developing a digital RRI intervention it is desirable to understand what runners' views and preferences would be for such an intervention. This section of the survey was designed to map runners' requirements when they considered a digital RRI prevention and self-management programme. Runners were asked if they would be interested in a smartphone app that would help prevent or manage injury. This was to gain an insight into whether this is something that recreational runners in Wales would be interested in. If runners ticked 'No' they could be moved to the 'Finish' page of the survey. Runners who indicated yes could continue to the next questions which aimed to ascertain what recreational runners wanted to see from such an app. Runners could indicate whether they wanted an:

- 'Injury Free' running toolbox (e.g., advice on running mileage)
- Resilient Runner toolbox (e.g., advice to exercises for better running),
- Self-diagnostic tool (e.g., to find out what type of injury I may have),
- Self-screen tool (e.g., to decide when to seek help from a professional),
- After injury guide (e.g., to guide on recovery/rest periods),

- Return to Running Toolbox (e.g., advice on starting to run again after injury),
- Injury Prevention (e.g., to advise on the best way to try and avoid /prevent injury).

There was also an 'other' option so that runners could add any additional information that they would want to see in an RRI prevention and self-management app. This question was designed to map the content that recreational runners would want from the intervention. This information would help to guide development of any future intervention. Runners were asked who they would want to receive this information from and how important that it was that this information was evidence based. Again, this was with the intention of developing the content of the proposed intervention.

The survey used a closed question format. Participants were given a range of possible answers which gave them prompts about the type of information that was required from each question. A wide range of possible answers also provided respondents with answers that they may not have thought of themselves but once seen prompted their response (Bowling 2002). An 'Other' option was also provided should there be any unknown responses that the researcher KW had not thought of. A mixture of dichotomous and multiple-choice response formats was used in this survey depending on the information that the researcher KW wanted to extract from participants (Bowling 2002). In some sections a multi-item response frame was used as it was identified that in some scenarios, with respect to running behaviour training and injury management, there may not be one answer for individuals answering the question.

5.4 Survey sampling

This method of sampling used for this survey was purposive sampling whereby the survey was aimed at a group of people with a characteristic, in this case recreational runners based in Wales (Bowling 2002). Recreational runners were deemed to have the knowledge and information required for the research in terms of running experiences, training, use of technology and experiences of running injury so they were specifically targeted. Further sampling was conducted via the snowball method whereby recreational runners who had already completed the survey shared the survey via word of mouth, email and social media to fellow recreational runners (Bowling 2002).

5.4.1 Survey inclusion and exclusion criteria

Participants who were eligible to take part in this survey were recreational runners in Wales, male and female, aged over 18. They did not have to be a member of a running club or group to complete the survey. Participants were excluded from the survey if they were under the age of 18, did not complete the required questions in the study or did not complete the electronic consent. Elite athletes and individuals on a national funding programme were also excluded from the study.

5.4.2 Sample and recruitment

Access to recreational runners was gained via Run Wales. Run Wales is the social running programme created by Welsh Athletics (Welsh Athletics 2022). Welsh Athletics, NGB for athletics in Wales, were part funders for this project. Run Wales stores a database of Leaders in Running Fitness (RL). The survey was distributed via this database in an email containing the link to the survey (Appendix 19). RLs were asked to complete the survey and to share it among their members by forwarding the email. The survey was posted in relevant social media groups that were specific to recreational runners in Wales.

5.4.3 Ethical considerations

If participants no longer wished for their information to be used for the research study, they could retrospectively ask for their personal information and responses to be removed and not used for the study. Participants were also asked if they were happy to be contacted for further research and only supplied contact details if this were the case (Braun 2017).

5.5 Data collection and analysis

The online survey builder collected and stored the information and responses provided by all participants who took part in the survey. All information was transferred from the survey builder to Microsoft Excel prior to initial examination of descriptive statistics. Descriptive statistics on demographic information, running and training information and injury information were examined. Statistics collected regarding recreational runners' requirements on the 'Ideal App' were also examined.

Data analysis was performed using IBM SPSS v.25. Initial analysis was descriptive. A more in-depth inferential analysis was performed with sub-groups of runners and their use of technology. Initial analysis was performed to identify possible relationships between sub – groups of runners and use of technology. These sub-groups were running experience; average distance run per week (miles); age category; gender.

Pearson's Chi square test of association and cross tabulation was performed first (Field 2016). This test was done to identify whether two categorical variables (independent and dependent) were associated (Laerd Statistics, 2023). Significance levels set as $p<0.05$. Following this logistic regression analysis was performed to identify whether there were any predictors for the uses of technology by sub-groups of runners.

Pearson's chi square and logistic regression analysis were performed to see if the sub-groups of running experience; average distance per week (miles); age category; and gender were associated with or predictors of:

- Use of a smartphone app to monitor training
- How many apps were used to monitor training.
- Whether NHS sites were useful.
- Whether online videos were useful.
- Whether physiotherapy/sports therapy sites were useful.
- Whether they would be interested in the proposed intervention.

The inferential analysis described above was conducted to achieve the main aim of this study: establish how runners in Wales are currently using digital technology and what runners would want from a proposed digital RRI prevention and self-management intervention.

5.6 Results

5.6.1 Baseline Demographics and Descriptive data

A total of 232 runners completed the survey. In context of the running population being sampled, there are 400,000 people recorded as running regularly in Wales (Welsh Athletics, 2022). Of those surveyed 147 (63%) were women and 85 (37%) were men. The average age was 44.6 and 47.6 for females and males respectively. The majority of those surveyed resided in Cardiff (27.04%) followed by Rhondda Cynon Taf (15.45%), Bridgend (9.44%), Vale of Glamorgan (7.73%) and Carmarthenshire (6.8%) (Figure 5). The mean BMI of runners surveyed was 24.6 for women and 25.3 for men. Table 8 provides an overview of the average age, height and weight for runners who completed the survey. Table 9 gives an overview of the characteristics of this sample of runners.

Table 8 Demographic data of the sample of runners

	Age	Height	Weight
Mean	45.77	168.1	72.51
Std. Error of Mean	.640	.620	1.014
Median	46.0	167	69.85
Mode	44	167	68
Std. Deviation	9.732	9.284	15.385
CI (95%)	44.52 – 47.02	167.42 - 169.8	70.51 – 74.51

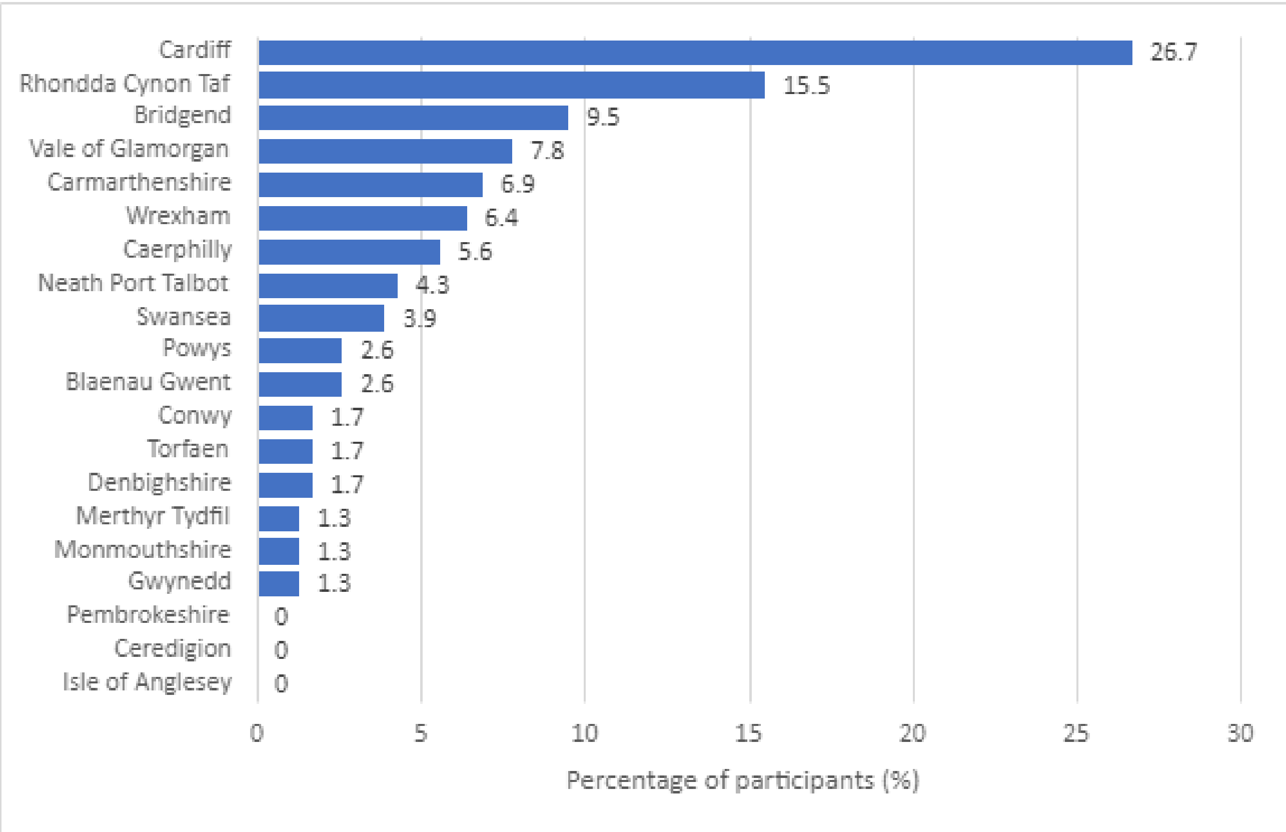


Figure 4 Survey respondents by regions of Wales

Table 9 Characteristics of runners who completed the survey.

Characteristic		Number of participants (%)
Gender	Female	147 (63)
	Male	85 (37)
Age category NB: 7 runners did not answer this question.	18-24	3 (1.3)
	25-34	25 (10.8)
	35-44	78 (33.6)
	45-54	77 (33.2)
	55-64	36 (15.5)
	65 and above	6 (2.6)
	Did not answer	7 (3)
Miles per week	0-5	18 (7.7)
	6-10	72 (30.9)
	10-30	115 (49.4)
	30+	28 (12)
Who do you run with? Can tick two most frequent, 421 responses.		
	With a running club	135 (32.1)
	With a community running group	55 (13.1)
	I run alone	143 (34)
	I run with friends	83 (19.7)
	Other	5 (1.2)
How long have you been running?	Less than 3 months	2 (0.9)
	3 months – 2 years	47 (20.2)
	More than 2 years	184 (79)
How many races in last 12 months? *227 responses	0	6 (2.6)
	1-5	91 (40.4)
	6-10	69 (30.6)
	11-15	29 (12.8)
	16-20	12 (5.3)

	20-29	5 (2.2)
	30-39	7 (3.1)
	50+	4 (1.7)
	110+	2 (0.8)
Any activities besides running? *Runners able to tick all that apply, 422 responses	Cycling	77 (17)
	Swimming	68 (15)
	Weight training	79 (17.4)
	Exercise classes e.g., circuits, spinning, cross fit	88 (19.4)
	Yoga/Pilates	70 (15.5)
	Other	40 (8.8)
What motivates you to run? Respondents were able to select up to 3 responses. 590 responses.	Health reasons e.g., to be fitter	211 (35.8)
	To meet people	63 (10.7)
	For mental well being	157 (26.6)
	To compete in races	78 (13.2)
	Weight loss	72 (12.2)
	Other	9 (1.5)

Nearly half of those who participated reported running between 10-30 miles per week (49.4%) followed by 72 (30.9%) of runners who run 6-10 miles per week. 18 (7.7%) of runners were running less than five miles per week.

Seventy-nine percent of respondents had been running for more than two years, 20.2% had been running for between three-months and two-years and 0.9% of respondents had been running for less than three months. This sample of runners was therefore experienced and comprised of very few novice runners. The three most common reasons for running were health reasons (35.8%), mental wellbeing (26.6%) and to compete in races (13.2%). The majority of participants (97.4%) reported that they took part in mass participation events. Table 9 also shows other activities runners take part in outside running. Exercise classes such as circuits, spinning and CrossFit were the most popular among runners. Only thirty-one respondents indicated that they did not do any other activities besides running.

5.6.2 About your training

This section aimed to establish information about how recreational runners in Wales approached their running training and their use of digital technology. Table 10 gives more detailed information about how runners use digital technology to complement their training, how runners monitor their training, devices used and where runners sourced their training programmes. In this survey 97% of runners reported monitoring their training. Of the 225 runners who monitored their training, the three most popular ways were a running watch (45.1%), smartphone app (37.6%) and web platform (10.1%).

Most runners reported not following a training programme and ran according to how they felt. However, for those who used a programme, most reported that they would devise it themselves, source a training programme online or ask a running coach or leader to write a programme for them. The most popular place to source a training programme was Runner's World magazine and website.

The survey aimed to explore what runners looked for in a smartphone app or GPS watch. The most sought-after functions were to monitor training and volume i.e., distance and distance per week, a way to monitor training intensity and a heart rate monitor function. The next most popular function was a motivation function that provided rewards, challenges or feedback on weekly mileage and effort. Strava was the most popular smartphone monitoring app, followed by Garmin Connect. Garmin was the most popular watch brand.

Table 10 Training habits reported by runners who completed the survey.

Characteristic		Number (%)
How do you monitor your training? *	Paper diary	26 (6.2)
*** Participants were able to select 3 answers, resulting in 414 responses.**	Running watch	188 (45.1)
	Smartphone app	157 (37.6)
	Web platform	42 (10.1)
	Other e.g., spreadsheet	4 (1)
	Strava	180 (65)

What smartphone application do you use? ***Participants were able to select multiple answers leading to 277 responses.**	Map My Run	15 (5.4)
	Run Keeper	5 (1.8)
	Nike Run Club	7 (2.5)
	NHS Couch to 5K	10 (3.6)
	Other e.g., Garmin connect, Fitbit	60 (21.7)
Which brand of running watch do you use? ***Participants were able to select multiple answers resulting in 218 responses**	Garmin	164 (75.2)
	Suunto	6 (2.8)
	FitBit	18 (8.3)
	Apple	15 (6.9)
	Other e.g., Samsung, TomTom	15 (6.9)
Where do you source your training programmes from? ***participants were able to select multiple answers resulting in 394 responses.**	Online	81 (20.5)
	Running magazines	31 (7.8)
	A book	17 (4.3)
	Running coach/club/leader	86 (21.7)
	I devise the programme myself	83 (21)
	I don't follow a programme, I run by how I feel.	90 (22.7)
	Other	8 (2)
What do runners look for in a smartphone app or GPS watch? ***participants were able to select multiple answers resulting in 794 responses.**	Training programme resource	21 (2.8)
	Function to monitor training distances	197 (25.8)
	Function to monitor intensity	172 (22.5)
	Function to monitor rest	34 (4.5)
	Heart rate monitor	132 (17.3)
	Connectivity to other runners	55 (7.2)
	To be able to compete with other runners	19 (2.5)

	Function to keep track of running shoes	43 (5.6)
	Motivation function	78 (10.2)
	Other e.g., music, aesthetics, route planning, cross training	12 (1.6)

Over 50% of the runners surveyed did not take on board advice on training volumes, intensity and rest periods. Reasons given for this were that the advice was not realistic, the advised rest periods were too long, they were receiving advice from coaches or that they tended to listen to their own body. A lack of accuracy and a lack of information were also cited as reasons for not utilizing the app or watch for training advice. Some of the participants indicated that they would sometimes do more than the training programme recommended (38.2%). Reasons for this were commonly that they felt so good that they could do more, that they wanted to compete and that they felt 'more was better'. Runners also said they would ignore the training programme if it didn't fit in with races they were training for or if other commitments such as work, and family prevented them from following the programme.

5.6.3 Injury experiences

Two hundred and three (87%) runners reported having had an RRI with 125 being women and 78 being men. Most runners had been injured between one to three times (67%) with 24.6% reporting that they had been injured between three to seven times (Figure 6). Only 8.4% of runners reported having been injured more than seven times. When analysed via gender, 62% of women reported being injured between one to three times compared with 52% of men. Of those runners who had been injured three to seven time, 29% were men and 17% were women.

The most common injury was Achilles tendon injury followed by foot injury e.g., plantar fasciitis and calf injury. The 'other' category was selected by 11 runners (5.4%) of respondents with these injuries including meniscal tears and upper limb fractures. Table 11 indicates the time respondents took off from running due to RRI and the ways in which runners reportedly managed their injuries.

5.6.4 Runners' management of running-related injuries

Injured runners were asked how they had managed their most recent injury, how they self-managed injury and what they found most beneficial when managing and injury (Table 11). Predominant methods of RRI management were rest and self-management followed by advice from an HCP. The most popular self-management strategies were stretching, strength exercises and ice treatment.

Only 16 (7.9%) runners said that they had to take time off work due to RRI with reasons including being unable to weight bear and mobilise due to the injury. One runner said that their GP signed them off as they had become severely depressed at being unable to run due to injury. Twenty-five runners reported that they had had to stop their daily functional tasks as a result of their RRI. Runners reported not being able to do tasks such as walking the dog, taking care of children, driving and housework due to their RRI. This was linked to being unable to weight-bear, walk for any distance or being in too much pain.

The most beneficial management strategies reported by runners were advice from HCPs, sports massage and finding the right shoes (Table 11). Physiotherapy and sports therapy websites were most frequently used by runners as sources of online RRI advice, followed by the NHS website (Table 11). Only six runners reported finding their smartphone apps or GPS watch useful when managing RRI. These runners reported using their device to monitor training volume such as distance, monitor intensity of runs or take advice on rest periods.

<u>Table 11 Strategies implemented by runners to manage and self-manage RRI.</u>

Characteristic		Number (%)
How did you manage your last running injury? (participants able to tick all that apply = 491 responses)	Rest	140 (28.5)
	GP visit	27 (5.5)
	Visited a sports physiotherapist/sports therapist	102 (20.8)
	Had a sports massage	64 (13)
	Self-management	126 (25.7)
	Followed advice from running peers	32 (6.5)
How runners self-managed their last injury (participants able to tick all that apply = 514 responses)	Heat treatment	40 (24.2)
	Modified running training	46 (27.9)
	Cross trained i.e. cycling, swimming etc	65 (39.4)

	Foam rolling	69 (41.8)
	Ice treatment	73 (44.2)
	Strength exercises	86 (52.1)
	Stretching	124 (75.2)
	Other	11 (6.7)
What runners find most beneficial when managing an injury (participants invited to tick the three most important = 443 responses)		
	Advice from healthcare professionals (e.g. Physiotherapists, GP, Pharmacist)	113 (55.9)
	Advice from running coach/running leader/running club	41 (20.3)
	Orthotics	17 (8.4)
	Massage	70 (34.7)
	Advice from running peers	31 (15.3)
	Gait assessment	17 (8.4)
	Finding the right shoes	59 (29.2)
	Exercise programmes	38 (18.8)
	Online advice	38 (18.8)
	Other	19 (9.4)
Online resources reported to be the most useful when managing injury. (participants invited to tick all that apply = 234 responses)	NHS website	53 (22.6)
	Information video format e.g. You Tube	52 (22.2)
	Physiotherapy/Sports therapy websites	72 (30.8)
	Online running magazine	52 (22.2)
	Other	5 (2.1)
Time taken off running due to injury	None I continued to run through the injury	46 (22.8)
	1-2 weeks	61 (30.2)
	2-4 weeks	31 (15.3)
	4-6 weeks	26 (12.9)
	6 + weeks	38 (18.8)

5.6.5 The Ideal Running App

Of the 232 participants surveyed, 193 (84.5%) respondents indicated that they would be interested in a digital RRI prevention and self-management intervention. Participants were asked what they would want to see in the Ideal Running App. The three most popular responses were for an Ideal App to include a ‘Resilient Runner’ toolbox which would include advice on exercises for better running, ‘Injury Prevention’ to provide information on how best to avoid injury and a ‘Self-diagnosis’ tool to help runners identify what type of injury they might have (Table 12).

Table 12 Features that runners surveyed wanted to see in the proposed digital intervention.

Question		Number (%)
Features runners would want to see in the Ideal App? (participants invited to select up to three = 739 responses)	An 'Injury Free running toolbox) e.g., to advise on running mileage and training)	102 (51%)
	Resilient runner toolbox (e.g., advice on exercises for better running)	131 (65.5%)
	Self-diagnostic tool (e.g., to find out what type of injury I may have.	117(58.5)
	Self-screening tool (e.g., to help decide when to see a health professional)	61 (30.5)
	After injury guide (e.g., to guide on recovery/rest periods)	99 (49.5)
	Return to running toolbox (e.g., advice on starting to run again after injury)	99 (49.5)
	Injury prevention (e.g., advice on the best way to avoid/prevent injury)	127 (63.5)
	Other	3 (1.5)
Who runners would want to deliver this information. (201 responses)	Health professionals e.g., Physiotherapists, Sports therapists, doctors, podiatrists	170 (84.6)
	Fellow runners	8(4)
	Well-known runners	5 (2.5)
	Running coaches/leaders	17 (8.5)
	Other	1 (0.5)
How important is it to runners that this information is evidence based? (204 responses)	Very important	164 (80.4)
	Important	36 (17.6)
	Not important	1 (0.5)
	Not sure	3 (1.5)
Would runners find it beneficial if the app advised when to see a health professional? (232 responses)	Very helpful	126 (54.3)
	Helpful	72 (31)
	Not helpful	13 (5.6)
	Not sure	21 (9.1)

What other information would runners want to see within the proposed intervention? (participants able to tick up to 3 = 282 responses)	Nutritional information	115 (40.8)
	Hydration information	90 (31.9)
	Information on managing stress.	44 (15.6)
	Sleep advice	26 (9.2)
	Other	7 (2.5)

Runners (n= 171, 84.7%) predominantly wanted information delivered by an HCP e.g. physiotherapist, sport therapists or doctors (Table 12), while 164 (80%) runners considered it very important that the information provided by the intervention was evidence-based (Table 12). Over half of the respondents (54.1%) thought it would be very helpful to have a feature in an app that allowed runners to enter their symptoms and advise whether they need to see an HCP (Table 12). The majority of runners (90.6%) said that they would want to see exercise programmes for the prevention or management of specific RRIs. Runners indicated that they would also like to see other information included, with the two most popular categories being nutritional information and hydration (Table 12).

5.6.6 Runners and how they use technology to monitor training.

Ninety-seven percent of runners who completed this survey reported monitoring their running training. Runners were asked how they monitored their training. It was found that runners are predominantly using running watches (45.2%) and smartphone applications (37.7%). Running watches can be linked to smartphone apps where runners can also log their training, which could explain the high use of both of these pieces of technology. Runners were predominantly using one application to monitor their training (Table 13).

Table 13 Number of apps used by runners to monitor training.

Number of apps	Frequency	Percent
0	19	8.2
1	149	64.2
2	55	23.7
3	7	3.0

4	2	0.9
Total	232	100.0

Runners were asked which online resources they found most useful to inform them about RRI prevention and self-management. The three most popular resources for runners in this survey were physiotherapy/sports therapy web sites (30.8%), information videos sites e.g. You Tube (22.6%), and NHS websites (22.2%). The majority of runners who responded to the survey were in favour of a proposed digital intervention to help them prevent and self-manage RRI, with 196 (85.5%) respondents indicating that they would be interested and 36 (15.5%) responding that they would not.

Data was analysed according to sub-groups of runners (running experience; average distance per week (miles), age category; and gender). Chi-square analysis and logistic regression analysis was conducted to establish whether there were associations/ between selected independent variables of runner and whether they monitored their training, the number of apps they used to monitor training and the sources of information they found useful (NHS web sites, physiotherapy/sports therapy websites, online videos e.g. You Tube). Chi-square analysis and logistic regression was also performed to see whether there were associations for these same variables and whether runners were interested in the proposed intervention. The first section of the analysis covers the initial chi square analysis. This is then followed by logistic regression analysis to explore whether the selected predictors (running experience, average miles per week, gender and age) were associated with dependent variables related to runners' use of technology.

5.6.6.1 Running experience and use of technology.

Pearson's chi square test showed a significant association for running experience and monitoring training (16.592, $p<0.001$, df 2), however the descriptive analysis suggests this relationship was in the novice category, which notably only had 2 participants (Appendix 13 for Cross tabulation and chi square tables). There was a statistically significant association between use of a smartphone app and running experience ($\chi 2 = 8.042$, $p = 0.018$, df = 2).

For experience those running 3 months – 2 years were more likely to use a smartphone app to monitor training than those who had been running less than 3 months and those had been running more than two years. Runners who had been running more than 2 years were more likely to say that they did not use a smartphone app compared with those who had been running 3 months to 2 years.

There was also a significant association between running experience and the number of apps used ($\chi 2 = 18.977$, $p = 0.015$, $df = 2$). It was noted that runners with 3 months to 2 years running experience were using more apps to monitor training than runners in the other two categories (Figure 6). The mean number of apps used was greater for the 3 months to 2 years category (Figure 7). It is noted that the data is examined by the mean number of apps per running experience group, for the least experience group there is a large confidence interval, indicating that the true mean may lie somewhere between the upper and lower limit (Hespanhol et al 2019). The low number of respondents in this category may explain the large CI (Holger et al 2023).

Pearson's chi square test was performed to identify whether there was an association between running experience and the types of online resources (NHS websites, online videos, physiotherapy/sports therapy websites) that runners found useful. There were no statistically significant associations identified between finding all these online resources useful and running experience. Running experience did produce a statistically significant association for being interested in the proposed intervention ($\chi 2 = 7.559$, $p = 0.023$, $df = 2$). More experienced runners were more likely to respond no to the question of whether they would be interested in the proposed intervention (Figure 8).

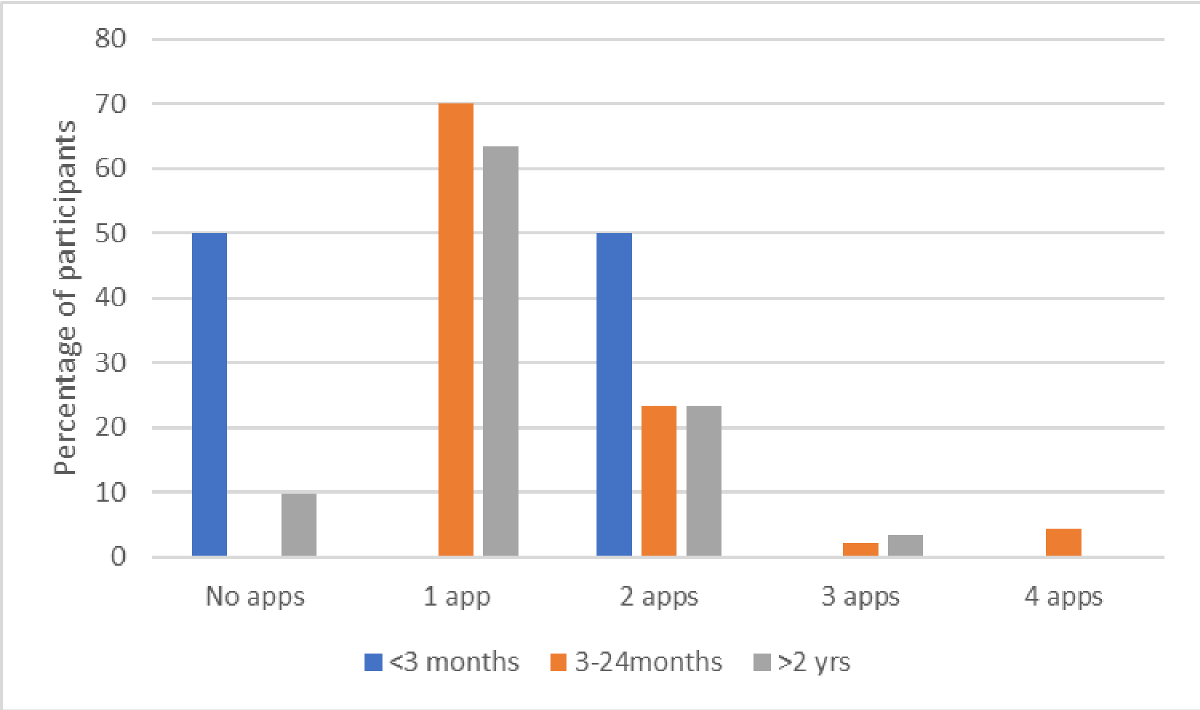


Figure 6 Percentage of participants in each running experience category and number of apps used to monitor training.

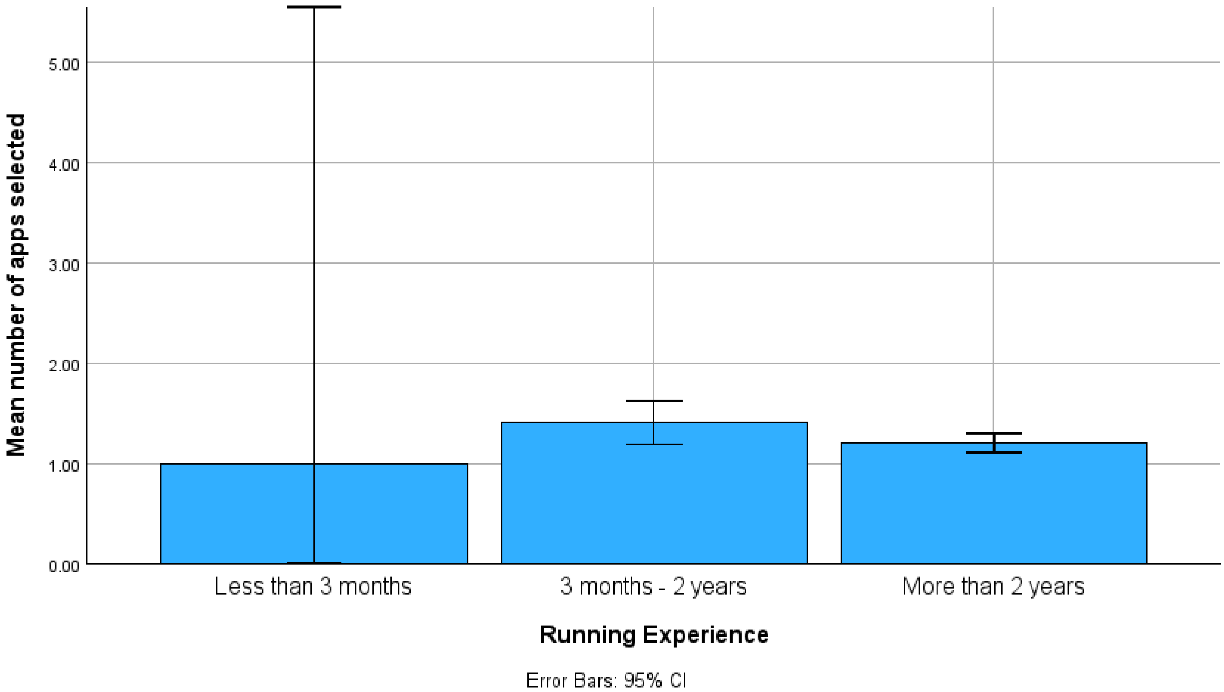


Figure 7 Mean number of apps used by runners according to running experience.

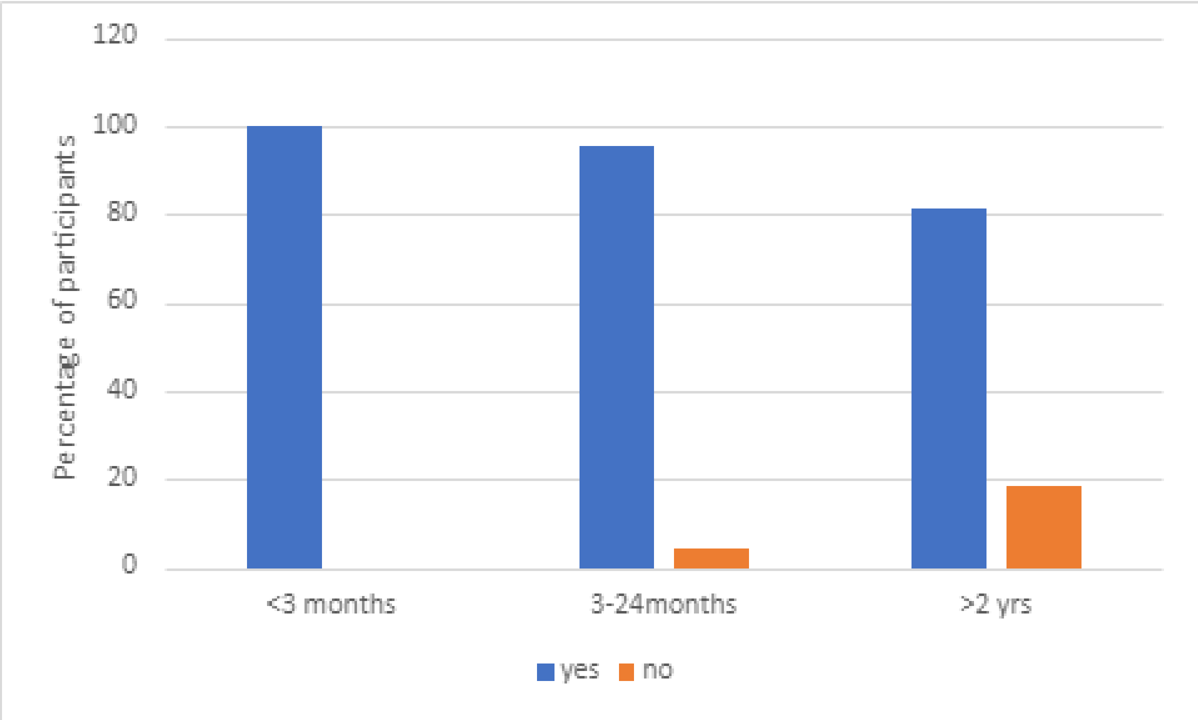


Figure 8 Percentage of participants in each running experience category and whether they were interested in the proposed intervention.

5.6.6.2 Average miles per week and use of technology

Pearson Chi square test for association showed no significant association for monitoring training and average miles per week (4.973, p=0.174, df 3). There was a significant association between use of a smartphone app to monitor training ($\chi 2$ = 54.059, p = 0.001, df=3). Those who ran 10-30 miles per week were more likely to use a smartphone app to monitor training while those who run 6-10 miles a week were less likely to use a smartphone app. No association was found between average miles per week and the number of apps used to monitor training.

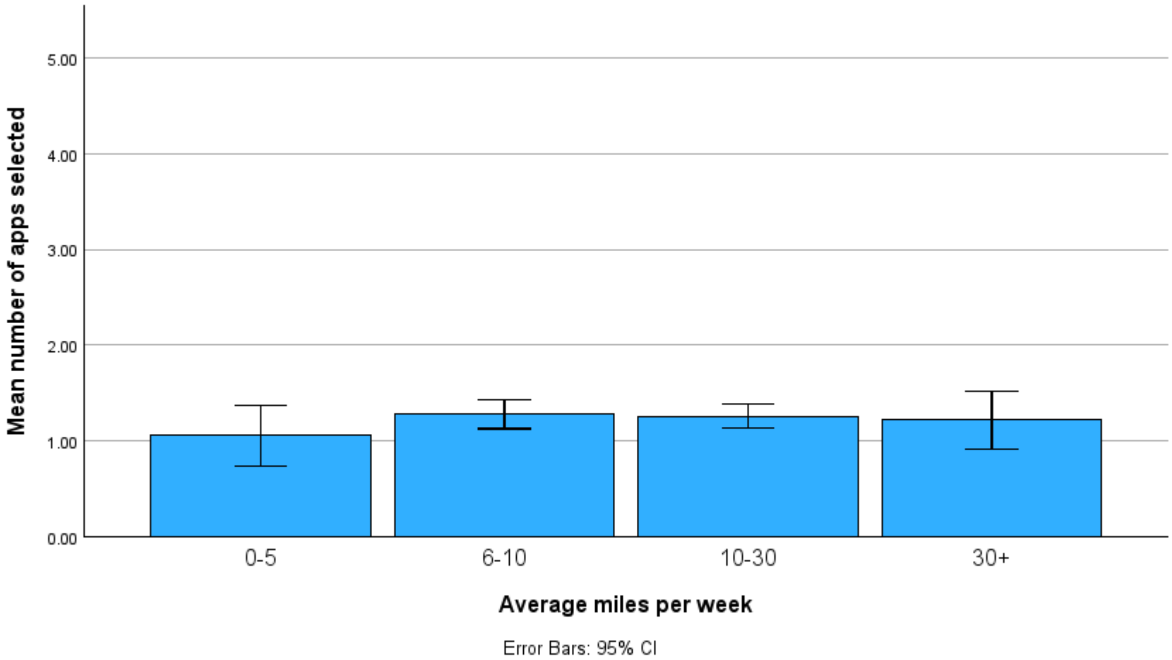


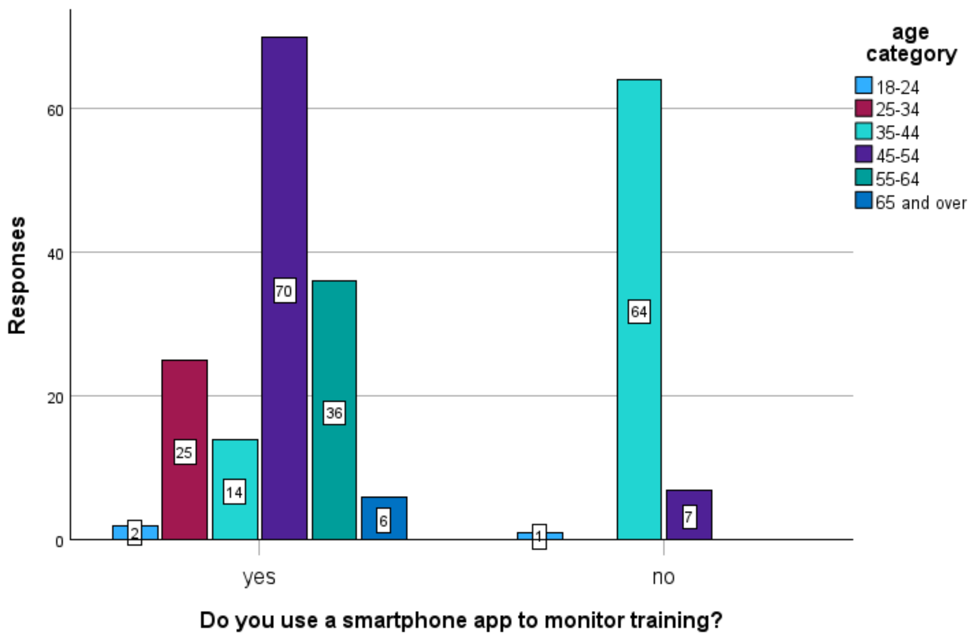
Figure 9 Mean number of apps used by runners according to average miles per week.

Pearsons chi square test was performed to identify whether average miles per week was associated with the types of online resources of information that runners found useful. Significant associations were found for average miles per week and reporting NHS websites, ($\chi2$ = 100.566, p=0.001, df = 3), online videos, ($\chi2$ = 95.317, p= 0.001, df = 3) and physiotherapy/sports therapy websites ($\chi2$ = 54.290, p = 0.001, df = 3).

The majority of those who did report find NHS sites useful were running 6-10 miles a week (71.7%). Of those who responded yes to finding online videos useful 73.1% were running 6-10 miles a week and 21.2% were running 0-5 miles a week. This is in contrast with those running 10-30 miles a week (5.8%) and over 30 miles a week (0%). The majority of runners who found physiotherapy/sports therapy sites useful were running 6-10 miles per week (52.8%). In comparison of those who found physio web sites useful, 30.6% were running 10-30 miles a week and 16.7% were running 0-5 miles a week. No one running over 30 miles a week reported finding physio web sites useful for RRI information.

5.6.6.3 Age category and use of technology

Age category was not found to have no significant association with monitoring running training (4.183, p=0.523, df 5). There was a significant association between age category and use of a smartphone app to monitor training ($\chi 2$ = 139.901, df = 5, p = 0.001). Runners in the 45-54 age group were more likely to use a smartphone app to monitor training. Runners aged 35-44 were more likely to state that they did not use a smartphone app to monitor training (Figure 10). There was a significant association between age category and number of apps used to monitor training ($\chi 2$ = 38.333, p= 0.007, df=5). Runners who were aged over 65 were more likely to use no apps to monitor training (Figure 11).



<u>Figure 10 The number of runners in each age category and whether they use a smartphone app to monitor training.</u>

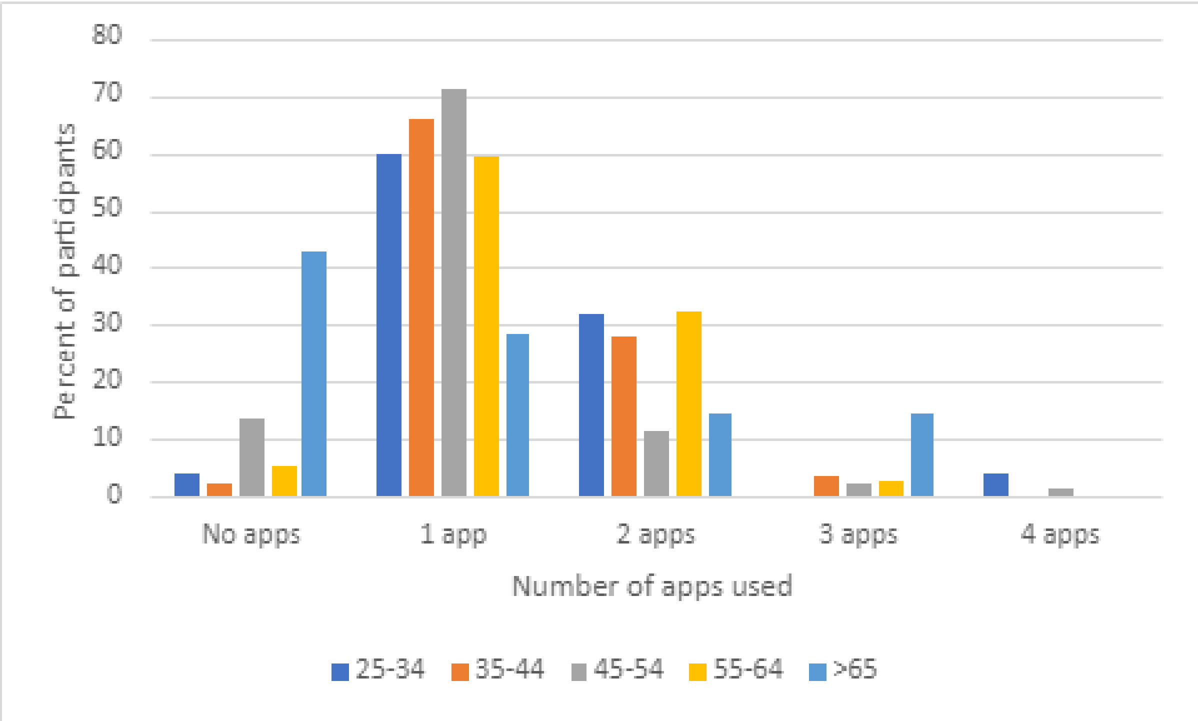


Figure 11 Percentage of participants in each age category and the number of apps they reported using to monitor training.

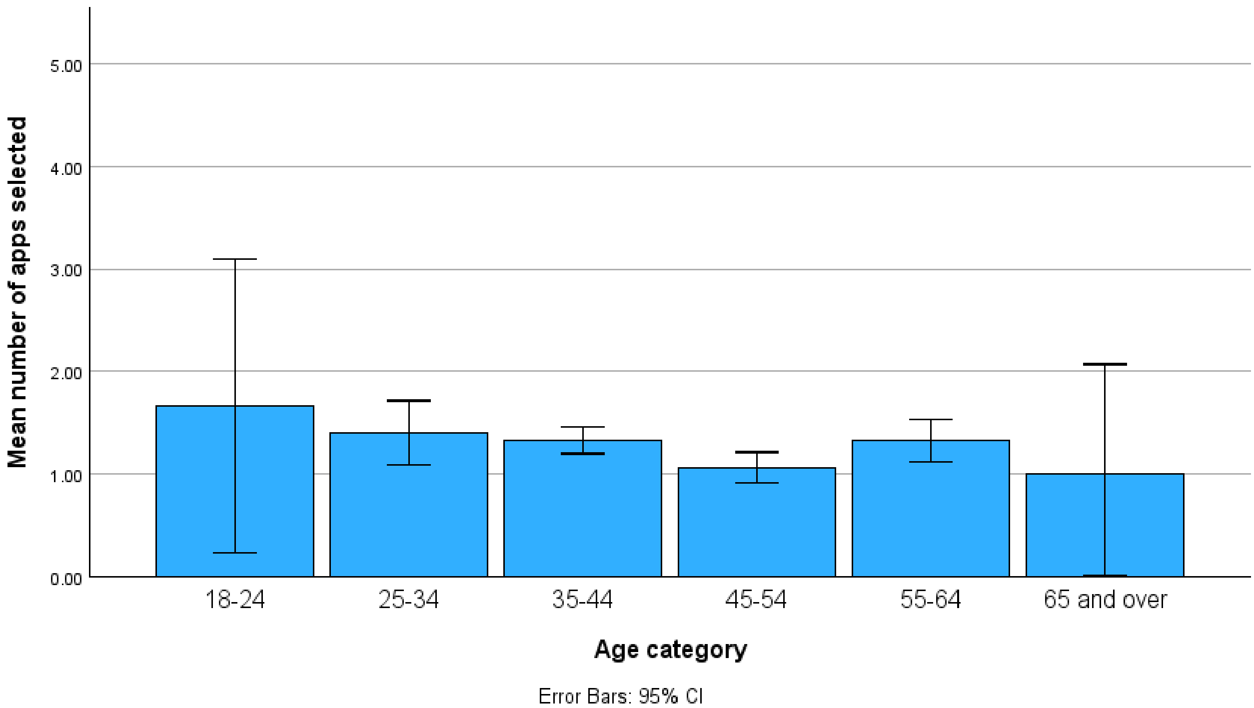


Figure 12 Mean number of apps used by runners according to age category.

Analysis was performed to explore whether there were associations between age category and the online resources used by runners (NHS websites, online videos, physiotherapy/sports therapy sites). There were significant associations found between age category and the explored variables: NHS websites ($\chi2 = 81.657$, $p=0.001$, $df = 5$); online videos ($\chi2 = 80.677$, $p = 0.001$, $df = 5$); physiotherapy/sports therapy sites ($\chi2 = 111.442$, $p= 0.001$, $df =5$).

In the 35-44 category 77.4% said they found NHS sites useful. No runners in the three older categories reported finding NHS sites useful for RRI information. Runners in the 35-44 age group found online videos useful (78.8%) compared with 0% of runners in each of the three older age groups (45-54, 55-64 and 65 and over).

Nearly 80% of runners in the 35-44 age category reported that they found physio websites useful. No runners in the 55-64 category and 65 and over category and only 4.2% aged 45-54 found physio web sites useful.

5.6.6.4 Gender and use of technology

Pearson's chi square test found no association between gender and whether runners monitored training ($\chi2 = 1.553$, $df = 1$, $p = 0.213$). There was a significant association between gender and using a smartphone app to monitor training ($\chi2 = 62.504$, $p = 0.001$, $df = 1$). All male respondents reported using a smartphone app to monitor their training while for females it was a 50/50 split between those who did use a smartphone app to monitor training and those who did not.

Analysis performed to identify whether there was an association between gender and different sources of online information found significant associations for NHS websites ($\chi2 = 41.656$, $p=0.001$, $df = 1$), online videos ($\chi2 = 8.045$, $p= 0.005$, $df = 1$) and physiotherapy/sports therapy sites ($\chi2 = 63.663$, $p= 0.001$, $df =1$).

No male respondents reported finding NHS sites useful while 100% of women reported they did. No male runners reported that physiotherapy/sports therapy sites were useful.

5.6.6.5 Exploring selected predictors and how they are associated with runners' use of technology.

Logistic regression was used to explore the relationship between the selected predictors (running experience, average miles per week, gender and age) and whether these predictors were associated with 1) whether runners monitored training; 2) if runners used a smartphone app to monitor training; 3) finding NHS websites useful; 4) finding online videos useful; 5) finding physiotherapy/sport therapy sites useful; 6) whether runners were interested in the proposed intervention (Tables 14-19).

For monitoring training (Table 14) the model was not significant ($\chi2$ = 9.166, p = 0.241). None of the selected individual predictors were significant and therefore not associated with whether a runner monitored training. The model for use of a smartphone app to monitor training was significant ($\chi2$ = 170.363, p = 0.001) but none of the individual predictors were found to be associated with the use of smartphone apps to monitor training (Table 15).

Models for finding NHS websites useful($\chi2$ = 210.369, p = 0.001). , online videos useful ($\chi2$ = 204.984, p = 0.001) and physiotherapy/sports therapy sites useful ($\chi2$ = 195.901, p = 0.001) were all significant. However, none of the selected individual predictors had a significant association with any of these dependent variables (Tables 16, 17 and 18).

Logistic regression was performed to explore the selected predictors and whether runners would be interested in the proposed intervention (Table 19). The model was significant. ($\chi2$ = 15.523, P =0.30.). However again there were no significant associations with being interested in the proposed intervention for any of the selected individual predictors.

Table 14 Logistic regression table for predictors of running experience, average distance per week, gender and age and whether runners monitor training.

Predictor	B	S.E.	Wald.	Sig.	Exp (B)
Running experience					
0-3 months			.000	1.000	
3 months – 2 years	.379	30354.815	.000	1.000	1.460
More than 2 years	-17.269	31134.625	.000	1.000	.000

Average distance per week					
0-5 miles	---	---	.070	.995	
6-10 miles	-.013	12718.890	.000	1.000	.988
10-30 miles	17.609	13809.645	.000	.999	44417488.32
30 + miles	17.358	13809.645	.000	.999	34548281.16
Gender (male)	-18.385	5379.231	.000	.997	.000
Age	-.039	.043	.837	.360	.962
Constant	22.724	28418.209	.000	.999	7395291696

NB: Gender is males compared with females.

Table 15 Logistic regression model for selected predictors (running experience; average distance per week; gender; age) and whether they are associated with smartphone use by runners.

Predictor	B	S.E.	Wald	Sig.	Exp (B)
Running experience					
0-3 months			.000	1.000	
3 months – 2 years	-21.071	10728.912	.000	.998	.000
More than 2 years	1.439	12549.965	.000	1.000	4.214
Average distance per week					
0-5 miles	-----	----	---	1.000	----
6-10 miles	19.876	10728.912	.000	.999	428514648.5
10-30 miles	-1.427	12549.964	.000	1.000	.240
30 + miles	-1.405	15613.175	.000	1.000	.245
Gender (male)	-21.131	5362.730	.000	.997	.000
Age	-.016	.024	.458	.499	.984
Constant	.632	1.695	.139	.709	1.882

NB: Gender is males compared with females.

Table 16 Logistic regression model for selected predictors (running experience; average distance per week; gender; age) and whether runners found NHS websites useful.

Predictor	B	S.E.	Wald	Sig.	Exp (B)
Running experience (more than 2 years)	-42.420	9560.941	.000	.996	.000
Average distance per week					
0-5 miles			.000	1.000	
6-10 miles	22.992	6994.362	.000	.997	9667183374
10-30 miles	47.060	9560.941	.000	.996	2.74
30 + miles	47.070	13338.028	.000	.997	2.769
Gender (male)	18.337	5369.442	.000	.997	91977666.08
Age	-.007	.052	.020	.886	.993
Constant	-1.441	2.557	.318	.573	.237

NB: Gender is males compared with females. Running experience is more than 2 years compared with 3 months – 2 years.

Table 17 Logistic regression model for selected predictors (running experience; average distance per week; gender; age) and whether runners found information videos useful.

Predictor	B	S.E.	Wald	Sig.	Exp (B)
Running experience (more than 2 years)	-42.435	9555.417	.000	.996	.000
Average distance per week					
0-5 miles			.000	1.000	
6-10 miles	22.501	6989.803	.000	.997	5919181305
10-30 miles	46.583	9555.417	.000	.996	1.700
30 + miles	46.601	13330.319	.000	.997	1.732
Gender (male)	18.328	5366.420	.000	.997	91114234.37
Age	-.013	.049	.067	.796	.987
Constant	-.701	2.388	.086	.769	.496

NB: Gender = males compared with females. Running experience is more than 2 years compared with 3 months – 2 years.

Table 18 Logistic regression model for selected predictors (running experience; average distance per week; gender; age) and whether runners found physiotherapy/sports websites useful.

Predictor	B	S.E.	Wald	Sig.	Exp (B)
Running experience (More than 2 years	-42.423	9.559.611	.000	.996	.000
Average distance per week					
0-5 miles			.000	1.000	
6-10 miles	22.992	6993.274	.000	.997	9670053535
10-30 miles	44.614	9559.611	.000	.996	2.374
30 + miles	44.626	13336.172	.000	.997	2.404
Gender (male)	20.784	5368.714	.000	.997	1062681345
Age	-.009	.028	.097	.755	.991
Constant	-1.378	1.526	.815	.367	.252

NB: Gender is males compared with females. Running experience is more than 2 years compared with 3 months – 2 years).

Table 19 Logistic regression model for selected predictors (running experience; average distance per week; gender; age) and whether runners were interested in the proposed intervention) ***NB: Gender is males compared with females.***

Predictor	B	S.E.	Wald	Sig.	Exp (B)
Running experience					
0-3 months			.284	.868	
3 months – 2 years	19.200	28419.743	.000	.999	217893651.1
More than 2 years	18.815	28419.743	.000	.999	148392365.8
Average distance per week					
0-5 miles			1.426	.700	
6-10 miles	0.83	.908	.008	.927	1.087
10-30 miles	-.984	1.276	.595	.440	.374
30 + miles	-1.041	10275.844	.000	1.000	.353
Gender (male)	-17.937	5974.681	.000	.998	.000
Age	.023	.030	.581	.446	1.023
Constant	-22.101	28419.743	.000	.999	.000

It is noted that in these models that there are large numbers for standard error. These large values indicate that the statistics for the sample may not be an actual reflection of the running population that the sample came from (Field, 2016).

5.6.6.6 Features that runners want in the proposed intervention.

Runners were asked about what they wanted to see featured in the proposed intervention (Table 12 found above). Runners were able to give multiple responses. The most popular features that runners wanted to see were a 1. 'A Resilient Runner tool kit' to advise runners on exercises for better running (65.5%), 2. 'Injury Prevention' to advise on the best way to prevent/avoid injury (63.5%) and 3. 'Self-diagnostic tool' (58.5%) to help runners find out what type of injury they have. These three responses were then taken, and further analysis performed. Pearson's chi square analysis was performed to establish if there was an association between the sub-groups of runners (gender, age category, running experience and average miles per week and the content that runners wanted to see within the intervention (Resilient runner tool kit, Injury prevention, self-diagnostic tool). No significant associations were found between sub-groups of runners and the content that runners wanted to see within the intervention (Appendix 13 for SPSS output).

5.7 Discussion

The main aim of this survey was to map the use of digital platforms and smartphone apps by recreational runners in Wales and their views on RRI prevention, self-management and a proposed 'Ideal RRI prevention and self-management' intervention. The findings of this survey and how they related to the study's aims and the related literature will now be discussed.

5.7.1 Demographics

The overall demographics of the survey were comparable to demographics identified in previous studies on recreational runners (Linton and Valentin, 2018, Fokkema et al. 2019f). One study found that the mean age of all respondents, male and female (n=1145) was 47.38 with a BMI in injured runners of 24.64 and 24.15 in non-injured runners (Linton and Valentin 2018). A study of novice runners found that those who completed their survey were of an older age (44.6) and had a BMI of 25.3, (Fokkema et al. 2019f) which again are findings which are comparable with the present survey. More women than men completed this survey, and this has been reflected in previous surveys conducted on recreational runners (van Dyck et al 2017, Kennedy et al. 2019). Despite running traditionally having higher male participation rates, findings of studies on recreational runners are increasingly finding that participation is becoming more balanced between men and women (Mayne et al. 2021).

Respondents were most heavily represented by Cardiff in the survey with 63 of the runners who responded coming from the Cardiff region. There was a large disparity noted in the number of those who responded from Cardiff with those who responded from areas in North Wales. This could be due to a number of reasons. There are large differences in population density between regions of Wales. For example, the population density of Cardiff is 2585.2 people per square kilometer compared with 270.2 people per square kilometer in Wrexham (Stats Wales 2018). This could account for the different response levels from different regions in Wales. If there is a smaller population then there are potentially running clubs, community running groups and possibly less runners in the local population which again could account for the differences in response rates between the regions.

There was a large disparity in responses from North and South Wales. Most respondents were based in South Wales with only thirteen participants from North Wales (Conwy, Denbighshire, Flintshire, Gwynedd and Wrexham). Results of this survey are therefore biased towards the experiences of those in South Wales. The sample for this survey is a small one and therefore generalisations about the population cannot be fully extrapolated but it is suggested that further research on running, physical activity levels and comparisons between areas of Wales.

Most runners in this study reported running between 10-30 miles (16-48 km) a week. Previous research investigating an intervention for RRI prevention in trail runners found that the intervention group and control groups ran 30.1 km/week and 30.7 km per week respectively (Hespanhol et al. 2018). Another study found that the average weekly running distance of their participants was 22.2 km/week (Fokkema et al. 2019c) The differences in findings could be due a number of reasons. Firstly, the instrument used in the current study provided pre-determined answers consisting of a weekly distance range e.g., 0-10 miles, 10-30 miles, therefore establishing the average weekly running distance in this sample was not possible. The two aforementioned studies also looked at very specific populations of runners: trail runners (Hespanhol et al. 2018) and runners registered for 3 large running events (Fokkema et al. 2019c). The current study sampled runners of all types and experience levels and was inclusive of those who do not run events; therefore, the findings of weekly distance may be across a wider range than those in other studies. A relationship was found between running experience and the occurrence of injury with the data, suggesting that more experienced runners were affected more by injury than less experienced runners. However, the data set in the current study consisted of a small proportion of novice, less experienced runners which will have created bias within the data. There were no significant differences in injury occurrence found between runners reporting to run a higher average mileage compared with those who ran a lower average mileage.

Weekly running distance has been cited as a risk factor in development of RRI (van Mechelen 1992; Nielsen et al. 2014b). It has been proposed that training intensity and training volume are associated with specific RRIs, however an RCT found that there was no differences in hypothesized intensity and volume specific RRIs between running schedules which progressed in either volume or intensity (Ramskov et al. 2018). A study on novice runners found that those who increased their running distance by more than 30% over a two week period seemed to be more vulnerable to distance related injuries compared to those who progressed by 10% per week (Nielsen et al. 2014b). However a retrospective cohort study on marathon runners found that runners who ran under 30km per week had a higher risk of developing an RRI, than those who were running over 30km a week or even those running over 60km per week, leading the authors to conclude that in training for a marathon runners should be advised to run a minimum of 30km per week to reduce their risk of injury (Rasmussen et al. 2013). Those results are limited to those who run marathons, but these studies suggest that gradual progression of running combined with consistency of running distance could provide a protective effect against RRI. The current study did not explicitly investigate running volume and how this relates to injury, but any interventions for novice or experienced runners needs to consider training habits and emphasise avoidance of training errors.

The most popular race distance among those surveyed was 10km followed by half marathon and 5km. Marathon distance and ultra-marathon had been completed by a far lower proportion of the runners surveyed. This may be because the shorter distances are more accessible and require less time expenditure for training.

5.7.2 Exploration of relationships between groups of runners and their use of technology

The main aim of this survey study was to establish how runners in Wales are currently using digital technology to support running and whether they would be interested in a digital RRI prevention and self-management intervention. Digital methods of monitoring running training were found to be very popular, with 98.7% of runners using a GPS watch or smartphone app to monitor their training. Previous research has identified that recreational runners utilise some form of wearable technology or monitoring application such as a GPS watch or a smartphone app (Janssen et al. 2017; Clermont et al. 2020; Mayne et al. 2021). A previous survey also found that the majority of runners use a smartphone to monitor their training, which was also a finding in the current survey (Zeng et al. 2020). Studies have found that runners will utilise more than one type of digital technology to monitor their training (Janssen et al. 2017; Clermont et al 2020) with one study finding that that eight out of ten runners used at least one monitoring device and one out of four runners used both a smartphone app and a GPS watch (Janssen et al. 2017). This is reflected in the current study with some runners reporting using an app, watch and another method of monitoring their training such as a paper diary.

Inferential analysis found that an association between running experience and the number of apps runners were using to monitor training. Runners with 3 months to 2 years' experience were using more smartphone apps to monitor training than runners in the other experience categories. New runners may not be ready to make the time or monetary investment to apps and technology until they feel ready to commit to running or know that they are likely to continue running. It could also be that novice runners are testing apps to try and discover what works for them before using them continuously. In contrast to the current study, previous research has identified that apps are more likely to be used by less experienced runners (Jannssen et al 2017). Equally novice runners may not feel that information provided by smartphone apps are applicable to them. Therefore when designing the proposed intervention the needs of runners at different experience levels need to be considered and content tailored so that it appeals to runners across all experience levels. There was also a statistically significant association found between age category and runners who use no apps to monitor training, with significantly more runners in the 65 and over category using no apps to monitor training compared with those in younger age categories. This is a contrasting finding to the study by Mayne et al (2021). It could be possible that older runners in the current study were less digitally literate than runners in the study by Mayne et al (2021), however this is an assumption and would need further research of this population. A previous study found that the main reason for not using an app to monitor running training is that runners 'prefer to listen to their own body' (Weisner et al, 2018). This study also found that there were significant differences in age groups for runners who cited this as a reason not to monitor training with runner aged 50-59 and 60-69 preferring to trust their own body feedback (Weisner et al 2018), thus reflecting somewhat the findings of the current study that older runners tend not to use any apps to monitor training. Being a more experienced runner and being an older runner were both associated with not using smartphone apps for monitoring training, indicating that these variables could be co-variants. It could be argued that experienced, older runners have already established what works for them regarding training and RRI prevention and management. The literature refers to the phenomenon of the 'healthy runner effect' whereby runners who have developed more experience and more years of running experience less RRI compared with novice runners (Kluitenberg et al 2015). A consequence of having more experience and falling into this hypothetical category of runner could mean that experienced, older runners feel less of a need to monitor training with smartphone apps. When developing and marketing the proposed intervention, consideration will need to be given to who this intervention should be targeted at as well as having the potential to tailor content to experience levels and age categories to enhance implementation and perceived usefulness. Average distance per week was not found to be associated with the use of monitoring technology. At first glance this is in contrast with the study conducted by Mayne et al (2021) who found that those using technology were running nearly double the weekly running volume of those who did not use technology to monitor training. However, when monitoring technology is broken down into the type of technology used by the runner, those runners who were running a higher average distance per week were found to be more likely to use a smartphone app to monitor training. Mayne et al (2021) argue that those users may have had higher engagement with running prior to the advent of monitoring technology. This is something that would need to be explored further in future research.

A statistically significant association was found between the use of a smartphone app to monitor training and all sub-groups. For gender it appeared that being female meant you were less likely to use an app when compared to men. All men surveyed indicated that they used a smartphone app to monitor running training. The development of the proposed intervention needs to consider how it is marketed and information tailored so that it appeals to both male and female runners. For average miles per week the relationship appeared to be that those running more than 30 miles a week were more likely to use a smartphone app to monitor training. This is in contrast to a previous study which found that competitive runners (running more than four days a week) were more likely to use a running watch to monitor their training, and recreational runners (classed as running less than four days a week) were more likely to use a smartphone app (Clermont et al. 2020). Average miles per week and frequency of running are different measures but both could be argued to relate to volume of running. Even though the study by Clermont et al (2020) defined competitive and recreational running by frequency, they did not refer to running experience. Future surveys could collect data on the frequency of running and running experience to analyse further inferences in relation to the use of digital technology for running.

An association was found in the current study between using a smartphone app to monitor training and age category. Runners aged 45-54 were more likely to indicate that they used a smartphone app to monitor training. This is in contrast to a previous study which found that the use of wearable devices is associated with runners of a younger age group and was statistically significant for runners aged 30-39 years of age (Wiesner et al, 2018). However, this study also included walkers and Nordic walkers from an event which could impact the findings in relation to running.

Runners were asked which online resources they found most useful for RRI information e.g. NHS websites, information videos such as You Tube, physiotherapy web sites and running magazine sites. Runners in the longer distance categories (10-30 miles a week and those running over 30 miles a week) did not find NHS web sites useful for RRI information.

Similarly, runners in these categories did not find online videos or physiotherapy web sites useful. Those who did find these resources useful tended to be running 6-10 miles a week. It could be argued that runners who are running 6-10 miles a week are still novice runners or less experienced runners generally and are therefore trying to educate themselves by actively seeking out RRI information via these online resources. Runners who tend to run less miles per week could be in need of a digital intervention that could provide them with trustworthy educational resources for RRI prevention and self-management.

With regards to gender, women were more likely to find NHS sites useful whereas they were more likely to report that they did NOT find information videos or physiotherapy websites useful. It could be argued that women may find NHS sites more trustworthy as the NHS is a recognized organisation for providing health information.

Runners in older categories did not appear to find any online resources useful. It could be argued that those in older categories may be less digitally literate or may be more likely to seek out face to face advice from their General Practitioner (GP) or another HCP. In addition, older adults are more likely to experience digital exclusion (Digital Communities Wales, 2022). Older adults are reported to experience anxiety and have fear around using digital devices (Steelman et al. 2016). Digital inclusion needs to be a consideration for the development of any future intervention so that all groups of runners can access the intervention if they wish to.

This data provides insights into the future development of a digital intervention for the prevention and self-management of RRI in regard to the format the information should be presented and the platform that should be used. Even though smartphone applications are incredibly popular there are sub-sets of runners who are using web platforms and may therefore prefer to source RRI information via a web site rather than a smartphone application. Many runners also report combining smartphone applications and web sites to monitor training, therefore future development may need to consider a combined platform approach.

Runners reported using their device or app to monitor variables such as distance and intensity, as a heart rate monitor and a source of motivation. This is reflected in previous research which found that tracking personal training data was the main reason for using digital technology (Clermont et al. 2020). The study by Clermont et al. (2020) study included 'competitive' runners and 'recreational' runners, finding that competitive runners were more interested in tracking personalised data and biomechanical data whereas recreational runners used digital technology for running motivation (Clermont et al. 2020). This finding contrasts with the recreational runners in the current study who reported using digital technology predominantly for tracking their training data. The reason for this contrast may be in the definition that Clermont et al. (2020) used to distinguish between recreational and competitive runners. Clermont et al. (2020) labelled runners "as 'Recreational' or 'Competitive' if they ran less or greater than four days a week, respectively. It could be argued that defining a recreational runner in such a way is simplistic as there are runners in the current study who run more than three to four times a week and yet do not take part in regular mass participation events or even at all. There are also recreational runners who take part in mass participation events but who do not see themselves as competitive.

Runners reported a motivation element to digital technology as being something that they look for in platforms they used to monitor their training. The most popular application used by runners in the current survey was Strava and as discussed above runners reported being motivated by features such as followers, leaderboards, competing with other runners over a route and gaining likes or 'kudos' on their activities. There are benefits to this motivation as it can inspire people to run faster/longer but could potentially inspire over training via sudden increases in training load via volume and intensity. Research has looked at whether there is a relationship between running applications and RRIs but found that there was no statistically significant relationship between the use of applications and the development of an RRI (Kemler et al. 2018). However, the authors did highlight that runners using running applications should be aware of injury risk and be aware of the need for recovery to help prevent RRI. It should be noted though that the study did not account for the competitive nature of such applications as has been discussed above, where recreational runners are encouraged to compete for virtual challenges. This has the potential to encourage risk-taking behaviour which could lead to RRI (West 2015).

Fifty percent (50%) of runners surveyed reported not using their device for training advice, citing that the information provided was inaccurate, confusing or inappropriate for their needs. This contrasts with previous research on the use of monitoring technology by runners which found that 43.8% of runners surveyed used it to modify their training practices (Mayne et al. 2021). This difference in the findings of Mayne et al (2021) and the current study could be due to differences in the survey instruments being used, however findings of the current study indicate there is a need for digital interventions which can provide education on how to monitor training loads effectively to optimise prevention and management of RRI. Considering gamification of monitoring technology and the possible problems this can cause in relation to RRI (West 2015; Kemler et al. 2018; Shei 2018), digital interventions for RRI need to be evidence based, tailored to the individual and informed by HCPs while allowing recreational runners to enjoy challenging themselves in a safe way that aims to avoid development of RRI.

It was found that runners who did not monitor their training reported less RRI than those who did monitor their training. This group of runners could fall into the group of runners who listen to their bodies when training, as has been described in the literature (Weisner et al 2018). As reported previously in this discussion, runners who didn't tend to use smartphone apps to monitor training were older and more experienced, again reflecting previous research (Weisner et al 2015, Jannssen et al 2018). More experienced, older runners could again be argued to be benefiting from the theory of the 'healthy runner effect' (Kluitenberg et al 2015) and subsequently experiencing less RRI within this sample of runners. The relatively small sample of this study may have caused bias within the data set, but this finding could benefit from further research to establish if there is a difference in RRI rates between runners who are avidly tracking their running training and those who do not.

The current study found that 84.5% of recreational runners surveyed would be interested in a digital intervention for RRI prevention and self-management, indicating a possible unmet need in this sample of runners. Current technology used by runners focusses on monitoring of training rather than RRI prevention which may explain the great interest in the proposed intervention across sub-groups of runners. Further analysis also found that there was a relationship between running experience and whether runners were interested in the proposed intervention. Less experienced runners were more likely to be interested in the proposed intervention. Novice runners who are less knowledgeable about their new sport may be more likely to be interested in the proposed intervention as they want to be educated in the best way to approach running to prevent and manage RRI. That is not to say that more experienced runners would not want to be educated regarding RRI prevention and management.

Features that runners wanted to see within the proposed intervention were exercises to improve running, advice on exercises for injury prevention and a self-diagnostic tool to help runners identify that RRI they may have. It is noted that the response rate for the 'self-screening tool' appears low. However, this could be due to the design of the survey as two of the answers in relation to self-diagnosis and self-screening are arguably very similar. This is discussed further in the 5.8 Limitations. There were no significant associations found between subgroups regarding what runners wanted to see in the intervention. However, there may still need to be a tailoring aspect to the intervention regarding accounting for gender, age-related changes, running experience and the average distance that individual runners tend to run per week. Previous research found that factors rated as important for runners in wearable technology included the ability of the technology to understand their running patterns, presentation of data in a meaningful way and personaliastion to fit their needs (Clermont et al 2020). Therefore, future development of any intervention needs to consider some personaliastion or tailoring to enhance the perceived usefulness and appeal to runners (Hu et al. 1999; Mohammadi and Isanejad 2018)

Large numbers of runners in this study were already using smartphone applications for monitoring training indicating a level of acceptability from runners regarding the intervention being accessed via smartphone application. Previous research on users' perspectives of an app for ankle sprain prevention found that opinions were favorable for information being disseminated via a smartphone app over a written booklet (van Reijen et al. 2018). Benefits of the app reported by participants were the use of instructional videos and the portability of smartphones. Suggestions for improvements of the app in van Reijen et al. (2018)'s study included a function to be able to postpone an exercise session and the provision of feedback on performed exercises. Experts have previously agreed that for physical activity apps to be effective they need to encourage safe behaviour change but applied feedback (in the form of rewards and motivation) and instructional feedback are also important (Dallinga et al. 2018). These findings would be important to consider when developing the proposed intervention.

In addition to the findings of the current study, a previous survey of recreational runners found that the most important ways for runners to receive injury prevention advice was via mobile phone applications (49.3%) and websites (45.4%) (Fokkema et al. 2019b). This research and the findings of the current study again indicate that a smartphone app would be the most desirable interface for the proposed intervention for runners in Wales. Fokkema et al (2019b) also found that 45.2% runners who did not perform injury prevention reported that 'not knowing what to do' was a barrier for them. Providing access to evidence-based injury prevention and self-management information via an easily downloadable app could remove that barrier and motivate runners to actively take part in injury prevention behaviours.

However, a survey study of coaches and Run Leaders regarding their beliefs on RRI reported that the participants felt runners should not rely on internet resources for injury prevention advice and that HCPs were the most reliable sources of this information (Linton and Valentin 2020). Future digital interventions should aim to ensure that information provided is perceived as trustworthy for all stakeholder groups, including runners, coaches, and Run Leaders.

5.7.3 Where runners source training information

When asked where they sourced their training programmes 22.6% of runners indicated that they did not follow a training programme. Other runners reported that they sourced training programmes from a running club, coach or leader and those runners devised the programme themselves. Runners also sourced their programmes online. To find that runners tended to run by feel or devise their training programmes themselves was surprising. This is in part linked to researcher beliefs as a runner and HCP who has learned to run and train using training programmes. However it has been noted by other authors that many runners have little to no exposure to injury prevention measures, such as using an appropriate training programme, because they are not members of a running club or group and therefore have no access to training or coaching support (Adriaensens et al. 2014; Mayne et al. 2021). It may have a link to the high rate of injury in the current study with 87% of runners surveyed having experienced RRI. Training error such as mismanagement of training loads have been indicated to be a factor in the development of RRI with it estimated that more than 60% of RRIs are due to training errors (Hreljac 2004). If runners are running by feel it is possible that they could run a higher volume or higher intensity which could then increase the risk of RRI. In contrast, running by feel may not be a harmful strategy if runners are using appropriate monitoring tools to assist them, for example it has been found that pain monitoring tools can be used to assist individuals with Achilles tendinopathy to continue loading activities during treatment with no negative effects (Silbernagel et al. 2007).

If loading is optimal and there is adequate recovery then neuromusculoskeletal structures will increase in strength (Hreljac 2004). If runners are 'running' by feel there is potential for them to take less time for recovery between running sessions. However, inadequate recovery can lead to running stresses exceeding the load capabilities of musculoskeletal structures (Johnston et al. 2003). Overuse injuries occur when there is an abrupt increase in an activity such as running and this can happen when sedentary people take up exercise to better their health or when recreational athletes aim for a more difficult goal (Brushøj et al. 2008). If novice runners or experienced runners are running by 'feel' or writing their own programmes without the guidance of running coaches or HCPs, it is possible that injuries are developing due to training errors. The proposed intervention could include training information alongside information on how to run to feel, using tools such as a pain monitoring tool or rating of perceived exertion (RPE) to guide whether to run and how long to run for (Martin et al. 2003). It is unclear from this survey whether runners who wrote their own training plans were experienced in the development of training programmes, or whether they understood principles of training. More research is needed to establish how runners devise their training programmes and whether this has an impact on RRI prevention and self-management.

Online sources were popular among runners for finding training programmes. These sources vary in quality and have the potential to be poorly informed and not based on up-to-date research or training practices (van Mechelen et al. 2014). It is possible that runners in Wales are cherry picking the information they find online and devising training programmes for themselves, resulting in programmes that may be unsuitable for their fitness levels and running experience. This again strengthens the argument for an accessible, trustworthy RRI prevention and management intervention that could assist runners with appropriate training information.

5.7.4 Management of running injuries

Self-management was the most popular strategy among runners who reported RRI. The most popular forms of self-management were stretching, strength exercises, ice treatment and foam rolling. These findings are reflected in a study in which recreational runners identified not stretching, excess training, not warming up and lack of strength as factors that could lead to RRI. (Saragiotto et al. 2014b). Other strategies that have been found to be popular with runner for RRI prevention include changes to training schedules, warming up and cooling down, and stretches (Fokkema et al. 2019b). The current study and previous research demonstrates that runners take an active role in identifying strategies that can help prevent and manage RRI.

The findings from the current study and other studies which have investigated runners' views on injury prevention, show that stretching as a preventive strategy for RRI remains popular. (Saragiotto et al. 2014b; Fokkema et al. 2019b). A systematic review found that stretching was not effective in reducing the incidence of exercise related injury, however this review only included seven studies and only four were randomised controlled trials (Small et al. 2008). The findings were also not specific to running, so cannot be generalized to recreational running. In contrast it has been reported via a review that stretching in addition to a warm up does not affect the incidence of sports injury, but again this review pertained to sport in general not just running (McHugh and Cosgrave 2010). Specifically for the running population static stretching has been reported to have no benefit to performance, running economy, the duration of delayed onset muscle soreness or the development of chronic injury (Baxter et al. 2017).

In contrast, the evidence for strategies for the prevention of sports injuries indicates that strength training is superior to stretching. However, this review applies to sports injuries overall, not just RRI. The review also concentrated on prevention of injury not treatment strategies for injury (Lauersen et al. 2018). Studies have investigated whether targeting certain muscle groups will have an impact on RRI such as the research that has been conducted to assess the effectiveness of gluteal muscle exercises on reducing pain in runners with PFPS (Earl and Hoch 2010; Ferber et al. 2015) and exercises have been found to be beneficial in the management of Achilles tendinopathy (van der Vlist et al. 2021). These studies indicate that in the development of any digital intervention for prevention and management of RRIs, the inclusion of strength exercises is justified.

5.8 Limitations

5.8.1 The survey instrument

Time constraints for this study mean that there was not enough time to fully establish validity and reliability of the survey instrument. Basic piloting was performed by asking colleagues to go through the survey and identify any issues or errors in the content. However, to fully establish the validity and the reliability of the survey tool it would need full piloting with a group of the target population (Bowling 2002). Respondents may have interpreted the questions and responses in different ways to the researcher KW.

In the section about features that runners saw as desirable in the proposed intervention, only 61 runners (30.5%) indicated that they would like to see a self-screening tool (e.g., to help decide when to see a health professional) within the intervention. At first glance this seems low however this could be due to ambiguity in the survey design. There is another answer option for this question which is worded 'Self-diagnostic tool (e.g. to find out what type of injury I may have)' to which 117 runners (58.5%) responded. It could be argued that the wording of these two answer options is too similar and led to runners being unsure as to which answer to give. This may have resulted in some error and bias within the results of this survey. This may also explain the conflicting findings between the apparent negative response regarding the low response to self-screening tool and the higher response to the follow up question which asked runners if they would find it beneficial for the app to advise when to see an HCP. A large number of runners responded that they would find this very helpful (54.3%). There are therefore potential issues over the reliability and validity of the survey design.

Runners were asked whether they would want the intervention to advise them when to see an HCP. A limitation in this question is that it did not allow participants to specify which HCP they would want to be signposted to i.e. GP, Physiotherapist, sports therapist. If this survey was to be conducted again this question would need to provide more specific answers. This would then provide more in-depth information about the types of HCP runners want to be directed to for RRI queries.

5.8.2 Analysis and sample size

An attempt was made by the researcher to perform logistic regression analysis with sub-groups of runners as categorical variables. Only one of the models was significant, the other models were not significant for the selected predictors in relation to dependent variables related to use of technology and the proposed intervention (Laerd Statistics, 2023). The standard errors for these models were also large. This could be due to the sample not being an accurate representation of the running population (Field, 2016). This can be seen in the category of running experience where only 2 respondents reported running for less than 3 months. This could in part be due to the sample size which could have limited the potential for regression analysis. It has been proposed that a sample size of over 500 is optimal for logistic regression (Bujang et al. 2018). Therefore, for further inferences to be made from the data with regards to logistic regression it is suggested that the survey could be conducted again but expanded beyond runners in Wales to those in England, Scotland and Northern Ireland with the aim to collect data from more than 500 participants.

5.8.3 Self-reporting

There are potential issues with the self-report aspect of surveys. Questions in this survey required participants to recall details about running history, injury history and training history. Recall bias has been cited as an issue among the running population (Fokkema et al. 2019c; Moore and Willy 2019). Different interpretations of running and RRI may influence self-reported experiences of RRI. (Fokkema et al. 2019c). There may also be issues surrounding validity of self-report of injury by runners (Smits et al. 2019). Future research requires clear definitions of running injury being provided to participants. Any intervention that is developed with the intention of preventing and managing RRI should consider the definitions used of RRI to minimize recall bias.

5.8. Definition of RRI

A broader definition of injury such as that used by (Hespanhol et al. 2018) which included integumentary injuries as well as musculoskeletal injuries could potentially be used in future RRI research. There is also a need for there to be further and wider research on what health professionals consider to be an RRI to be so that greater consensus can be sought as to what constitutes an RRI. This will enable greater consistency between studies, reliability and validity of results and enable true comparison between studies for future meta-analysis.

5.9 Conclusion

The results of the survey component of the study have indicated that the majority of runners in Wales use digital technology to monitor training. This monitoring is predominantly via smartphone applications and running watches. However, runners in Wales are not using these digital tools to help them prevent and manage RRI. Inferential analysis of the data found that those with less running experience were using more smartphone applications to monitor their training. Subgroup analysis found that those running lower distances per week were more likely to find websites such as NHS websites, information video sites and physiotherapy/sports therapy websites to be most useful when trying to find information on prevention and management of RRI. Women and those in the 35-44 age category were also more likely to find NHS sites, information video sites and physiotherapy/sports therapy sites useful for RRI information.

Runners in this study reacted positively to the proposal of an RRI prevention and self-management app. Subgroup analysis indicated that less experienced runners were more likely to be interested in the proposed intervention, indicating that when developing the intervention there may need to be tailoring of content based on runners' experience levels. Content that runners wanted to see in the proposed intervention included exercises for better running, advice on how to prevent injury and a self-diagnostic tool, however there were no strong associations between sub-groups of runners and the type of content that runners desire. Therefore further qualitative research is required to gain in-depth data about the content and format that runners would want from the proposed intervention.

A secondary aim of this study was to collect information on RRI and RRI prevention and management among runners in Wales. This study has shown that recreational runners in

Wales experience a high prevalence of RRI with lower limb injuries such as Achilles and calf injuries being the most common. Runners predominantly prevented and managed RRIs via rest, self-management, and face-to-face contact with HCPs such as physiotherapists. Self-management strategies included stretching and strength exercises. Runners found this information via physiotherapists and online platforms e.g. websites.

This study has provided insights as to how runners in Wales use their digital devices and smartphone applications, their level of interest in a proposed digital intervention, the types of runners who are most likely to be interested and the content should that the intervention should include. More information is required via qualitative studies with runners and other stakeholders to develop the proposed digital intervention. The next chapter will present a qualitative focus group study conducted with recreational runners in Wales.

Chapter 6: Recreational runners' accounts and experiences of RRI prevention and self-management and their opinions on the potential content of a proposed Digital RRI prevention and self-management intervention.

6.1 Introduction

This chapter reports Phase 2: Part 2, a qualitative study using focus groups with recreational runners in Wales. This study's aim was to build on the findings of the survey to gain in-depth understanding of runners' experiences and views on RRI prevention and self-management and their views on the proposed RRI prevention and self-management intervention.

6.2 Background

As raised in previous chapters there is a high rate of RRI in the running community which can see runners leaving the sport altogether with novice runners being at a higher risk of injury (Videbaek et al. 2015). RRI prevention is one way in which recreational runners can reduce their chances of sustaining an RRI which can be achieved using a proactive approach (Hreljac 2005). Lower extremity injury prevention programmes have been found to be effective in preventing lower extremity injuries (Brunner et al. 2019) with strength training being found to reduce sports injuries to less than a third (Lauersen et al. 2018). Research has examined the views of recreational runners on RRI prevention (Saragiotto et al. 2014b; Fokkema et al. 2019b). One study reported that runners rated RRI prevention as useful and that 81% of runners performed RRI prevention measures themselves (Fokkema et al. 2019b) with warm-up, cool-down, modification of training and stretching amongst the most commonly reported methods used by runners. An interview study with recreational runners regarding beliefs about RRI risk factors found that runners believed 'not stretching' as a primary factor associated with running injuries, indicating that runners see stretching as an important RRI prevention strategy (Saragiotto et al. 2014b).

Previous studies have looked at strategies used by runners to prevent RRI (Fokkema et al. 2019b; Hofstede et al. 2020; Mayne et al. 2021). In the 16-weeks leading up to a running event, one study found the most common prevention strategies used by runners included performing warm-up, cool-down and stretching exercises as well as use of adjuncts such as compression socks (Hofstede et al. 2020). However, the instrument used for this study only asked runners about warm-ups, cool-downs, stretching and their use of adjuncts such as tape, compression garments, insoles and shoes and did not ask runners if they used prevention strategies such as strength exercises or training load management. Another study found that alongside performing warm-up and cool-down, runners also adapted their training schedule to prevent and manage RRI (Fokkema et al. 2019b). A survey study of adult runners found that physiotherapists were the most frequent source of healthcare for those who had sustained an RRI followed by medical doctors (Mayne et al. 2021). This is supported by the findings of the survey study in Chapter 5 which found that runners turn to HCPs such as physiotherapists for RRI prevention and management. This demonstrates that face-to-face information and treatment is still important to recreational runners. However, this can create an economic burden in the form of healthcare costs for runners (Hespanhol Junior et al. 2016c; Hespanhol Junior et al. 2017). In an increasingly ‘online’ world recreational runners have turned to digital technologies to support their running. Fokina et al (2019b) reported that 68.4% of the runners they surveyed searched for information online themselves. The internet provides a huge amount of training information via websites and forums while smartphone apps help runners to track and analyse their training. Online websites committed to running content offer vast amounts of information on types of RRI, how to prevent or avoid it and how to self-treat. A pitfall to using online sources and smartphone apps for the information is that consumers cannot be sure of the quality of the information, its evidence and its appropriateness to their circumstances. A systematic review analysed content of smartphone apps dedicated to sports and physical activity-related injury prevention and found that out of eighteen applications, only four contained information that was evidence based (van Mechelen et al. 2014). Five of the applications reviewed contained information regarding the prevention of RRI, suggesting strategies such as use of proper running shoes, warming-up and stretching, cool downs and strengthening exercises.

For RRI the internet and smartphones have the potential to impart RRI prevention and self-management information to a substantial number of recreational runners of all abilities. The survey findings in the previous chapter identified that the majority of respondents monitor their training and that they do this via smartphone apps and running watches. With the increasing use of digital technology by runners, digital platforms are able to provide high quality, evidence based RRI prevention and self-management information to many recreational runners and the findings from the previous chapter also revealed that runners who responded to the survey are interested in a digital RRI prevention and self-management intervention. In the development of a complex intervention, it is critical to establish the views of all stakeholders who may use the proposed intervention, and this includes end users. Therefore, while the previous chapter indicated that there is interest in such an intervention, it is vital to explore views and attitudes regarding the proposed intervention. Therefore, the objectives of this study were to:

1. Explore the views of runners as to what should and should not be included in a proposed digital RRI prevention and self-management intervention.
2. Explore the perceived barriers and facilitators to using digital RRI prevention and self-management intervention.

6.3 Methodology

Synchronous qualitative in-depth focus groups (FG) were the method chosen for this study. Focus groups are a more naturalistic method of data collection allowing for more natural, every day social interactions, stimulating rapport and engagement than interactions generated during one-to-one interview (Clarke and Braun 2013; Braun 2017). It is also thought that FGs can result in a more open environment where richer data is shared, and accounts are more detailed (Clarke and Braun 2013).

FGs were identified to elicit a wider range of views and perspectives surrounding RRI prevention and self-management, enabling runners to use their own vocabulary regarding the issues discussed (Braun 2017). The FG design also aimed to help reveal the understandings that recreational runners have about RRI, RRI prevention and self-management. Runners taking part in FGs may also feel more confident to share information if they realise that they are not alone in their feelings, views and experiences, something that may not be the case in a one-to-one interview with a researcher (Clarke and Braun 2013; Braun 2017).

The FGs were originally intended to take place in-person, but due to the pandemic and government restrictions on face-to-face contact implemented by the UK Government in March 2020, the FGs had to be help online via the Zoom online video conferencing platform. Cardiff University reviewed security surrounding Zoom and approved it for use within the university with recommendations regarding some of its features. For every FG conducted via Zoom meetings a unique meeting ID and password were used to ensure that only participants invited to the FG were able to join. Only the researcher KW could admit participants to the Zoom FG. Only KW was able to screen share if it was required. Personal chat was deactivated to ensure participants could not message each other.

There were advantages to the online FGs: Runners were able to take part in their own home which is more convenient (Braun 2017). Online FGs are time and cost-effective as there are no travel or related expenses. For the researcher online FGs are time and cost effective as there is no need for travel or room booking. Online FGs are not limited by geography as people can participate from a wider geographical area, which would be more difficult in a face-to-face situation (Clarke and Braun 2013). By remaining in their own homes for the FGs all participants (including the researcher KW) were adhering to government guidelines and precautions relating to COVID-19, therefore maintaining the safety of everyone involved.

6.3.1 Sampling and recruitment

The sampling method that was adopted for this study was purposive convenience sampling, targeting the population of interest who have the characteristics required (Clarke and Braun 2013). This method of sampling drew on a database of 181 runners who had previously taken part in a quantitative survey that made up the first part of data collection for this project (Chapter 5). Recruiting participants for qualitative evaluation via online surveys is a standard method of recruitment previously been reported (Quach et al. 2013; Watson et al. 2018). The pool of runners participating in the Part 1 survey had indicated in the consent process that they were happy to be contacted regarding participation in a focus group. Out of the participants who completed the survey (n = 232), 181 runners who completed the survey had indicated interest in FG participation. The contact details for these runners were kept on a secure database accessible only by the researcher KW. Selection of runners to be contacted was conducted via randomisation. Simple randomisation was conducted via an online random number generator to select a sample of runners to be contacted for the focus group (Suresh 2011) . Once those runners were selected from the database an invitation email was sent to each runner along with a Participant Information Sheet (PIS) and Consent Form. The PIS and Consent Forms for the focus groups can be found in Appendices 12 and 13. Runners were encouraged to read the PIS and to contact KW if they had any questions. Runners who were happy to take part were asked to complete the consent form (Appendix 13) and return it electronically via email to KW.

6.3.2 Inclusion and Exclusion criteria

The inclusion criteria and exclusion criteria for the focus groups of recreational runners were the same as the criteria for survey participants in Chapter 5 (page 89). Runners had to have access to the internet due to the FGs taking place virtually via online platform. Runners had to have completed the consent form and returned it to KW to be included in the FGs.

6.3.3 Data Collection

Focus groups tend to be unstructured but are guided around the topic of interest (Clarke and Braun 2013). The intention for these FGs was that runners would openly share their experiences of RRI and their views and opinions on RRI prevention, self-management, and views on a proposed digital RRI prevention and self-management intervention. As recreational running is a broad topic there was potential for the FGs to divert from the proposed aims of the study however, it is also argued that the online method can facilitate greater control and participants experience less social pressure than in face-to-face situations (Braun 2017). Therefore, a topic guide (Table 20) was developed to be used to prompt runners to discuss these topics and to take points raised by runners related to the aims to stimulate further discussion among the participants.

Once runners returned the consent form, they were allocated to an FG of up to seven to eight runners. FGs were oversubscribed to allow for potential dropouts or failure to attend. Once consent forms were received the author KW sent out a date and time for the online FG along with the Meeting ID and Password for the Zoom call. Participants could only be admitted to the online FG by KW.

Prior to each FG KW greeted the participants, thanked them for taking part, explained the purpose of the FGs, gave the opportunity for any questions form participants and then asked participants for consent to audio and video record the FG (Bowling 2002). All FGs were audio and video recorded so that there was an accurate record of each FG (Clarke and Braun 2013). KW then started recording the FG and the Zoom platform prompted participants to indicate that they were happy for the session to be recorded.

The topic guide consisted of open questions which were built around the aims of the study. Initial questions were openers to develop rapport with participants and to encourage all participants to take part (Clarke and Braun 2013). The next part of the discussion was around whether the participants had ever experienced RRI. Discussion then moved on to what participants did to prevent and self-manage RRI. The final part of the FG centred around a proposed digital RRI prevention and self-management programme. Participants were asked to share their thoughts on the facilitators and barriers of such a platform and content that they as runners would want to see included in the proposed intervention.

Table 20 Topic guide for focus groups with runners

Introduction • Greeting • Research team intro with aim of the FG. • Why do you run? • What benefits e.g., physical, social, emotional etc. does running give to you?
Injury Experiences • Have you ever been injured through running? • How do you decide that a niggle or pain is an injury? • What do you do when you are injured? • How does being injured affect you?
RRI prevention and Self –management strategies • What strategies do you currently use to try and prevent RRI? • Where do you go for information to prevent RRI? • What strategies do you use if you self-manage an RRI?

• Where do you go for information if you self-manage an injury? • How do you find these programmes? • What are the pros that you have found to online RRI prevention and injury information? • What have been the least helpful elements to online injury information? • How important is online information to you when trying to prevent an RRI?
<u>Potential content for a self-management programme</u> • What content would you consider most useful from an RRI prevention self-management programme? • What format or platform would you consider most appealing/useful for an RRI prevention self-management programme? • What would be the facilitators to using a digital injury prevention and self-management programme? • What would be the barriers to using a digital injury prevention and self-management programme?

Five FGs were conducted between September and October 2020. It was felt that saturation was reached at this point, when similar topics were being discussed and no new topics or information was being shared. The length of time for each FG varied with the shortest FG lasting just under twenty-five minutes and the longest FG lasting sixty-seven minutes. It is felt that the differing lengths in the time of these FGs were due to factors such as the number of people involved and the level of rapport that developed between participants. Table 21 presents the number of focus groups, the number of participants in each group and the length of each focus group.

Table 21 Number of participants in each focus group and the length of each focus group

Focus group	Number of participants	Length of focus group
1	3 (1 female 2 male)	39 minutes
2	4 (2 female 2 male)	38 minutes
3	4 (2 female 2 male)	67 minutes
4	3 (1 female 2 male)	24 minutes
5	6 (3 female 3 male)	67 minutes

Chatham House rules (Chatham House, 2022) were reiterated by the researcher for those taken part in the FGs so that the anonymity of the participants and confidentiality of the discussions was maintained. This rule states that: “When a meeting, or part thereof, is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed” (Chatham House, 2022).

Once each FG had been completed the audio and video recording was saved and stored under password protection on a device used only by the researcher KW. Audio recordings of all focus groups were transcribed verbatim by the KW. All transcripts were anonymised and stored securely under password protection again on a device only used by KW (example transcript: Appendix 15). Notes were made during each FG to promote further discussion and to stimulate reflection after each FG had taken place. Taking notes enabled the researcher KW to make a note of any interesting themes and topics that came up during discussions. By doing this the researcher was also practicing reflexivity towards the data collection.

6.3.4 Rigor

Member checking is the practice of checking transcripts with participants to establish reliability of the data that has been collected (Clarke and Braun 2013; Morse 2015). Once each transcript was completed it was emailed to the relevant participants. All the participants were asked to read the transcript and to contact the researcher KW if they felt there was anything that they said that they felt had been misrepresented or if there was anything that they wanted to be redacted from the transcript. Participants were also informed that they could have their contributions to the FG removed from the transcript if they no longer wished to be a part of the study. Following this process one participant did contact KW as they felt that one word in the transcript would not have been a word that had been used and suggested a change that has been utilised instead in the final transcript to trustworthiness and to avoid misrepresentation (Braun and Clarke, 2013). No other participants contacted KW with issues regarding inaccuracies in the transcripts and no other transcripts were revised.

Transcripts were shared with a fellow PhD student to achieve further rigor and trustworthiness in a form of peer review, to ensure that KW has not missed or omitted any crucial elements. Themes were also discussed with PhD supervisors in further peer review (Morse 2015).

6.3.5 Data analysis

Thematic analysis (TA) was the method chosen for analysis of the data set. TA enables qualitative researchers to identify, analyse and report themes within a data set (Castleberry and Nolen 2018). Transcripts were analysed using reflexive thematic analysis (Braun et al. 2019). Analysis followed the six stages of thematic analysis: 1) familiarisation, 2) code generation, 3) theme construction, 4) reviewing of themes, 5) definition and naming of themes and 6) production of this report (Braun et al. 2019)

The first step of **familiarisation** required the researcher (KW) to become familiar with the data via reading and re-reading the transcripts (Braun and Clarke 2006; Castleberry and Nolen 2018). This initial stage allows for immersing in the data, making notes and reflexive observations (Braun and Clarke 2006). No formal labels were attributed to the data at this stage, but points of interest were highlighted and potential connections between the data and existing literature about running, RRI and RRI prevention and self-management were identified. Similarities between data sets but also differences were noted. Notes taken were always related back to the research question at hand to establish whether they had a true connection to the aims of the study.

The next stage involved **generation of initial codes** (Braun and Clarke 2006). Data from the transcripts started to be organised around similar meanings and chunks of text that related to these similar meanings started to be highlighted in a more meaningful manner (Braun and Clarke 2006). In this study the data was approached with pre-existing ideas, concepts and theories that related to the aims and objectives of the study which were then explored and tagged within the data set. Initial code generation was semantic and at a surface level with interpretation of the data running very close to the explicit language used by participants (Braun and Clarke 2006; Clarke and Braun 2013). However, there was some latent, deeper level of coding at a later stage. Selective coding was used to draw out instances of the phenomenon that were relevant to the research question: RRI experiences, approaches to RRI prevention and self-management, views regarding online information regarding RRI prevention and self-management and views on what would make the ideal RRI injury prevention and self-management intervention.

Initial codes were used to start identifying broader candidate themes (Braun and Clarke 2006). These candidate themes were then tested against the aims and objectives of this study. Relevant codes were collected into the relevant themes (Braun and Clarke 2006). During this stage some text was uncoded for not fitting into the existing code or into the candidate theme. Once a set of candidate themes were identified they were reviewed and refined (Braun and Clarke 2006). Some initial candidate themes were rejected, or they were merged with another theme that covered data within both themes. This avoided thinning out of the data and allowed for a more coherent data set when applied to the aims of the study (Clarke and Braun 2013). These broader patterns became themes which were central organising concepts in the data. The central organising concepts identified in the data reflected the aims of the research: Injury experiences, Injury Prevention, Injury Self-Management, Sources of Information and the Ideal Injury Prevention and Self-Management App. As each theme was quite broad, each theme was then categorised into sub-themes. Paragraphs delineating the central concepts of each theme will be described in more detail in the results section (Clarke and Braun 2013).

In the fourth phase, themes continued to be **revised** and renamed until KW was able to move to the next phase and fully **define** the themes (Braun and Clarke 2006). The sixth and final phase of the analysis process was the **production of the study report**.

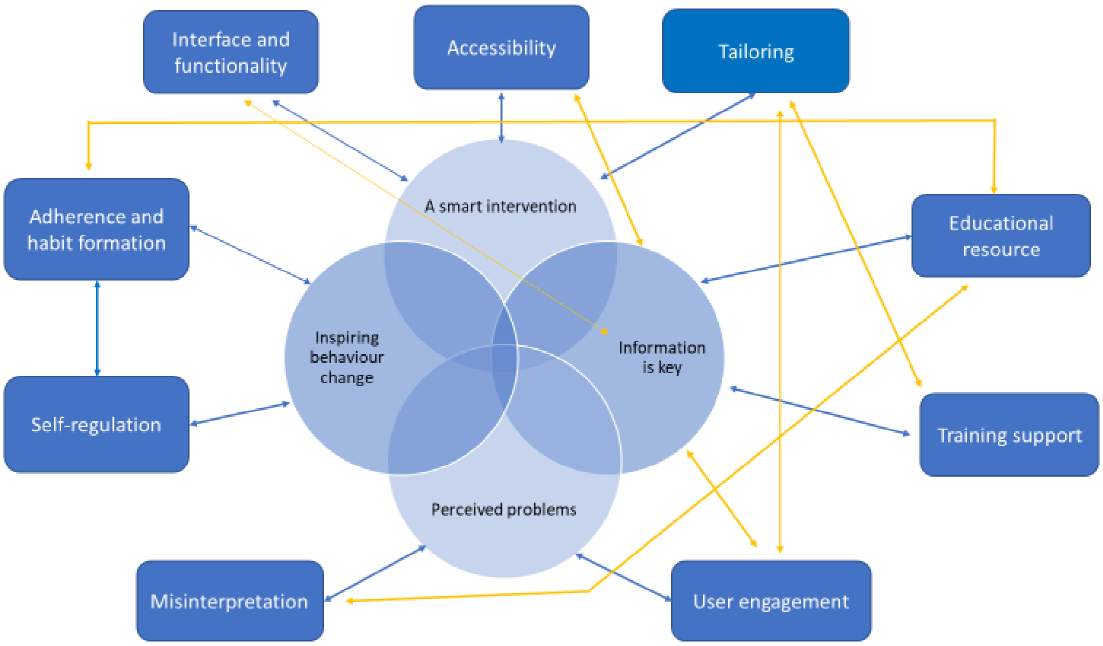
6.4 Results

Twenty participants took part in five focus groups between September and October 2020. The average age of the focus group participant was 45. The oldest participant was 67 and the youngest was 28. Nine women and 11 men took part. All but one of the runners had over two years' experience in running. One runner referred to themselves as a 'lockdown runner' and had started running due to gym closures during the pandemic.

Four central themes and nine sub-themes were devised. The four themes were:

1. A smart intervention
2. Information is key.
3. Inspiring behaviour change
4. Perceived problems

These themes are described in section 6.3.1. Figure 13 is a visual representation of the themes and sub-themes. Table 22 contains example quotes from the participants which related to each theme and sub-theme.



<u>Figure 13 Diagram representing the main themes and sub-themes identified following analysis. Blue arrows connect to sub-themes that sit directly under main themes. Orange arrows show the overlapping connections between main themes and sub-themes.</u>

Table 22 Central themes, sub-themes and example quotes from focus groups with runners.

CENTRAL THEME	SUB-THEME	EXAMPLE QUOTES
A SMART INTERVENTION	Interface and functionality	*R9: "I think an app would work, most people these days have got their telephone in their hand, their smartphone..'* *R3: '…it could be in a format that's easy to look at on your phone when you're sort of stretching in the gym or um, well you tend to have your phone with you…..,* *R2: "….mobile based, not necessarily an app to download, maybe something that you can access through browser on your phone? But that's just my personal preference".* *R13: "… would be good to link to Strava or Garmin because I'm probably not going to use another app to be putting my runs in, you know Strava already does that for me"*
	Tailoring	*R8: "If there was some sort of tool where you could put in all the specific information and really tailored information,…'* *R10: "the older I get the more things start playing up and I just feel overwhelmed and exhausted by the amount of different times I've like tried to sort injuries out."*

		R18: ".. a symptom checker, sort of how to diagnose your problem and how to tell it from another injury, does that make sense?" R6*: "I think if you've got some serious symptoms it would be a good idea…, 'if you've got any of these findings definitely seek immediate help' like a fracture or something."*
	Accessibility	*R7: "Something that's easily accessible. And could be understood by anyone really….* *R7: "…It's all about ease of access now isn't it and you haven't got to go trawling through loads of information to find what you need."* R6: "*I think there is a place for videos to show you kind of the right way to do certain exercises, um, that might be useful"* R1: "*I'd rather it was written down so that I can dip in and out cos if you were listening to a talking head you'd have to wait for them to finish"* R7: *".. most run leaders or coaches will have their phones with them at the session…, someone's more likely to come onto you at the end of a session and say, 'oh I can feel a pull here, I can feel a niggle here', you can*

		quickly have a quick check and then obviously point them in the right directions."
INFORMATION IS KEY	Educational Resource	*R16: "I think for me personally I think diet, like a little bit of dietary information would be helpful as well…'* R11: "*I don't think people…especially new runners.. see that connection you know; an injury feels like something that happens for whatever reason"* R20: *"I find it useful to be told why a strengthening exercise helps……. A bit of background detail is helpful and gives me more confidence that it's the right thing to do."* R10: *"I think it would be useful to have a section that, that um dealt with specific common running injuries."* R17: "*if you… start to feel a niggle… suggestions of exercises… you say where the pain is and the type of pain and then it promotes exercises that you can do"* R3: *"If you knew you had a specific injury in a specific area then it would be really good to know specific exercises that might help those particular issues."*

		R11: "If it's not evidence based then there's nothing to differentiate it from anything else you know…. So that's really important for me." *R3: '… .. I've had most confidence when I've gone to a physio and the physio has said right okay… it looks like your calf muscle problem or whatever is down to a weakness elsewhere and you get… a set of exercises, … if you could get that information from an app as well that would be really useful.'* R3: *"it's just too much, too many conflicts then between information and too much searching through before you sort of find anything….., it always ends up putting doubt in my mind and I always end up thinking… I want to go and chat to a physio and get some proper advice."*
	Training Support	*R6: "I think you could incorporate sort of like, things like saying not trebling your miles overnight."* R3: *"I had a brief illness, and I was coming back to running… I was really struggling because I'd always run to programmes in the past, so I was immediately looking for a*

		programme and it was sort of I guess an older guy's return to 10k running type thing that I was looking for, but I never really found them" *R14: The other one is not to do three or four hard sessions in a row. You do maybe two hard sessions and the next two need to be very much recovery sessions…'*
INSPIRING BEHAVIOUR CHANGE	Adherence and Habit Formation	R20: *"Would it have the option to give reminders throughout the week 'have you done your recommended prevention exercises?' or something like that?"* R12: *"… I'll drink coffee, but I won't drink enough like hydration stuff, that's my Achilles heel, I need that reminder."* R11: *"... I'd never go to a physio… week one.. because it's very expensive…. if I'm being entirely honest about it,…. you get given a load of exercises that you then don't do".* R9: "*a lot of our members say if they're left to do it on their own they won't do it, so we tend to then, so while we're going round perhaps Penallta Park we'll find a bench, or*

		you know just use our body weight and we'll just do a couple of exercises" R12: "*We've got in the habit of doing it now, we're all, initially it was just one or two of us but now everyone who's been on the run will stretch all the muscle groups. And I actually think that really helped…"*
	Self-regulation	R4: "*It might encourage people to use it freely and that's quite useful… because as and when they have a twinge or a niggle or whatever, that inspires them to think 'ooh let me just go and check maybe there's something I can be doing to mitigate this or deal with the issue'"* R4: *"Reduce the running but do other stuff to keep you going,"* *R17: "…if you know you've got an existing injury to take preventive measures before that."*
PERCEIVED PROBLEMS	Misinterpretation	*R7: "There is potentially a risk then that they're doing the wrong exercises or self-diagnosing an injury themselves, that's the only thing I'd say"*

		R14: "one of the difficulties you've got as well is that with pain is that it isn't always where it hurts." *R6: "… people might mismatch what they think they've got with something else and not really having anyone to kind of back any of that information up, kind of going down the wrong route …. I guess that's kind of the worry really."* *R11: "It is a difficult one because as we were just touching on there is that's a huge remit there and when you take into account that there is no one size fits all, um like you say it's a challenge."*
	User Engagement	*R6: "…. niggles start to come back, and you think actually I know I haven't done what I needed to do and so it's just, fitting all that back in again and keeping on top of things"* R15: "*people don't listen they tend… they do what they want to do quite often. If they've got that mindset, even if you say to them you know 'wouldn't it be a good idea to take a step back now, you know your body needs time to recover' they go 'yeah, yeah, yeah ,*

		yeah,' and they'll be off and doing what they want to do anyway." R11: "*..when you look stuff up, say somebody said to you right, do this exercise it's really good for your calves.. sometimes when you look it up it's like 5 minutes long or they're talking for 5 minutes before it even starts."*

6.4.1 Theme 1: A smart intervention

This overarching theme explains the general features that runners saw to be valuable within a proposed digital RRI prevention and self-management intervention, indicating that runners wanted a ‘smart intervention’. When being asked what they want from an intervention that can help support RRI prevention and management, runners expressed the interfaces and functionality that they would want the intervention to have. Runners overwhelmingly preferred the intervention to be a smartphone app due to the ease of access they provide. Some runners also expressed a desire for the proposed intervention to be accessible via a web browser as well as being able to connect to existing apps e.g. Strava, Garmin. Runners felt that the intervention should have a ‘Tailoring’ aspect to it, so that the intervention could provide information and content that was highly relevant to them. For some runners this meant very specific information related to previously diagnosed medical conditions or their medical/running history while for others it meant tailoring to age. Participants explored the idea that the intervention could have a screening tool which could then tailor information according to symptoms or a diagnosis. Based on this, participants also wanted the intervention to signpost runners to face-to-face assessment from an HCP based on information provided by the runner. This connects with the idea of the overarching theme as the intervention being ‘Smart’ and having this interpretive function, with the intervention becoming an intuitive interface for the user.

The sub-theme ‘Accessibility’ explores how runners wanted to be able to access the intervention anywhere via the specific platform, but also covered how runners wanted the intervention to be easily understood. Runners indicated they would like to access information relevant to their situation with relative ease, without having to spend time hunting through the intervention for it. Videos, written instructions and exercise demonstrations were all discussed by runners as ways of providing accessible information that would enable them to put advice into practice. The intervention was also seen as an accessible tool for running coaches and running leaders to signpost runners towards should they be approached by runners reporting an injury.

6.4.2 Theme 2: Information is key.

This theme centered around the importance of information to help runners support runners' injury prevention and self-management. Runners considered that the proposed intervention would be an 'Educational resource' which would provide information and content around many areas of RRI prevention and self-management. Most participants expressed preferences for educational content on specific running injuries, chronic injuries, how to prevent running injuries, contributing factors to running injuries and exercises to help prevent specific RRIs. They also expressed a desire for the intervention to provide information on diet and hydration. The intervention was also seen as a potential resource for novice runners to help them in learning and performing prevention behaviours such as warm-ups.

Research articles and evidence-based information were seen as trustworthy and desirable within a digital intervention. Therefore, when developing educational and practical content for any future intervention, trustworthiness of the content needs consideration.

It was also important to runners that the proposed intervention provided 'Training Support'. Information about training practices is something that can be provided to educate runners to avoid training errors but also enable runners to build sustainable training practices. Runners had an appreciation of how training error and a lack of recovery could lead to RRI. The intervention was also seen as being a potential source of training support after returning from a running break, e.g. due to illness.

6.4.3 Theme 3: Inspiring Behaviour Change

This theme explains the behaviours that could be facilitated by the proposed digital intervention, with the result that runners could be influenced to engage in behaviours that were less injurious and lead to more sustainable running habits. The sub-theme of 'Adherence and Habit Formation' explores runners' ideas of how they could develop habits that were linked to RRI prevention and self-management and how they could develop an adherence for these behaviours. Runners explored the idea of notifications within the intervention reminding them to perform activities such as warm-ups or exercises. Participants in this study showed an awareness of their own behaviour in that they didn't always adhere to exercises that were prescribed to them, indicating a lack of motivation.

Within this sub-theme it is clear that some runners may struggle to adhere to prevention and self-management strategies. When developing an intervention for RRI prevention and self-management, habit formation and motivation to perform these behaviours needs consideration to promote adherence.

The sub-theme of '<u>Self-Regulation</u>' explores how runners have a desire to be able to assess their own injury or risk of RRI via the proposed intervention and captures the idea of runners being able to intuitively know when to adapt their running behaviours. Runners envisaged being able to self-assess by providing the proposed intervention with information which the intervention could interpret. The intervention would then provide feedback and information to the runner to empower them to make decisions, again performing as an intuitive interface. The decisions that runners saw themselves as being able to make via this self-assessment included selecting appropriate exercises, making a decision on whether to stop running and deciding whether they needed to make an appointment with an HCP.

This theme explored the ways in which runners would self-regulate which included adapting running training, doing more cross-training or performing preventive measures such as exercises, based on a mixture of self-assessment and past experience. This self-regulation has the potential to help runners reduce the chances of injury or spend less time out with injury. This theme links back to the themes of '<u>Information is Key</u>' and '<u>Smart Intervention</u>'. If runners are provided with information, then they are able to assess their current status for running and will be able to regulate their behaviour accordingly.

6.4.4 Theme 4: Perceived Problems

This theme identified the possible issues and problems that runners perceive the proposed digital intervention to have. The first sub-theme '<u>Misinterpretation</u>' captured two concerns that participants had regarding the intervention. The first is that information from the intervention could be interpreted in different ways by runners and possibly interpreted incorrectly. This could therefore result in inappropriate decisions being made regarding an RRI, resulting in a worse situation for runners. Self-diagnosis via online interventions was seen as having the potential to be problematic.

The second concern was that the intervention itself could misinterpret information which was entered by users and potentially provide incorrect information which would be catastrophic for runners. Underlying this misinterpretation of information was that it could result in runners suffering more, developing worsening symptoms and being out of running for longer.

The second sub-theme was 'User-Engagement' which explored how runners felt about engaging with RRI prevention and self-management information. There were concerns from that runners may not engage with the provided advice at all and whether the intervention would sufficiently motivate runners to adhere to the advice offered. It was also highlighted that if digital content took too long to provide the relevant information, they would be less likely to engage with it. This sub-theme links back to the theme of Inspiring Behaviour Change and demonstrates how considering user engagement is important when developing digital interventions.

6.5 Discussion

This study is built on the findings of the previous survey (Chapter 5) to gain deeper understandings on how recreational runners use digital technology to prevent and manage RRI and their views on a proposed digital RRI prevention and self-management intervention. This study provides insights as to the content that recreational runners would want to see in a proposed digital RRI prevention and management intervention, how they would want to see this information presented, the platform that runners perceive to be desirable for the proposed intervention and how it would intuitively work for runners.

6.5.1 A smartphone app that can be tailored.

Runners in this study were largely in favour of a 'smart intervention' in the form of a smartphone application as the platform for the intervention. This was due to accessibility of smartphones and being able to access the intervention from any location. Previous research has identified that runners are regular users of smartphone apps to monitor their training (Janssen et al. 2017, Clermont et al 2020, Mayne et al 2021). Qualitative research on users of an ankle rehabilitation smartphone app found that users reported phone portability as being a benefit to a smartphone app (van Reijen et al 2018). Building on the findings in Chapter 5, previous literature, and the qualitative findings of the current study it can be argued that a smartphone app would be the most appropriate platform for the proposed intervention.

Runners expressed that it would be desirable for the proposed intervention to have the ability to be personalised to them and their characteristics such as age or experience. Previous research has identified that certain sub-groups of runners are at risk of particular types of RRI such as age, sex, BMI and experience (Buist et al 2010c; Nielsen et al. 2013; Kluitenberg et al. 2015a; van der Worp et al. 2015; Kemler et al 2018). In addition, the research has concluded that apps should be personalised to different groups of runners, such as novices who may not have access to professional coaching (Janssen et al 2017).

There is already precedent for tailoring within RRI interventions. Previous research provided tailored information to runners via a self-assessment questionnaire (Hespanhol et al. 2018). The authors of this study found that the intervention had a preventive effect for RRI, concluding that tailored advice may be used as a component of online RRI prevention programmes, somewhat supporting the results of the current study that runners are keen for the intervention to be able to be a screening tool and enable self-assessment and subsequently provide information that was tailored to their needs.

Runners were frustrated that some interventions and online sources required a lot of reading and interpretation before they found the information that was perceived to be appropriate for them. The literature has previously reported that time is a barrier to performing RRI prevention exercises (Linton and Valentin 2020). An intervention tailored to provide accessible information that saves time for runners would help remove lack of time as a barrier.

6.5.2 Content should be accessible.

The majority of runners showed a preference for videos of content such as exercises, reasoning that it would be easier to follow videos, with the added benefit of videos helping ensure that they were performing exercises correctly. Research on a smartphone intervention has found that users opted for video content over written content 67% of the time when using on-demand functions (Ben-Zeev et al 2018). Videos can model behaviour, provide a therapeutic experience and provide accessible content for people with limited literacy or reduced motivation for written content (Ben-Zeev et al. 2018). Qualitative research has also found that videos of exercises were reported to be beneficial by uses of an ankle strengthening app (van Reijen et al 2018). Another qualitative study on the acceptability of a digital health intervention to support patients following anterior ligament reconstruction reported that patients found videos useful to help inform their exercise technique, motivate them and give them confidence that they were doing them correctly (Dunphy et al 2017). Therefore the inclusion of videos within the intervention would not only provide accessibility to exercise content but also help runners to feel more competent in performing rehabilitation or prevention exercises (Deci and Ryan, 2008).

However the study by van Reijen et al (2018) found that a smartphone app and information booklet were given comparable scores for simplicity usefulness and satisfaction with the exercises. There were some runners in the current study who also suggested that written information would still be necessary in addition to videos. Therefore the way information is presented within the proposed intervention needs to consider the needs of all runners so that content remains accessible to as many users as possible. This would enhance the user experience and the usefulness of the intervention.

It has been highlighted in the literature that with the rise of 'social running' and increasing numbers of novice runners, there are groups of runners who do not have access to traditional sources of information regarding running e.g. clubs and running coaches (Mayne et al 2021). In addition to this it is acknowledged within the literature that being a novice runner is a risk factor for RRI (Buist et al. 2010b; Buist et al. 2010d; Linton and Valentin 2018a). The proposed intervention could therefore provide access to information on training practices and RRI prevention and self-management to novice runners and non-club runners who may not have access to this information via traditional means.

6.5.3 Self-assessment and screening.

In Chapter 5 there was some ambiguity over the question of whether runners wanted to have a screening function within the intervention. This was likely due to the design of the survey tool. However in the current qualitative study runners felt that self-assessment and screening would be desirable within the proposed study. Runners discussed ways in which the intervention could provide screening functions. This idea of 'screening' took two forms. One was that the intervention could diagnose a runner's RRI via information that was provided to the intervention. Runners referred to this as being a symptom checker. The other form of screening was the ability for the intervention to identify when a runner required face-to-face advice from and HCP and to prompt them to seek an in person appointment.

The concept of self-diagnosis and online surveillance is not new, with self-diagnosis technologies allowing the 'patient' to become empowered and directly involved in their own care (Lupton, 2013). There are in existence tools which allow patients in primary care to triage their symptoms and identify whether they need to see a health professional (Verzantoort et al. 2018). A review of online surveillance systems found that most of these systems exist in professional and elite sport resulting in a gap in amateur and community sport settings (Ekegren et al. 2016). Having a digital intervention which could collect information about RRI could help facilitate decision making for recreational runners as to whether they need to seek expert opinion about a potential or existing RRI. The development of any future digital RRI intervention should consider including some screening functions as a potential feature if it is to appeal to recreational runners.

6.5.4 Targeting Behaviour

From discussions with runners it is apparent that the proposed intervention would need to be embedded in behaviour change theories such as Self Determination Theory (SDT) and the Theory of Planned Behaviour (TPB). Between these theories, behaviour is initiated due to having self-efficacy in performing a behaviour in relation to knowledge but also due to attitudes towards a behaviour and internal and external motivations. In relation to knowledge, runners in the current study wanted the intervention to be an educational source to provide them with information and knowledge to be able to engage in behaviours such as recovery and exercises. A lack of knowledge has previously been cited as a barrier to RRI prevention and management for runners (Linton and Valentin 2020, Linton, Barr and Valentin 2022). By providing runners with knowledge they will be more likely to initiate or maintain new behaviours in relation to RRI prevention and management (Conner and Norman 2015; Deci and Ryan 2000; Conner and Norman 2015). Runners reported that they were more successful in performing an RRI prevention/management strategy such as exercises if they had external motivation such as that from a physiotherapist or an RL (Conner and Norman 2015). However, for a behaviour to continue it is argued that the behaviour needs to be internalised (Conner and Norman 2015). Having a physiotherapist supporting them with external motivation could eventually result in that behaviour being internalised. A digital intervention developed to support patients post ACL reconstruction found that patients reported that the intervention informed, motivated and improved confidence in carrying out desired behaviours (Dunphy et al 2017). Additionally a digital injury prevention intervention that was developed to support self-efficacy for athletes, parents and coaches in relation to injury prevention, illness, recovery and mental illness was found to significantly reduce injury incidence in the intervention population (Joacobsson et al 2023). These studies provide support for the proposed RRI intervention to be embedded in a reduction in RRI or time out of running due to RRI, further supporting the idea that the proposed behaviour change theories.

By embedding the proposed intervention in behaviour change theories it has the potential to help runners to self-regulate their running practices. Runners reported that they wanted to be able to take information from the intervention to help them adapt their training programmes or use it to support RRI prevention and self-management. This self-regulation of running behaviour has been described in a recent qualitative study with recreational runners, with runners reporting that they would adapt their load i.e. reduce running, to manage or resolve complaints (Verhagen et al. 2021). However it was noted by the authors that this self-regulatory process is supported by seeking knowledge and expertise gained from experts (Verhagen et al. 2021). Satisfying runners' autonomy regarding RRI prevention and self-management has the potential to enhance their competency and self-efficacy in prevention and management behaviours, potentially leading to intervention should have some basis in behaviour change theories.

Digital interventions also need to consider behavioural intention. The third iteration of the Technology Acceptance Model (TAM3) (Figure 14) (Venkatesh and Bala 2008) is an update on the original TAM which was developed to predict individual adoption and use of information technology (IT). The original model suggested that a person's intention to use IT was defined by two factors: perceived usefulness (the extent to which a person believes the IT will enhance their job performance) and perceived ease of use (defined as the degree to which a person believes using the IT is free from effort). Venkatesh and Bala (2008) developed TAM3 to present a more complete nonological network of the determinants of a person's intention to adopt technology. The TAM3 was developed after the widespread rise in social media and related technological use which would have impacted general population significantly, as well as being more valuable for a population that has gradually become more and more digitally literate. Determinants such as subjective norm, image and relevance feed into the perceived usefulness of a technological intervention. For runners in this study the subject matter of RRI and the importance of RRI prevention and self-management are extremely relevant to them and also feeds into their image as recreational runners. Through discussions it was evident that preventing and managing RRI was a subjective norm, therefore it can be argued that the proposed intervention has the potential to have a high level of perceived usefulness for runners.

In relation to the determinants in the TAM3 of perceived ease of use, runners clearly described the interface and platform they would want the intervention to be presented on. Discussions revealed how runners were already familiar with online source material and monitoring technology, so it could be argued that there would be low computer anxiety around using the proposed intervention as well as high self-efficacy around using the afore mentioned platforms. Participants indicated that they wanted the intervention to be responsive to information that they provided, implying a need for 'computer playfulness'. If these findings were applied to the intervention it would potentially increase perceived ease of use for recreational runners. There would be some anxiety initially for a new intervention, but this would eventually be moderated by experience, as highlighted in the TAM3 (Venkatesh and Bala 2008). By applying the findings of the current study to the proposed intervention and viewing them through the lens of the TAM3, the proposed intervention has the potential to have high perceived usefulness as well as high perceived ease of use which would lead to greater behavioural intention for potential users.

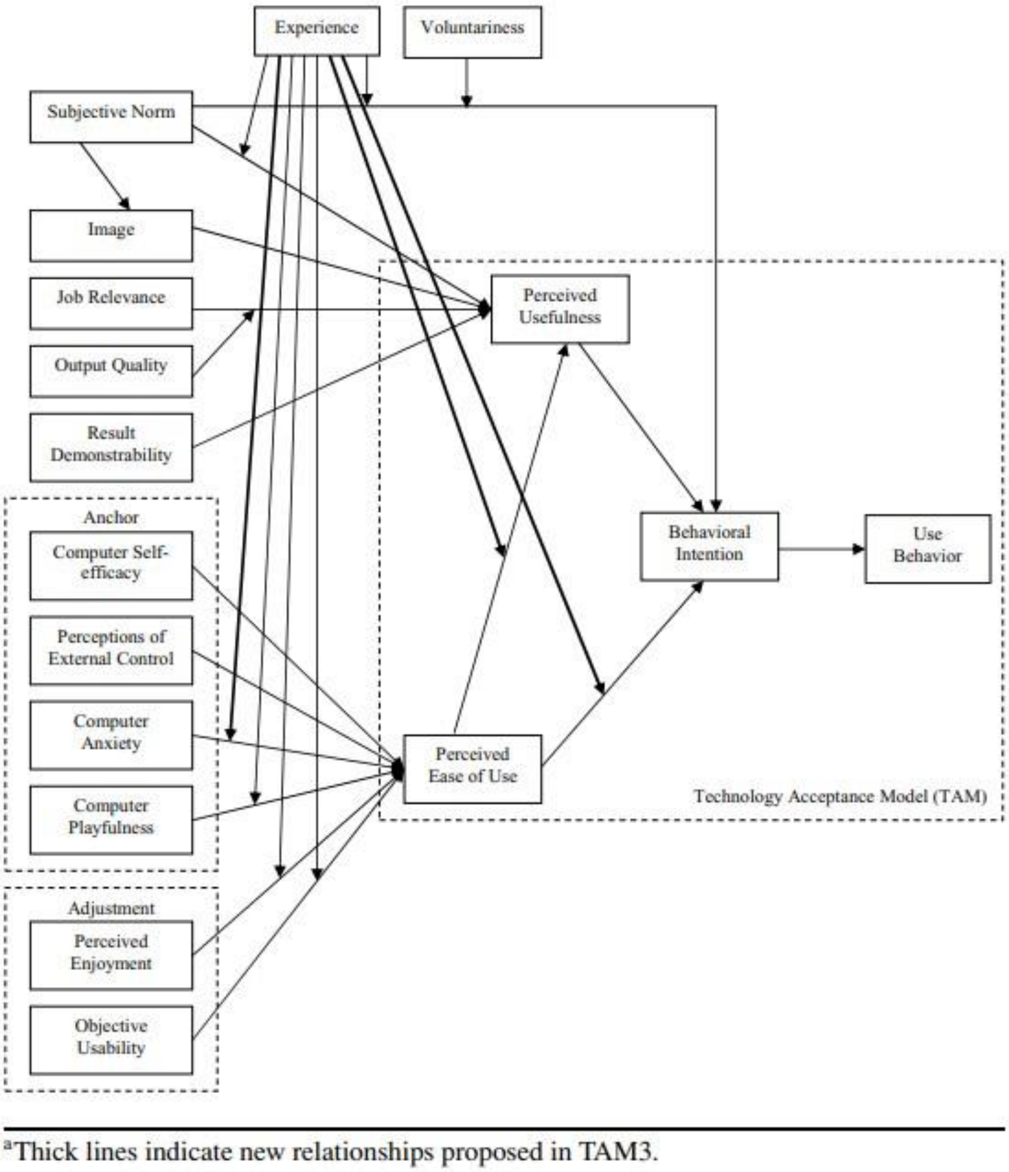


Figure 14 TAM3 model by Venkatesh and Bala (2008)

6.5.5 Challenges of the proposed intervention

Runners expressed at times that the intervention could become too complex and become 'too many things for too many people'. Runners were possibly acknowledging here that RRI prevention and management can be complex and multifactorial, and that the intervention would not be sufficient for all recreational runners. The recreational running population is a heterogenous one and it is not suggested that a digital intervention could provide bespoke RRI advice for all individuals that use it, however it could be argued that basic education in relation to RRI prevention and management could encourage healthier behaviours towards running while also indicating to runners when it is necessary to seek face-to-face advice from an HCP.

There were concerns that information provided by the intervention could be misinterpreted by runners and applied incorrectly, resulting in harm. Another form of misinterpretation was that the intervention itself could misinterpret information provided and give the runner the incorrect advice, again resulting in harm to the runner. It has previously been found that medical information contained within smartphone apps are not always based on scientific evidence (van Mechelen et al. 2014; Buechi et al. 2017). Misinterpretation was also a concern for runners as it could result in serious conditions being missed. Qualitative research with developers of digital behaviour change interventions found that participants felt that one of the barriers to creating a digital intervention was adapting a person delivered intervention to a digital form, highlighting that in a digital intervention the nuances of face-face interaction can be lost (Marcu et al 2022). This could potentially result in misinterpretation by both intervention and user. However this study also highlighted the importance of qualitative research with potential users of digital interventions, to engage the population and gather information pertinent to the lived experiences of that population to therefore improve digital interventions (Marcu et al 2022). The highlights the importance of a robust, iterative development and evaluation process such as the MRC framework (Skivington et al. 2021), where the intervention can be adapted and edited according to ongoing research. The possibility of misdiagnosis could be mitigated by the proposed intervention having the ability to advise face-to-face contact for assessment, which runners in this study had highlighted as something that they would want in an intervention.

There was concern that runners would not engage with the intervention and subsequently fail to adhere to advice provided. Low adherence among athletes has already been identified in previous research on the use of online sports-health surveillance systems (Barboza et al. 2017). During the discussions, runners indicated that they would find it helpful if the proposed intervention provided notifications to perform behaviours such as exercises. Physiotherapists interviewed about the acceptability of a digital intervention supporting patients who had had ACL reconstruction were reported as wanting a function for prompts and reminders within the intervention to facilitate engagement with the intervention (Dunphy et al 2017). Providing notifications and reminders could be a way to improve runners' adherence to advice provided by the intervention.

Runners' concerns over adherence to the intervention could also be due to the intervention having to compete with other events in their lives such as work and family commitments (Baumel and Yom-Tov 2018). It has previously been reported that barriers to engagement with RRI prevention behaviours include a lack of time (Linton and Valentin 2020). It could be argued that despite the concerns of participants regarding a lack of user engagement, the proposed digital intervention has the potential to enable users to engage in health care behaviours outside of usual health service hours, potentially saving time and possibly money. By involving runners as stakeholders in the continual, iterative development of the intervention, developers can identify barriers such as time and aim to mitigate for them. The intervention would also need to be grounded in a behaviour change framework or influenced by behaviour change theories (Ritterband et al.; Baumel and Yom-Tov 2018) such as the Theory of Planned Behaviour (TPB) (Ajzen, 1991; Ajzen, 2011) to further enhance adherence and uptake of healthy running behaviours.

Within the intervention there should also be a discussion around the trustworthiness of the information contained within the intervention to aim to mitigate for misinterpretation and misdiagnosis. Runners perceived information from HCPs to be trustworthy which has also been identified in previous research (Linton and Valentin 2020; Mayne et al. 2021). Evidence based information was also considered trustworthy by participants. Runners also perceived information from accredited bodies e.g., NHS, National Governing Bodies, to be trustworthy and reliable sources of information. For an intervention to be deemed credible and thus providing accurate information it requires expertise and trustworthiness (Hu and Shyam Sundar 2009, Yang and Beatty 2016). Therefore to ensure credibility and trustworthiness of the intervention for runners the content of the intervention should be evidence based and have input from expert clinicians such as physiotherapists.

6.6 Limitations and further research

There are a number of limitations to this study. Firstly, the sample used in this study was limited to recreational runners in Wales, therefore the findings are representative of this population only and cannot be extrapolated to the general population of runners across the UK. Future research could expand on these FGs to groups outside of Wales to compare findings with runners across the UK.

One limitation was that the years of running experience of each runner taking part was not established prior or after the FGs. This would have enabled comparison in responses and to establish whether there was a difference in the opinions and views of less experienced runners compared with experienced runners. A pre-focus group questionnaire on runner characteristics would have provided more information about participants to give more context to the results. More FGs from a wider age bracket of runners would also provide greater insights.

There were some limitations to the online FGs. During one FG a participant started to have technical problems during the discussion due to a disrupted internet connection. It resulted in some data being lost as the participant was mid-discussion when the interruption occurred. One participant joined an FG late as there appeared to be confusion over the time of the FG and how to join the platform. There were also non-attendances and participants who changed their minds. One participant changed their mind due to personal issues. Another participant appeared eager to participate, returned consent and then stopped replying to emails about attendance. It is noted that there was one focus group that was very short in length at only 28 minutes. There were also FGs that were 37 and 38 minutes respectively. This is a limitation as it may mean that not all relevant data was extracted from the focus groups. This may in part be due to the skill of the researcher as a novice but also that there were smaller numbers in each of these FGs compared with the FGs with bigger numbers. These are all issues that have been documented in the literature (Braun et al. 2017).

6.7 Conclusion

The aims of this study were to explore recreational runners' views on a proposed RRI prevention and self-management intervention including their opinions on the platform, the content, presentation and any problems that they foresaw within the proposed intervention. The method used for this study was qualitative online focus groups. The transcripts from these FGs were analysed using thematic analysis.

Following data analysis and exploration of the themes, the proposed intervention should ideally be a smartphone app which is an educational resource containing practical RRI prevention and self-management content which is in both video and written formats. The intervention should be embedded in behaviour change theories so that runners become motivated to perform behaviours that support RRI prevention and self-management. When developing the intervention issues surrounding user engagement and adherence to the provided advice need consideration.

Development of any health intervention requires involvement of other stakeholders such as HCPs and practitioners involved in advising and managing recreational runners, and those who represent NGBs. The next phase of the study will involve stakeholders who have contact and involvement with recreational runners. Chapter 7 reports a qualitative focus group study with practitioners who are involved in the assessment, treatment, or training of recreational runners. This is followed by a qualitative interview study with Run Leaders who represent the NGB of Welsh Athletics (Chapter 8).

Chapter 7: Practitioners' approaches to running-related injury (RRI) prevention and self-management and their views on a proposed digital RRI prevention and self-management intervention.

7.1 Introduction

This chapter introduces the third and final phase of the thesis. Phase 3 aims to explore the views of all other stakeholders who are involved in running and who are impacted by RRI. The following chapter entails part 1 of this Phase which is exploring practitioners (clinicians, coaches, trainers) approaches to RRI prevention and self-management and their views on a proposed digital RRI prevention and self-management intervention. Chapter 8 reports a qualitative interview study with Run Leaders from Welsh Athletics.

7.2 Background

Those in the health and exercise professions such as physiotherapists, coaches and trainers have a role in supporting runners who have sustained an injury in recovery and rehabilitation so that runners can return to the sport (Linton and Valentin 2020). These practitioners also have a role to play in helping runners in preventing or mitigating the risk of injury through injury prevention strategies and education.

Current approaches to RRI prevention and self-management include load management, exercise programmes, gait retraining and the identification of intrinsic and extrinsic risk factors that may contribute to injury such as biomechanics and footwear (Barton 2018). It could be argued that evidence for interventions aimed at preventing and managing RRI are limited but this could be due to the way interventions are implemented. Evidence of effectiveness within research does not always lead to successful implementation within a sporting population such as recreational runners (Verhagen et al. 2014a). Approaches to injury prevention in sport can take a top-down approach whereby researchers develop an intervention which is then implemented within the target population (Verhagen et al. 2014a). Any measures and interventions that are developed are created from a researcher's perspective only resulting in knowledge that needs to be translated into practice. Engaging practitioners in the research process is one way to ensure effective translation of research into the care of the sporting population (Esculier et al. 2018a).

Previous research has utilised the opinions and views of end users to develop RRI interventions with one study adopting the Knowledge Transfer Scheme (KTS) framework to develop an injury prevention intervention for trail runners. (Hespanhol et al. 2018a). The authors involved researchers, HCPs, and runners to develop the intervention that was used for the study which was then evaluated for its effectiveness via an RCT. They found that there was a significant preventive effect against RRIs for their online intervention which they felt suggested its implementation in practice was supported by the evidence. The authors cited the participatory approach to the development of the intervention as a strength in its design and this also gives some evidence for the benefits of having end users involved in the development of an intervention which is intended to be disseminated into clinical practice. The MRC framework discussed in Chapter 3 involves stakeholders in the development stage of the proposed RRI prevention and management intervention(Skivington et al. 2021b). Stakeholders are those who will deliver, use, and benefit from the intervention and this can include the target population, service providers, policy makers and those involved in National Governing Bodies (NGB) (O'Cathain *et al.* 2019). In this research project stakeholders not only refers to recreational runners, but also practitioners who may deliver the intervention and Run Leaders from the NGB who may recommend the intervention to runners.

From the scoping review (chapter 4) it is evidence that there has been limited involvement of stakeholders in the development of digital RRI prevention and management interventions for recreational runners, which demonstrates a gap. The involvement of practitioners in the field is important so that translation of evidence into practice is effective and that the intervention itself is relevant, effective and easily accessible to end users such as runners, practitioners, coaches and RLs (Wensing and Grol, 2019). The views and current knowledge of practitioners would be invaluable in the development of the proposed digital RRI prevention and self-management intervention and this approach is also justified by the adoption of the MRC framework for the development of complex interventions (Skivington et al. 2021b). Therefore, the objectives of this study are to:

1) Explore practitioners' (clinicians, coaches, and trainers) current approaches to running injury prevention and self-management.
2) Identify what practitioners perceive to be barriers to running injury prevention and self-management for the recreational running population.
3) Map practitioners' views on the content for a proposed digital RRI prevention and self-management intervention.
4) Identify perceived risks of a proposed digital RRI prevention and self-management intervention.

7.3 Method.

The primary method for this study was qualitative synchronous online focus groups (FG). This method was selected to stimulate a wider range of views from participants of all backgrounds and experiences (Hennink et al. 2019). The FG method and its advantages have been discussed in previous chapters. As this study was conducted during a lockdown period in Wales during the COVID pandemic, all COVID restrictions were adhered to. FGs were conducted via the Zoom platform which had been approved for data collection by Cardiff University. Each FG had a separate meeting identification number and password that were only known to participants of that FG and by the researcher KW. Only KW could admit participants to the FG via a virtual waiting room. Only KW had control of Zoom functions such as sharing and starting and ending the Zoom meeting. Personal chat was turned off so that participants could not message each other. All FGs were recorded with participants prompted to consent prior to recording. After each FG the Zoom platform converted the video and audio to files which were then saved on KW's computer. These files were stored under password protection and only KW had access to them. Chatham House rules (previously referred to in Chapter 6) were enforced for each FG to ensure that participants allowed each other to speak and to ensure information given in the FG was not shared (Chatham House, 2022). Participants were also reminded that they could withdraw from the study at any time.

All participants had read the PIS (Appendix 15) and completed a consent form (Appendix 16) electronically which was returned to KW prior to the FG taking place. Participants had all consented to being audio and video recorded via the Zoom platform but were reassured regarding anonymity and that the recordings would be stored under password protection.

7.4 Sampling and recruitment

Convenience purposive sampling was used to recruit clinicians, strength and conditioning coaches and personal trainers for this study. These sampling methods are non-random and with the intent to deliberately recruit participants with a particular set of characteristics (Bowling 2002). The sampling was for convenience, as the researcher targeted potential participants who were likely to respond and known to be in the relevant professions (Bowling 2002). The characteristics that the researcher targeted were clinicians, coaches and trainers who had experience of managing and coaching recreational runners. Participants who were known to the researcher (KW) were contacted directly via email to enquire whether they would be interested in taking part in an FG on RRI prevention and self-management.

7.4.1 Inclusion and Exclusion criteria

Inclusion criteria for participants was that they were qualified and registered in their relevant profession i.e., physiotherapist, strength and conditioning coach, personal trainer, and that they had knowledge and experience of managing, coaching or training recreational runners. Any clinicians, coaches or trainers that did not have experience of managing or coaching recreational runners were excluded from the study.

7.5 Data collection

An open format was used for the focus groups but a topic guide (Table 23) was developed which was built around the objectives of the study (Clarke and Braun 2013). The first part of the topic guide aimed to establish a rapport with participants, welcoming them to the focus groups and thanking them for their participation while also encouraging them to take part (Clarke and Braun 2013). The topic guide was developed to establish 1) their views on RRI prevention and self-management 2) their beliefs around barriers to RRI prevention and self-management 3) their views on a proposed digital RRI prevention and self-management intervention 4) thoughts on the possible unintended consequences of the proposed digital intervention. The topic guide also enabled KW to keep the discussion relevant to the aims of the study.

For the third section of the FG's, an activity-based question was used to engage participants and promote further discussion for the third objective of the study, which was to explore views of participants on a proposed digital RRI prevention and self-management intervention. This is a documented approach in the literature and can be used to help participants gather their thoughts and reflect on the activity prior to engaging (Colucci 2007; Bourne and Winstone 2021). Activity based questions can also enhance the quality of the responses and maintain focus of the discussion (Bourne and Winstone 2021). The activity employed in these FGs was to share a graphic developed from data that had been collected from recreational runners in the previous FG study (Chapter 6). KW had previously analysed the data from these FGs and identified the content that recreational runners wanted to see in a digital RRI intervention. A list of what runners wanted from a proposed digital RRI prevention and management intervention was compiled from data collected from the study in Chapter 6. This list can be seen in Table 24. This enabled KW to demonstrate to participants the content that recreational runners wanted to see included in the proposed intervention. This was with the intention of prompting discussion among the group as to whether the content desired by recreational runners was appropriate, whether they deemed it to be unfeasible in such an intervention and whether they felt there was information that had been omitted by the runners and in their view should be included in the proposed intervention.

Table 23 Topic guide for focus groups with practitioners

Introduction • Greeting • Research team intro with aim of the FG. • To develop rapport, brief discussion about where each clinician assesses and treats runners.
General experiences treating runners. • What are clinicians' general approaches to prevention of RRIs? • What self-management strategies do they advise runners to adopt? • What are the barriers/challenges to RRI prevention and self-management? Adherence, access to equipment, self-efficacy?
Use of online programmes/software • Do clinicians utilize any online programmes when preventing and treating RRIs? Which ones? • What are their thoughts about online programmes/apps? Are they aware of CSP app finder?
Potential content for an online programme

Activity based question (Table 24) to show clinicians the topics that runners said they would want to see in the injury prevention app – to stimulate talking points.

- What do they think about these topics as potential content? Are they feasible?
- Anything they feel should be included/omitted?
- What format do clinicians feel would be most feasible for an RRI prevention programme?
- Do they see any potential risks/safety issues? Unintended consequences?
- Can they be counteracted?

Table 24 Advice that runners wanted to see within the proposed intervention. This list was used to provoke discussion among practitioner participants

Injury and Management advice that Runners would want to see in a digital RRI prevention and self-management intervention.	
Loading information	Exercises
Return to running information	Stretching
Recovery Information	Dietary advice
Warm-up advice	Tailored Information
Age related information	Equipment

Once it was felt that saturation had been reached and no new ideas were being shared it was felt that no further FGs needed to be held (Hennink et al. 2019). The shortest focus group was 35 minutes, and the longest focus group was 63 minutes. The length of time of these FGs is reflected by the number of people that took part. The longest FG had six people which was also the largest FG. The shortest FG had just two people which was also the smallest FG. Despite over-recruiting to try and ensure adequate numbers for the FGs there were people who cancelled or did not turn up to the meeting which meant that in three of the FGs there were only two participants. This was out of the researcher's control.

Following each FG, the recordings were transcribed verbatim by KW (example transcript: Appendix: 19). Each transcript was saved under password protection to the device that was only accessible to KW. After each transcript was completed it was sent to each participant for member checking to enhance trustworthiness of the data (Clarke and Braun 2013; Morse 2015). Participants were asked to read the transcript and to inform KW if they wanted any changes, for anything to be redacted. None of the participants requested for any amendments to be made to the transcripts. To enhance trustworthiness and rigor, a transcript was sent to a PhD student colleague to see if there were any themes or codes that KW had potentially missed (Morse 2015). Themes were also discussed in meetings with both supervisors.

7.6 Data analysis

Transcripts were analysed using reflexive thematic analysis (Braun et al. 2019). Analysis followed the six stages of thematic analysis: 1) familiarisation, 2) code generation, 3) theme construction, 4) reviewing of themes, 5) definition and naming of themes and 6) production of this report. The thematic analysis method used for this study was used by KW in previous chapters and has been described in more detail in those chapters.

7.7 Results

A total of six online FGs took place with a total of eighteen participants between February and May 2021. Participants were made up of three personal trainers, one strength and conditioning coach and fourteen chartered physiotherapists (Table 25 and Table 26). All participants had experience of treating and managing recreational runners and amateur athletes. Nine physiotherapists worked within the NHS and five worked in private practice, but all had experience of managing recreational runners. Within the FGs there were participants who reported that they were recreational runners. This would have provided them with an extra layer of perspective on the topics being discussed. The strength and conditioning coach had an interest in injury prevention and injury management, but his predominant experiences were in football and cricket. The personal trainers all reported an interest in running and one was also an LiRF, who lead running groups. The diversity of experiences between the participants ensured that a wide range of views would be heard.

Table 25 Participant characteristics in each focus group

Focus group	Number of participants	Sex of participants	Profession
FG 1	2	Female	Physiotherapists
FG2	3	2 female/1 male	Physiotherapists

FG3	6	3 female/3 male	Physiotherapists
FG4	2	2 males	Physiotherapists
FG5	2	2 males	Physiotherapist Strength & conditioning coach
FG6	3	Female	Personal Trainers

Table 26 Professions of participants

Participant	Profession
P1-14	Physiotherapists
P15	Strength and Conditioning coach
P16-18	Personal trainers

Following analysis five key themes were identified. These were named as:

1) Approaches To RRI Prevention and Management.

2) Barriers to RRI Prevention and Management.

3) Participants Use of Digital Technology.

4) The Ideal RRI prevention and self-management intervention

5) Potential risks of the proposed intervention.

Each main theme was then categorized further into sub-themes. The following section will provide a description of the central themes and the sub-themes.

Table 27 gives an overview of the central themes, sub-themes and example quotes from participants. The central themes and sub-themes are also described in section 7.7.1.

__Table 27 Central themes, sub-themes and stand out quotes.__

CENTRAL THEME	SUB-THEME	EXAMPLE QUOTE
APPROACHES TO RRI PREVENTION AND MANAGEMENT	Readiness to run	*P1: " functional assessments of things like your kind of single heel raise max…how many… what is their max in relation to kind of the averages for their age groups… can they do things like single leg bridges, …. single leg squats…. it's often really surprising how poor some of those elements are'.* *P5: "we've got a large population of runners that are physically not ready to run particularly …so getting them prepared to run is really important I think that's a step people often skip".* *P16 "the biggest thing when I started taking some running groups was I was trying to get them to do strength training….'*
	Training load management	*P1: '… graded loading…….. being able to sustain a particular speed or distance or speed and distance comfortably before they then press on to either an increase in speed or distance…'* *P13: 'add no more than 10 percent on each week to either distance, pace, I thought that was always a sensible one to give to patients…'*
	Recovery	*P2: '…. looking at their recovery, how much, how much are they training,… what loading are they doing, have they ramped up too soon,… sleep?* *P4: '… thinking from a tissue healing point of view and from a bone injury prevention point of*

		view…. what .. factors do we need to consider when we're trying to prevent injuries that are effected by nutrition, *P14: 'rest and backing off a little bit is going to be a good thing and then gradually reintroduce training and follow the symptom patterns really, and that not all pain is bad pain.'*
	Education	*P18: '… really trying to explain to them in plain English that they can understand um how the body works…'* *P15 "…. educating them on accurate monitoring of their workload as well because you can aim for a certain distance but whether you actually hit that is a different story….."* *P17: '…I think knowledge is something,…. like these people I didn't have a clue about my body or anything I just went out one day and started running....'*
BARRIERS TO RRI PREVENTION AND SELF-MANAGEMENT	Access to appropriate advice and training information	*P1: 'they're not going to be a priority in the NHS quite often….sometimes they've had a bad experience of it…. they would far prefer to listen to their coach who maybe doesn't have that kind of pathophysiological background..'* *P12: '…. most runners… they'd go on a routine list…..seen anything between 8 weeks to 16, 18 weeks maybe, so I guess a lot of runners probably*

		at that time with niggles and things would probably see private physios, if they could pay…'
	Beliefs and perceptions about RRI prevention and self-management	*P11: '…they are very influenced by influencers, club mates, coaches and some of the myths and misconceptions that we have to counter obviously with those and sometimes cause a little bit of animosity…'* *P13: '…. I worked private in the past and used to see people quite acutely you know you'll do your soft issue, you'll do your manual therapy um and I think sometimes they think that's enough…'* *P5: '.. people will buy anything that enhances performance… it's a harder sell injury prevention than performance… But if you can train more often and you can develop more often then that's going to improve your performance.'* *P11: '…. there's also the misconception towards the therapists, so most runners will believe that we will tell them to stop running, so when we start looking at that education package and we have to break down some of those beliefs that we're a negative thing…'*
	Internal and external pressures	*P2: 'needing, wanting to keep up with whoever they're running with, whatever group they're running with…'* *P5: 'I remember some of the comments saying you know if I don't run with my watch I'm not running, um it doesn't count if it's not on*

		Strava….. there's not that many people out there for kind of the love of running….' *P16: '…. people would prefer to go for a 45 minute run rather than take down to maybe a half an hour run and actually do a warmup and do a cool down so I think that's probably time would be a constraint'* *P11: 'most recreational runners are time poor, just like as us therapists, they've got limited time to engage with everything and most of that time wants to be dedicated to running…'*
PARTICIPANTS USE OF DIGITAL TECHNOLOGY	Websites	*P2: REFERRING TO A PARTICULAR WEBSITE: ' it's pretty well presented, easily digestible, sensible, lots of like evidence based stuff but also um clinician experience based stuff as well'* *P11: 'I've built a business off it…. I just use my own stuff, …. that's what I've done with my social media is form an online resource… I do everything myself'* *P17: REFERRING TO A SPECIFIC YOGA WEBSITE: 'I suppose the clientele that she's worked with for them it's a, they're riding on the back of that, that's you know, it must be good because she's worked with all these people'*
	Smartphone applications	*P13: '… people who've maybe come in and more recently have taken up running I sign post them*

		to things like the Couch to 5K you know if they've never run before…' *P12: 'I use Strava and the Nike app………… and um yeah just to quantify distance and elevation or I guess how often they are running ….. it gives them some tangible objective to look at.'*
	Social media	*P16: '…. there's an Instagram account, RUN RX and it's all about where you know you put your foot positions ...… so I would refer people to that..'* *P14: 'I've used a couple of You Tube channels and the name escapes me at the moment but there's some, there's an Aussie fellow who's got some videos out there about common errors in running and what might be causing that..'*
THE IDEAL RRI PREVENTION AND SELF-MANAGEMENT INTERVENTION	Promote education of RRI prevention and self-management	*P5: '… it needs to be based in evidence and we could do with dispelling some of the running club myths you know, some of those commonly held beliefs that you know that go round the running clubs…'* *P11: 'it all goes back to the start of the conversation of how you're going to approach this, with education versus information almost.'* *P1: '..just because you always run doesn't mean you're going to get OA (OSTEOARTHRITIS) of your knees and kind of, maybe kind of reiterating kind of those messages'*

	Content that complements runners and running	*P2: 'I think the dietary advice is nice because there's … just so much rubbish isn't there, and fads ….it's so confusing…'* *P16: 'I'd maybe add something about running shoes, … making sure they're wearing the right trainers..'* *P10: '… if the average age is 44, you're going to be picking up like a lot of perimenopausal and you know later on menopausal women so I wonder whether that might be a good, more generic information section..'* *P12: '… things like REDS (relative energy deficiency in sport) um osteoporosis or those, um medication, HRT (hormone replacement therapy) stuff, in terms of bone health, yeah.'*
	Training and exercise content	*P2: '… you could have like… a couple of really nice just general strength and conditioning… routines that they could add in…You could do these as a session once a week and they would definitely add to your running and your overall fitness and health…'* *P5: 'exercises that could be done anywhere, you know at home with whatever you've got so you know rather than involving particular equipment..'*

		P1: '…a check list of those functional things you know like the single heel raise max, … single leg squats…so they can see what their form is now compared to maybe what their average should be'
	Signposting for runners and practitioners	*P1: '.. one of the things that..you know would be I think really valuable… be able to sign post somebody to a really good, evidence based site or kind of training type programmes'* *P2: '.. if you're an NHS physio it's perfectly acceptable to recognise that you are limited… so in that respect the app would be lovely because you could go 'oh look at this, go and look at this app'* *P3: '… if there was like a body chart, so they could click on where their pain is and then you could go through to the different,… common running injuries in that area and then onto the traffic light system, …, help them self-diagnose… work out if they need to see someone or if they can self-manage.'* *P14: '…I think that might sort of be the disclaimer that sort of goes along with that you know if there's any doubt about any of this then you should seek appropriate professional advice wherever that comes from.'*

	Format and presentation	*P3: 'Probably videos for the exercises…. it's easier for them to watch and follow…but I think it really depends on the person,'* *P3 '..some people find it easier to watch someone talk and to listen to them, others prefer to read it.'* *P4: '… perhaps a web based thing will become outdated perhaps'* *P5: 'the world is going app based, you're going to have an app for everything um and if you're, if time is a barrier then if you're sitting on the bus or you're sitting waiting at the GP's , you're sitting in work, at dinnertime you can check an app, while you're not likely to load a web page.'*
POTENTIAL RISKS OF THE PROPOSED INTERVENTION	Liability and litigation	*P14: 'I think there's going to be some sort of liability considerations for any app like this that have to be considered, what they are I'm not 100% sure..'* *P6 '… I don't know where your liability would stand if for example you diagnosed it as a plantar fascia problem, and it turned out to be a navicular stress fracture or something.'*
	Misinterpretation	*P18: 'on a self-diagnosis situation… the runner having pain in their knee will just presume there's something going on in their knee but actually it could be linked to the hip, it could be linked to the back…so there's a danger there'*

	P15: '3 people could receive the same advice and interpret it three different ways and I think with having nobody to actually speak to and check that they are doing the right thing it so just could be a snowball effect.'
Runner recall and inaccuracies	*P15: 'you're relying on the person inputting the data to describe their symptoms accurately whereas if they have a face to face consultation it's a lot easier for you to diagnose because you've actually assessed it…'* *P18: '… the app is only as good as the information that is put into it from the people putting it in'*
Potential for harm	*P14: '.. it creates an element of danger…, especially those who are wanting that specific sort of I press on this bit, here's my symptoms, here's my diagnosis,…that is a danger for a specific diagnosis'* *P6 '… I don't know where your liability would stand if for example you diagnosed it as a plantar fascia problem, and it turned out to be a navicular stress fracture...'* *P13: 'medial knee pain could be, it could be a range of things and if it's maybe a, you know frayed meniscus which you know sort of continue to run on it and it gets more and more painful, and it could do more harm whereas if it was something like…'*

7.7.1 Key Theme 1: Approaches to Injury Prevention and Management

This central theme refers to strategies that participants employed in efforts to prevent or manage RRI in the recreational running population. Participants described multiple ways in which they would instigate RRI prevention and management with runners, but they can be categorized under the sub-themes of Readiness to Run, Management of Training Loads, Recovery and Education. Table 27 provides example quotes to evidence each sub-theme.

7.7.1.1 Sub-theme: Readiness To Run

Participants described using a number of methods to ensure that a runner's musculoskeletal system was ready to endure the loads that the body would come under while running. Participants described methods of assessment to establish areas of potential weakness or poor control that required intervention to optimize running. They also described interventions such as prescription of strength exercises to get the running body prepared for running. It was noted by participants in this study that novice runners have often been inactive for a period of time prior to taking up running, resulting in their musculoskeletal system being in a deconditioned state. Strength exercises were discussed by participants as a way to prevent RRIs. Preparing runners for running via functional assessment and prescription of exercises appeared to be important to participants as a way to mitigate RRI risks.

7.7.1.2 Sub-theme: Training load management

Participants frequently referred to training loads as being an important aspect of injury prevention. Managing training loads could include monitoring training volumes and intensity and ensuring that runners, particularly novices, did not progress their training distances beyond 10% each week. Training loads cold also be regressed in the event that an injury required management. This is evidenced in the standout quotes in Table 16.

7.7.1.3 Sub-theme: Recovery

Within this sub-theme participants explored the importance of recovery strategies in the prevention and management of RRI. Recovery strategies included adequate rest from training, adequate sleep and appropriate nutrition to support running training.

7.7.1.4 Sub-theme: Education

Participants reported educating runners in aspects of RRI prevention and self-management, and the purpose behind recovery strategies and exercise programmes. Participants also described educating runners about the importance of monitoring training programmes so that training volume and intensity did not become excessive and result in injury. Table 16 gives some supporting quotes.

These sub-themes all interact to address areas that participants appeared to feel that recreational runners were lacking: lack of recovery, poor strength and movement patterns and excessive training loads. By addressing all these aspects participants constructed a holistic approach to injury prevention and self-management which aim to mitigate the causes of RRI.

7.7.2 Key Theme 2: Barriers to RRI Prevention and Self-Management

This theme describes the barriers that participants felt affected uptake of RRI prevention and self-management behaviours. Further analysis of the data resulted in sub-themes being developed within the main theme: Access to appropriate advice; Beliefs; Internal and External Pressures.

7.7.2.1 Sub-theme: Access to Appropriate Advice and Information

Within this sub-theme participants described how runners were being presented with unhelpful advice on exercises via the internet and social media which put up a barrier to evidence based RRI information. Referral systems within the NHS were also seen as a barrier to runners receiving appropriate advice.

7.7.2.2 Sub-theme: Beliefs surrounding RRI prevention and self-management.

Participants felt that strongly held beliefs and the culture of running were barriers to RRI prevention and self-management. A tendency to defer to coaches and running peers regarding injury and historically held beliefs about what RRI prevention and management entailed were perceived to be a barrier. Participants also described a belief by runners that soft tissue therapies were adequate for RRI management and prevention without considering the need for strategies such as load management. Example quotes for this sub-theme are in Table 27.

7.7.2.3 Sub-theme: Internal and External Pressures

Participants reported that internal pressures to keep up with running peers resulted in a barrier to RRI prevention and management. Competitiveness via running peers, internally or via training applications e.g. Strava were perceived to provide a barrier to injury prevention and self-management behaviours among recreational runners. Time was also seen as providing a form of external pressure. Recreational runners were seen by participants to have limited time and would therefore opt to run rather than engage in RRI prevention and self-management behaviours.

7.7.3 Key Theme 3: Participants' Use of Digital Technology

This theme refers to the use of digital technology by participants in the prevention and management of RRI for recreational runners. This theme was broken down into sub-themes of websites, smartphone applications and social media. There did appear to be a split between the different professions as to what type of platform was used or recommended to runners. It was noted that physiotherapists tended to recommend websites that they knew were evidence based while personal trainers were happy to recommend smartphone apps or websites that they had personally used and gained positive results from.

7.7.3.1 Sub-theme: Websites

Participants reported using websites for their own education and learning with regards to RRI prevention and management. They would also advise runners to seek out websites for their own use. Aspects of these websites that appealed to participants included evidence-based information and recommendations from other practitioners. Two of the participants, who were clinicians, had developed their own websites to provide evidence-based information to recreational runners. Websites which were promoted as being used by high profile clientele or developed by well-known clinicians were seen as favorable.

7.7.3.2 Sub-theme: Smartphone applications

The sub-theme refers to the use of smartphone applications by participants to provide runners with information on running, exercises and advice. Participants who were personal trainers appeared to recommend certain applications based on personal experience. For clinicians the content of the application was more important. Smartphone applications were seen favorably if they provided ease of accessibility and whether other apps could be cross referenced with it.

7.7.3.3 Sub-theme: Social media

Social media was described by participants as a way of finding information and disseminating it via platforms such as Twitter, Facebook and Instagram. Social media such as Instagram was favorable for the format of short pictorial explanations of injury prevention strategies such as exercises. Social media users disseminating information about injury and prevention were seen by participants to be favorable if they had a profile, a significant number of followers and 'kudos'. You Tube was also used by participants to point runners towards video content of exercises.

7.7.4 Key Theme 4: The Ideal RRI prevention and self-management intervention

To achieve the second aim of this study, participants were asked for their views on a proposed digital RRI prevention and self-management intervention. As described previously an activity-based question was used to stimulate discussion around what runners had felt would be the content they would want from the Ideal RRI prevention and self-management intervention. Participants in the current study were then asked for their thoughts on the content suggested by runners, whether they deemed it appropriate, unfeasible for this type of intervention and whether they felt there needed to be additions to the information suggested.

This theme was then analysed to develop themes related to proposed content. Initially codes were generated that related strongly to training information, education, exercise prescription, self-assessment, lifestyle information, gender specific information, additional information, signposting, a resource for runners and practitioners, reframing the language around injury prevention, liability issues and the format of the intervention. Further analysis and revisions of the codes took place to review candidate themes which resulted in the following themes being developed underneath the overarching theme of The Ideal Intervention. These sub-themes were named Promote Understanding and Education of RRI Prevention and Self-Management; Content That Complements Runners and Running; Training and Exercise Content; Signposting for Runners and Practitioners; Format and Presentation of the Intervention.

Across the sub-themes there can be seen occasional conflict of opinions between what different clinicians feel would work and what would not work within such as intervention.

7.7.4.1 Sub-theme: Promote Education of RRI Prevention and self-management:

Participants wanted the intervention to be an educational tool for runners. Participants wanted to see myths around RRI, and running being dispelled by evidence based information within the proposed intervention. They also spoke of wanting to see a culture change with the approach to injury prevention and self-management for recreational runners with a move from the language of injury prevention towards building resilience, robustness and enhancing performance as a way to encourage runners to take on board information regarding RRI.

7.7.4.2 Sub-theme: Content That Complements Runners and Running

This sub-theme refers to 'additional' content that practitioners felt would be useful to runners. Examples of content that participants wanted to see can be found in the quotes in Table 16. Information that participants wanted to see included advice on nutrition and hydration, appropriate footwear and advice that might be focused on specific populations of runners such as masters runners, post-partum women and menopausal women.

7.7.4.3 Sub-theme: Training and Exercise Content

Participants wanted to see advice on training load information that could help both novices who were starting to run and more experienced runners who were returning from injury. Participants felt that having information on readiness to run for novice runners and a functional check list of exercises would aid those wanting to start running or returning to running. In terms of the exercise content, it was felt that more general advice on strengthening would be appropriate alongside exercises that the evidence shows can help specific RRIs.

7.7.4.4 Sub-theme: Signposting for Runners and Practitioners

Participants wanted the intervention to be able to identify when to signpost runners towards face-face contact with an HCP when necessary. Participants working with the NHS and currently conducting virtual or e-consults due to COVID also felt that having an evidence-based digital RRI prevention and self-management intervention would be helpful to be able to direct runners to.

However, it was important for participants that the intervention was able to recognize, via information provided to the intervention by the runner, when individuals would need to be directed back to HCPs. Examples of when this could occur included runners describing ‘red flag’ symptoms and runners who had severe pain or pain that was ongoing for a significant amount of time.

7.7.4.5 Sub-theme: Format and Presentation of the Intervention

Participants overwhelmingly preferred video content for examples of strength exercises over written information. It was felt that written information would be useful to have but that videos were more likely to be watched by the end users. Participants also felt that shorter videos would be more desirable than longer videos so as not to lose the attention of the end user.

Concerning the platform, it was felt by participants that a smartphone app would be more accessible to the end user over a web based platform and that a smartphone app would be more likely to be used by runners due to the potential simplicity of apps and they’re ability to be accessed anywhere.

However, some participants felts that having a website connected to the app would be beneficial to provide complimentary information to a smartphone app.

7.7.5 Key Theme 5: Potential risks of the proposed intervention

This theme explains the potential risks, barriers, and negative aspects to a digital RRI prevention and self-management intervention. These risks were then categorized into sub-themes: Liability and Litigation, Misinterpretation, Running Inaccuracy and Potential for Harm. Despite being distinct sub-themes there is clear overlap between them. Quotes relating to evidence of each sub-theme can be found in Table 16.

7.7.5.1 Sub-theme: Liability and Litigation

Participants showed concerns regarding the potential legal implications for the proposed digital intervention. Participants questioned where liability would lie for developers of the proposed app and for those who recommended such an app should a serious event occur such as an injury being misdiagnosed by the app.

7.7.5.2 Sub-theme: Misinterpretation

Participants felt that there was the potential for runners who used the proposed intervention to misinterpret information or to cherry pick the information that they felt applied to them rather than taking on board all the appropriate advice. It was felt that this could lead to further injury and harm if runners were misunderstanding or misinterpreting the provided content.

7.7.5.3 Sub-theme: Runner Recall and Inaccuracies

It was felt by participants that an intervention such as the one being proposed was only as good as the information that was entered into it. Participants felt that there was the potential for runners to misunderstand questions, enter inaccurate information or enter false information which could result in inappropriate advice and exercises being provided which could then result in a negative outcome.

7.7.5.4 Sub-theme: Potential for Harm

The potential for the proposed intervention to lead to misdiagnosis and result in serious harm was of the greatest concern to participants when questioned about unintended consequences. Participants felt that serious symptoms and red flag signs could be missed such as those that would indicate stress fractures or serious illness.

Stress fracture was used frequently as an example of a serious RRI that could be failed to be identified by a digital RRI prevention and self-management intervention. Participants were also concerned that by the intervention failing to pick up on certain signs and symptoms, there was the potential for runners to continue to run on an injury thereby worsening it and consequently having an impact on long term health.

In summary, participants used approaches to RRI prevention and management such as education, training load management and exercises to prepare runners for running. Barriers to RRI prevention and management included a lack of time, a lack of available appropriate advice and myths and beliefs around RRI held by runners. Participants in this study were using a range of digital interventions to assist runners which included websites and smartphone apps. Overall participants were in favour of the proposed intervention and saw it as an educational tool that contained information that would complement running such as exercises. They were not in favour of it as a diagnostic tool or symptom checker. Potential risks to the intervention described by participants included a potential for harm and misinterpretation of the information within the intervention. The next section will discuss the results in relation to current literature and the previous studies conducted in this thesis.

7.8 Discussion

This study provides insights into how practitioners (clinicians, personal trainers, strength and conditioning coaches) currently approach RRI prevention and self-management. It also reveals what practitioners believe the barriers are to RRI prevention and self-management and their own use of digital technology. This study also explores what practitioners think should be the content of a proposed RRI prevention and self-management intervention and the potential unintended consequences of such an intervention.

Following analysis central themes identified were 1) Approaches to RRI prevention and management, 2) Barriers to RRI prevention and self-management, 3) Participants use of digital technology, 4) the Ideal App, 5) Unintended consequences. Participants used a wide range of approaches to RRI prevention and management in the form of preparing runners for running, the use of training load management, recovery strategies and education of runners. Barriers to RRI prevention and self-management included access to appropriate and timely advice on prevention and management and the beliefs held by runners regarding such topics. Overall participants were in favour of the proposed intervention, seeing it as a way to promote RRI prevention and self-management education to runners while also providing useful content and advising when to seek qualified assessment and advice. The possible risks identified of such an intervention by participants included the potential for harm and misinterpretation of information provided by the intervention.

7.8.1 Approaches to RRI prevention and management

Participants referred to preparing runners for running, educating runners on RRI prevention and self-management and utilising training load management with recreational runners. Previous research has explored running coaches' views on RRI prevention, finding that 'prehabilitation' is seen as important for RRI prevention (Linton and Valentin, 2020). This is comparable to the current study where practitioners, mainly physiotherapists, described preparing runners for running via functional movement screening and addressing any weaknesses that were revealed.

One of the approaches cited by participants in this study was to establish a runner's 'readiness for running' and to address any issues that were revealed by such an assessment. Clinicians utilise movement screening as a means to try and predict injury in sporting populations and the Functional Movement Screen (FMS) has been used as a screening tool to assess injury risk. It assesses movement patterns, mobility and stability via seven component tests and its validity has been confirmed in studies (Chorba et al. 2010) while it's inter and intra-reliability has been found to be moderate (Moran 2015). Previous research has tried to establish whether functional screening can be used to predict injury in competitive runners (Hotta et al. 2015). This study found that out of 7 tests used in the FMS, only deep squat and active straight leg raise were useful for predicting injury among their participants. This could imply that the FMS is not a suitable tool for predicting running injuries. Participants in this study were also male competitive athletes aged between 18-24 years old so the findings of this study may be limited when applied to the recreational running population. Another study investigated whether functional tests could predict injury resistance in a cohort of recreational runners but found that clinical measures of strength, range of motion (ROM) and foot alignment were not superior in non-injured runner compared with recently injured runners (Dillon et al. 2021). In fact, recently injured runners were found to display superior hip abduction strength and plantar flexion strength to injured runners. These studies call in to question the use of functional tests as predictors of RRI. However, it can also be questioned how relevant isometric muscle strength is with regards to a sport that requires muscular endurance. Repeated movements such as calf raises, or hopping may be more relevant to the motion of running. The calf raise test has been used by clinicians to establish the properties of the calf-muscle tendon unit such as endurance, strength, fatigue, function and performance (Hébert-Losier et al. 2009), all functions that can be argued to be relevant to running. Previous research found a strong correlation between one repetition maximum (1RM) and sprint time over short distance (Möck et al. 2018). A systematic review found that endurance and reporting the number of calf raises performed during the test were the most frequent purpose and outcome measurement for the calf raise test (Hébert-Losier et al. 2009; Möck et al. 2018). However this review reported that there was no consensus on purpose, test parameters or normative values associated with the calf raise test, therefore calling into question it's reliability and validity as a test of plantar-flexion (Hébert-Losier et al. 2009). So, while functional tests have potential to be included as a form of self-assessment within a digital RRI intervention, helping runners identify areas of weakness that could benefit from specific exercises, the tests used within such an intervention will need careful consideration when looking at the current evidence.

Participants in the current study reported that novice runners may need help in becoming conditioned for running. Again, this is comparable with the study with running coaches by Linton and Valentin (2020) that found that prehabilitation was considered as important in preventing RRI. It has been suggested that novice runners may not be sufficiently conditioned for the repetitive, high level forces of running (Hreljac 2004a). Previous studies investigated whether pre-conditioning or graded training programmes prevent the development of RRI (Buist et al. 2008a; Bredeweg et al. 2012). A four week pre conditioning programme of hopping and walking drills for novice runners found that there was no influence on the incidence of RRI when compared with a control group (Bredeweg et al. 2012). A study comparing a gradual training programme over thirteen weeks to an eight week standard running programme and found no difference on the incidence of RRI between groups (Buist et al. 2008a). It could be argued that what the participants were doing in the pre-conditioning hopping/walking drill study as well as the length of time they were doing it may not have been adequate enough to have an effect on the injury incidence. It could be argued that inexperienced runners would need a longer period of pre-conditioning to have an effect on the incidence of RRI.

Participants also described strength exercises as an approach to RRI prevention and self-management. This is comparable with findings from a previous study which found that physiotherapists, doctors and trainers most frequently cited muscle strengthening as an injury prevention strategy (Saragiotto et al. 2014b). This study was based on what the participants opinions were for injury prevention directed at the elite athlete population, making extrapolation of the findings to recreational running populations limited. However, running coaches who coach recreational runners cited prehabilitation in the form of exercises as important in RRI prevention (Linton and Valentin 2020). Systematic reviews have concluded that strength training was superior to other interventions such as stretching in the prevention of sports injuries (Lauersen et al. 2014; Lauersen et al. 2018). One review found that that strength training reduced sports injuries to less than a third and that overuse injuries were halved (Lauersen et al. 2014). This is particularly relevant to recreational runners as they are most likely to develop overuse injuries as opposed to acute injuries. However, this review was not specific to recreational runners and most of the studies included in the review investigated team sports such as soccer and basketball so extrapolation of the findings to runners and RRI is limited, although strength training as a way to lower the risk of injury is promising. The type of strength training prescribed is also important for consideration when aiming to prevent sports injury. A review analysed strength training-based sports injury prevention trials to establish the best evidence recommendations (Lauersen et al. 2018). The review found that despite variations in the implementation of strength training across studies, strength training was found to reduce both acute and overuse injuries. From their findings the authors also recommended that prescribers of strength training should consider sufficient programme volumes and intensities as they had found that strength improvement and injury prevention were closely related (Lauersen et al. 2018). Again, a limitation of this study is that the studies included only involved military conscripts and those from team sports such as soccer so applying the findings to recreational runners is limited but shows promise with respect to the prevention of overuse RRI. Whether RRI can be truly prevented or mitigated via strength training is unclear but there is some evidence to support inclusion of strength exercises within the development of a digital RRI prevention and self-management intervention. This could be in the form of pre-conditioning the runner, functional testing, or specific exercises to address any identified weaknesses so that the intervention can help runners prepare for running.

Participants in this study described encouraging runners not to do too much too soon and adhering to the ‘10%’ rule of increasing running distance. Previous research has reported similar findings physiotherapists, doctors and trainers identifying overtraining as being associated with the development of sports injury among elite athletes. To minimize injury it has been recommended that training intensity of duration should not be increased by more than 10% each week (Johnston et al. 2003). The 10% ‘rule’ has been investigated within a group of novice runners but it found that there was no effect of the graded 10% rule training programme on the incidence of RRI compared with a standard training programme (Buist et al. 2008a). The authors of this study acknowledge that the training programmes may have been too similar for differences in the incidence of injury to be identified. Giving the other group a standard training programme would have provided those runners with a structure and adequate recovery which could also have had a protective effect against the development of RRI. Therefore, from this study the use of the 10% rule isn’t supported but it is likely that a structured programme with adequate recovery could be the key to preventing RRI among novice runners. More still needs to be done to understand the implications (Nielsen et al. 2014b) of the ‘10% rule’ for the development of RRI but other studies have shown that exposure to increasing running distance can lead to RRI (Nielsen et al. 2014b; Damsted et al. 2018b). Nielsen et al (2014) found that runners who increase their mileage by more than 30% had a higher RRI rate than those who progressed their mileage by less than 10% while Damsted et al. (2018) found that significantly more runners were injured if they increased their running mileage by 20% to 60% compared with those who increased their distance by less than 20%. These studies could provide evidence that running distances can be safely increased up to 20%. These studies highlight that currently the advice regarding the ‘10% rule’ and avoiding increasing mileage ‘too fast too soon’ is limited (Barton 2018).

Distance isn’t the only training variable that requires consideration and participants in the current study also referred to other training variables as being key in RRI prevention and management such as intensity and frequency, speed or pace (Nielsen et al. 2012). It has also been suggested that the type of RRI incurred by a runner can also be influenced by the type of training error that has occurred however this has not been conclusively shown by studies (Nielsen et al. 2014b; Ramskov et al. 2018). In the development of a digital RRI prevention and self-management programme all these variables could be considered to aid runners mitigate and manage RRIs.

Participants in this study saw rest and recovery as important in the prevention and management of RRI, describing how they would question runners about factors such as sleep, rest, and nutrition. These factors were important to participants when considering the health of tissues and tissue repair from training loads. This is supported in the literature, when examining the risk factors for RRI and mitigating for them lifestyle and sleep need to be considered (Mousavi et al. 2021). Lack of sleep has been linked to a higher risk of developing sports injuries (Huang and Ihm 2021). A study aiming to develop profiles of recreational runners found that of the runners surveyed, 70.1% reported getting between six and eight hours of sleep per night while 25% of respondents reported getting less than six hours of sleep per night (Besomi et al. 2018). This is similar to a study which found that non-professional runners had an average of seven point one (7.1) hours of sleep per night (Restrepo Villamizar et al. 2020). Sleep and good quality of sleep is essential for musculoskeletal recovery (Mousavi et al. 2021). Mousavi et al. (2021) sought to establish via a cross sectional survey whether poor sleep quality was associated with higher reporting of RRIs in recreational runners. They found that poor sleep quality was associated with RRIs but then acknowledged that being injured contributes to poor sleep quality. Therefore, despite the findings of this study that poor quality sleep is associated with injury it becomes less clear as to whether it is poor quality sleep potentially due to the stress and worry of being injured. The finding of this study that sleep quality is associated with RRI needs further investigation. However, it is suggested from other studies that sleep does have an impact on sports injury and could therefore have an impact on the development of RRI. But due to the nature of the lifestyles of many recreational runners the control they have oversleep as a recovery tool may be limited e.g. due to shift work, parents of new-borns and young children, caring for other relatives. Sleep is obviously an ideal recovery tool, but it is possible that for those recreational runners that sleep is difficult to come by other recovery tools may need to be employed. Non-professional runners need real-life solutions so that they may be supported (Restrepo Villamizar et al. 2020), therefore the development of any RRI prevention and self-management intervention needs to consider methods of recovery that are optimal and suitable for recreational runners.

Education was seen an important tool in helping runners identify causes of RRI and to help runners modify training behaviours to reduce the chances of RRI. Education in how to return after RRI, to try and prevent reinjury and reassurances about pain were important to participants in helping runners return to sport. Education was also seen as important to help runners understand that other activities such as cross training and strength training could be alternatives to help them improve their running and to change potentially injurious running behaviours. Previous research has found that running coaches and RLs felt that having more education and knowledge about RRI prevention would help them to impart RRI prevention strategies to runners (Linton and Valentin 2020). Education and knowledge can help improve self-efficacy of behaviours such as performing exercises for injury prevention. Therefore in the development of an RRI prevention and self-management intervention, it is argued that there needs to be an educational and learning component that can help runners develop their RRI prevention and management knowledge, improve their self-efficacy with regards to prevention and management strategies which would arguably help runners to adopt preventive behaviours to RRI and ultimately help them to prevent or mitigate RRI as far as is reasonably possible.

7.8.2 Barriers to RRI prevention and self-management

Participants in this study felt that lack of access to appropriate advice and information was a barrier to RRI prevention and management. Not knowing what to do has previously been cited as a barrier to RRI prevention for runners who had experienced RRI (Fokkema et al. 2019b). Running coaches and RLs have reported that lack of knowledge about prehabilitation exercises and appropriate advice led to a lack of confidence in giving out RRI prevention advice to runners (Linton and Valentin 2020). Having a lack of knowledge can be a perceived barrier to behaviour change (Deci and Ryan 2008). If individuals do not perceive themselves to have the knowledge they believe they need to change behaviour or engage in a new behaviour then the new behaviour will not occur. Providing runners with accessible advice and information via a digital RRI prevention and management intervention could provide a way to remove this cited barrier.

Participants felt that the beliefs held by runners presented a barrier to RRI prevention and management. Studies have examined the beliefs and attitudes of recreational runners, coaches and RLs towards RRI prevention (Saragiotto et al. 2014d; Fokkema et al. 2019d; Wilke et al. 2019; Linton and Valentin 2020). A lack of stretching and wearing the wrong shoes have consistently been reported by runners as being a factor in the development of RRI (Saragiotto et al. 2014d; Fokkema et al. 2019b; Wilke et al. 2019). Stretching and shoe type are not supported by the scientific literature as preventing RRI and yet runners are consistently found to believe that these are key factors in preventing injury. As reported by Wilke, Vogel and Vogt (2019) interventions such as strength training and balance exercises were rarely named by runner as a means of preventing injury. It was felt by participants in the current study that beliefs and perceptions of RRI originated from coaches and running peers and that this information was inconsistent. It also appeared that participants felt that there was a clash between information that came from practitioners and information that came from coaches, leading to potential conflict and runners having to pick between the two viewpoints. However a study in which running coaches and RLs were surveyed about their beliefs and perceived barriers to RRI prevention found that they agree that education and prehab strategies are important for reducing risk of RRI (Linton and Valentin 2020). Coaches and RLs in this study acknowledged that barriers to imparting prehab strategies included a lack of time, resistance from runners and a lack of knowledge regarding RRI prevention interventions such as exercises (Linton and Valentin, 2000). Thus, as per some participants' comments, there are myths and misconceptions about RRI prevention and self-management which need to be addressed but there is potential for this to be achieved via dissemination of information via the intervention not only to runners but also to coaches and RLs, to assist these stakeholders with gaps in their own RRI prevention and self-management knowledge.

Participants described internal and external pressures that recreational runners would place on themselves that could pose potential barriers to RRI prevention and self-management. Internal pressures centred around psychological pressures that runners would place on themselves for training and races. This would result in a 'go hard or go home' mentality that participants felt could result in over training thus this internal pressure would provide a barrier to RRI prevention and management. Participants felt that internalised pressure to compete with other runners could again result in over training as they would ignore their own graded training plans. Internal pressures to compete and continue an activity without regard for ability, load capacity or recovery can be described as obsessive passion (Mousavi et al. 2021). Obsessive passion has been associated with the development of sports injuries (Stephan et al. 2009). Obsessive passion for running can be argued to lead to the development of RRI as runners will ignore pains and continue to run, potentially leading to overuse injuries which become harder to treat (Mousavi et al. 2021). Mousavi et al (2021) found a positive association between obsessive passion for running and RRIs. Therefore, internal pressures to continue to run and compete with oneself or others provides a very real barrier to RRI prevention and self-management.

Participants felt that pressure also came from wearable technology such as watches and smartphone apps, with an external pressure being placed on runners via the collection and analysis of data. The relationship between the use of running applications and RRIs has been explored and has not been found to be associated with increased RRI (Kemler et al. 2018b). However, the authors found that training with the aid of a running programme via a running application was positively related to RRI. This was suggested to be because running programmes via running applications are not tailor made and do not take into account personal information of the runner such as running experience, history of RRI and current fitness levels. However not all runners using running applications are using running programmes and as identified by one participant in the study there are games and challenges on many of the running applications such as Strava and Garmin connect that have the potential to encourage runners to engage in injurious behaviour. Therefore, the pressure from the gamification of apps can be a barrier to injury prevention. An RRI prevention and self-management intervention may be able to help runners identify unhelpful and unhealthy running behaviours and pressures and give strategies to help runners mitigate for them.

Participants identified time as an external pressure and a barrier to RRI prevention for recreational runners. It was noted that recreational runners have busy lives involving work, family and other commitments which had the potential to limit their engagement with RRI prevention and management behaviours. Runners were identified as being time poor and it was noted that runners with family who required childcare would prioritise running over injury behaviours such as resistance training or yoga. Recreational runners and the devices they use do not always take into account more subjective variables and off-training factors that may have an impact on training and recovery such as work stress, disrupted sleep due to young children or a reduction in activity due to illness (Düking et al. 2018). A study investigated how the integration of subjective training, off-training and contextual factors might lead to better screening and health protection methods for non-professional runners (Restrepo Villamizar et al. 2020). It was found that a lack of time was the second most cited reason for runners not to train, highlighting that if lack of time is a barrier for some running sessions, then it will also be a barrier to injury prevention strategies. Training performed by recreational runners is often unstructured and unpredictable, influenced by off training factors such as sleep, lack of time, family commitments and work stresses (Restrepo Villamizar et al. 2020). An intervention which could provide structured advice around RRI prevention and management could help runners save time by providing necessary information all in one place.

7.8.3 Participants’ use of digital technology

Participants described the types of digital technology they used in their management of runners. Digital technology utilised by participants could be divided into three distinct categories: websites, smartphone applications and social media. It was important for participants that the websites they used or directed runners towards were evidence-based, easy to follow and had a good reputation. Two participants described how they had grown their own websites and developed their own content via their experience as clinicians. Smartphone applications that participants would recommend to their patients and clients included applications that were specific to increasing mobility, and Couch to 5k for aiding people who wanted to get into running. Other participants used monitoring apps such as Strava and Nike apps to quantify runners’ training habits. Interestingly none of the participants directly used smartphone applications as a tool for the prevention or management of RRI, although it could be argued that the use of monitoring apps serves as a means of monitoring training loads which in itself is a form of injury prevention and management.

Signposting runners to applications seemed to be based on personal experiences or on recommendations from others. As discussed in previous chapters regarding smartphone apps for sports injury prevention, there are a limited number that are informed by scientific evidence (van Mechelen et al. 2014). Having evidence-based content is important to participants before they will recommend it, therefore as per the study above if smartphone applications are not found to be based in evidence (van Mechelen et al. 2014) then it is clear why this group of practitioners are not currently signposting runners to smartphone applications. Therefore, if the proposed intervention in this thesis is developed, it must be evidence-based so that it will be seen as trustworthy and reliable by HCPs and therefore more likely for HCPs to recommend it to runners in Wales.

Participants described following social media accounts across a number of platforms including You Tube, Facebook, Twitter and Instagram. It was important for participants not only that the content was evidence-based but that the account had a certain number of followers which gave the account some 'kudos'. At the time of writing this, an Instagram account highlighted by one of the participants had 208,000 followers so it is possible that practitioners are looking at the number of followers that a social media account to decide on the trustworthiness and reliability of the information provided by the individuals running the account. The internet and social media have become more popular as a source of health information (Song et al. 2016). Health information online can take two forms: experience based health information in the form of blogs, social networking sites (SNS) and online support groups, or expertise based health information usually in the form of web sites (Song et al. 2016). Research has found that there are cultural differences in the type of health information that is used by individuals but expertise based sources were found to be universally trusted (Song et al. 2016). Any future RRI intervention should have some involvement from experts for it to be trusted by both HCPs and runners.

7.8.4 The Ideal RRI prevention and self-management intervention

To achieve the final aim of this study, participants were asked for their opinions on what they felt would be the appropriate content for a proposed digital intervention aimed at preventing and managing RRIs in the recreational running population. To stimulate the discussion, participants were shown data collected from a previous study where recreational runners were asked what content they would want included in a digital RRI prevention and self-management intervention. Participants commented on these findings and also shared opinions on the information that they felt should be included in such an intervention plus anything that they felt runners in the previous study (Chapter 6) had omitted.

It was important to participants that any intervention should have an educational role based on evidence but that it should also help dispel unhelpful myths and misconceptions held around running and RRI prevention. For example participants felt that runners needed to be educated about the effectiveness of interventions such as stretching. Participants reported that they wanted to see information that complemented running in the form of information related to nutrition, sleep and hydration. This reflects findings from the focus groups with runners (Chapter 6) who also wanted to see information relating to nutrition and hydration included within the Idea RRI prevention and management app. This consensus between runners and practitioners demonstrates that this type of information would be of importance for RRI prevention and management.

Practitioners in this study wanted the proposed intervention to provide information on training and appropriate exercises for the prevention and management of RRIs. The training information that practitioners wanted to see related to training load management and ensuring runners were not increasing mileage too soon. This is reflected in the literature where it is advised that runners should not increase their training loads by more than 10% weekly to prevent RRI (Johnston et al. 2003). Adjusting training loads to prevent and manage RRI has been discussed in the literature and this has been discussed previously in this chapter. The opinions of participants in this study and previous research demonstrate that monitoring training loads is an important aspect of RRI prevention and management, therefore the development of the Ideal RRI prevention and management intervention should consider educating runner about how to safely manage all aspects of training loads (volume, intensity, frequency).

Participants were keen that any intervention included exercises that could help runners prevent RRI but also some exercises that could help manage specific RRIs such as Achilles tendinopathy. These findings are in agreement with runners from the previous study (Chapter 6) who also wanted to see exercises for the prevention and management of RRI to be included in the proposed intervention. As discussed previously in this thesis and in this chapter, there is some evidence for strength exercises in the prevention of RRI (Lauersen et al. 2014b; Lauersen et al. 2018). There is also some evidence for the use of exercises in the management of RRIs such as Achilles tendinopathy (Jayaseelan et al. 2019; van der Vlist et al. 2021) and PFPS (Baldon et al. 2009; Earl and Hoch 2010). Research has also shown that strength exercises have the potential to address lower limb biomechanics during running (Snyder et al. 2009b). The inclusion of exercises within the proposed RRI prevention and management intervention is supported by the findings of this study, the previous study and the current evidence.

Participants were also keen that the proposed intervention should have the ability to signpost runners towards HCPs. This was important for participants from a safety perspective so that runners exhibiting concerning symptoms such as those from a stress fracture or runners reporting red flag symptoms could be directed to appropriate face-to-face health care. There is a hope that health apps can provide low cost, accessible, good quality care but there is also the concern that health apps could be harmful (Parker et al. 2017). The "… ability of an app to affect health outcomes depends not only on the safety and effectiveness of the app intervention itself, but also on the safety and quality standards of the environment in which it is developed, distributed, promoted, and used.."(Grundy 2022). Therefore in the development of any RRI prevention and management intervention there needs to be an awareness of negative outcomes and for the development of the intervention to minimise potential for harm as much as possible (Parker et al. 2017).

Participants were in favour of the RRI intervention being in a smartphone app format to maximise accessibility. They reported that as most people used smartphones, an app would be the most appropriate format for the intervention. Regarding the presentation of information in the intervention, some participants were in favour of videos whereas other participants felt that having both visual and written information would be helpful for end users. This is reflected in the findings in the previous chapter where there was a divide between runners as to whether content should be just visual in the form of videos or also include written information. Visual learning via an app has been associated with higher user satisfaction when compared with a written booklet in ankle rehabilitation (van Reijen et al. 2018). There appears to be a consensus among runners and practitioners about the format of the proposed intervention and it is in part supported by some research, therefore any future intervention should consider a smartphone app format and the use of videos to encourage visual learning.

7.8.5 Potential Risks

In the final part of the focus groups, practitioners were asked what they considered to be the potential risks of the proposed intervention. Potential risks foreseen by participants included misinterpretation, liability and litigation issues, a potential for harm to be caused by the app and runner recall and inaccuracies when entering information into the app. The development of any digital intervention needs to work on delivering benefits in the form of RRI prevention and management but also do its best to minimise harm (Parker et al. 2017). Participants were concerned that runners could misinterpret the information provided within the app which could lead them to performing prevention and management strategies that were not suitable for them. Participants were also concerned that the app could have the potential for harm, potentially in the form of misdiagnosis e.g. stress fractures being missed by the intervention. It was also highlighted that the intervention would only be as good as the information that was entered into it, and that runners inputting incorrect information into the intervention could result in inappropriate information being provided to runners by the app. These are obviously huge concerns in the development of any digital intervention. Therefore when developing the proposed Ideal RRI app, government guidance would need to be considered, ensuring that the intervention is legally compliant and operates according to health care and industry standards (Parker et al. 2017).

7.9 Limitations

There are several limitations to this study. Recruitment for this study seemed to be more difficult for this round of online focus groups. Initially recruitment and uptake were promising, and practitioners agreed to participate. However, three participants withdrew due to personal reasons such as family commitments. One participant did not attend due to issues with the link to join the online FG and one participant agreed to attend and then sent an email after the FG had taken place to say they had forgotten. Issues with recruitment and attendance are documented issues with online FGs (Braun, Clarke and Gray, 2017).
The sample was limited to practitioners from Wales therefore the data collected is only representative of this subset of the population and cannot be generalised to practitioners across the UK or practitioners from other professions e.g. sports medics.

During focus groups there were occasional issues with internet connection and background noise (dog barking and family interruptions), all of which could have affected the flow of the FGs and impacted the collection of data.

7.10 Future research

Future research on the development of a digital RRI prevention and self-management intervention should consider these findings and should influence initial iterations of the proposed intervention. Further research could also be conducted with practitioners from a wider geographical area for comparisons. This study was limited to views from physiotherapists, strength and conditioning coaches and personal trainers. It is recommended that research be conducted with members of other professions who are also involved in managing and advising runners e.g. sports medics, General Practitioners (GPs), podiatrists.

7.11 Conclusion

This study explored the views of practitioners (physiotherapists, personal trainers, strength and conditioning coaches) on approaches to RRI prevention and management and the barriers they perceive to RRI prevention and management. This study also aimed to establish participants current views on digital technology in the prevention and management of RRI, their views on a proposed Ideal RRI app and the potential unintended consequences of such an app. Approaches to RRI prevention and management included preparing runners for running via exercises, educating runners in RRI prevention and management, advising runners on recovery, and helping runners to manage training loads. Participants saw barriers to RRI prevention and management to be access to RRI advice and information, the beliefs held by runners regarding prevention and management of RRI and the internal and external pressures experienced by runners such as time and pressure to perform/compete with others. Participants reported using digital technology in the form of websites, smartphone apps e.g. Strava, Couch to 5K and social media networking sites, but none of the participants were currently using digital technology which was designed specifically for the prevention and management of RRI.

Practitioners support the development of a digital RRI prevention and management intervention, with such an intervention being seen as an educational tool for RRI prevention and management which will also include practical elements such as exercises. Participants had concerns about the potential for the proposed intervention to cause harm via misdiagnosis or for runners to misinterpret information provided, therefore any intervention needs to instil trust and have the ability to direct runners to face to face contact with a health professional where appropriate so that the app is not seen as a replacement for qualified HCP advice and expertise. The implication of this study is that the development of any digital intervention for RRI prevention and self-management needs to incorporate these findings.

As discussed previously, all stakeholders who have contact with runners should be involved in the development of the proposed digital RRI prevention and self-management intervention. The next chapter is the final part of Phase 3 of this study and involves qualitative interviews with Run Leaders from Run Wales, the social running programme associated with Welsh Athletics (Welsh Athletics, 2021).

Chapter 8: The views of Run Leaders in Wales on RRI prevention and self-management and their views on a proposed digital RRI prevention and self-management intervention.

8.1 Introduction

The previous chapters have explored the views of runners and practitioners regarding RRI prevention and self-management as well as collating descriptive data around runners' experiences of RRI and how they currently prevent and self-manage RRI. However as per the MRC framework the views of other stakeholders should be considered to give full context to a proposed intervention (Skivington et al. 2021b). The final part of this thesis is a qualitative study with Run Leaders (RLs) from Run Wales who regularly interact with runners in Wales and support future RLs in the LiRF qualification.

8.2 Background

Over the last few years in Wales there has been a rise in the number of people participating in running and jogging. Statistics collected by Sport Wales found that in May 2020 14% of those surveyed were running with this rising to 18% in March 2021, indicating a change in exercise habits following the coronavirus pandemic (Sport Wales, 2021). The rise in popularity of recreational running and the turn away from more traditional running clubs has seen the inception of social running groups. Run Wales is the social running arm of Welsh Athletics, and they support more than fifty social running groups (Run Wales, 2017b). They support anyone of any ability who wants to participate in running, supporting more flexible, informal ways of providing safe running opportunities for people across Wales. (Run Wales, 2017b). To facilitate the development of social running and to provide support to those who attend social running groups, Welsh Athletics (WA) offer a role in their coaching pathway known as Leaders in Running Fitness or Run Leaders. Run Leaders (RL) are able to lead and support social running groups but are not qualified running coaches. (Welsh Athletics, 2021). Following a Leadership in Running Fitness (LiRF) course, which involves two days of training including theory and practical elements, an RL is qualified and insured to take groups of runners on a run. Part of the LiRF course focuses on helping to overcome barriers to running participation and aims to increase participation by individuals who do not want to attend a traditional running group (Run Wales , 2017a). RLs are volunteers and their involvement in athletics organisations has a direct effect on the organisation and its actions. RLs would be key to attracting and retaining recreational runners in the sport. In a social running setting, recreational runners are likely to turn to RLs and running peers for advice if they are concerned about RRI prevention or have sustained an RRI. RLs have become stakeholders within running NGBs as they affect the organisation but are also affected by any decisions or developments within the organisation. Stakeholders are defined as individuals affected by or who affect an organisation or business (Marques Miragaia et al. 2014). In an athletics NGB, stakeholders will include clubs, coaches, officials, athletes, recreational runners, and volunteers.

Running benefits to health and mental well-being, but a disadvantage of running is the musculoskeletal injuries that can occur, with the incidence of RRI reported as being as high as 85% in novice runners training for an event (Kluitenberg et al. 2015). Unlike elite runners who may have a network of qualified coaches and medical personnel to turn to when injured, recreational runners do not have that support. In the event of an injury, recreational runners will turn to those around them to seek help and advice for their RRI such as running peers and RLs. Previous research has explored the views and attitudes of stakeholders, such as runners, running coaches and RLs, towards running injury and running injury prevention (Johansen et al. 2017; Linton and Valentin 2020). The attitudes of runners and their coaches towards the development of RRI were explored via an online survey across twenty five Danish athletics clubs (Johansen et al. 2017). Coaches in this study reported that ignoring pain, reduced muscle strength and a high running distance were risk factors for RRI, demonstrating that coaches and runners had an awareness of factors that are known to lead to the development of RRI, however the study did not explore any preventive RRI strategies or attitudes towards RRI prevention by runners and coaches. A more recent study found that coaches and RLs believed that prehabilitation was important for runners, but lack of knowledge and confidence was a barrier to providing prehabilitation and RRI prevention information to runners (Linton and Valentin 2020). The authors also found that conflicting advice and resistance from runners were barriers to the uptake of injury prevention behaviours. These studies show that stakeholders within the sport of running such as coaches and RLs are aware of contributing factors to RRI and have an awareness of RRI prevention strategies. However, there are barriers to the offering appropriate RRI prevention and self-management information such as a lack of confidence, a lack of knowledge and conflicts of information between sources of information (Linton and Valentin 2020). Both these studies provide insights but perhaps lack more in-depth information and insights as to what can facilitate the uptake of RRI prevention and self-management strategies by runners, run coaches and RLs and what these stakeholders such as coaches and RLs would require to be able to confidently provide RRI knowledge and information. These studies highlight a potential need for education of coaches, RLs and runners regarding RRI prevention and self-management strategies, as well as a need to explore and understand the barriers to RRI prevention and self-management in the running community.

Any decisions and ideas that are implemented to runners via a running organisation will influence stakeholders within that organisation e.g. Run Leaders. Development of a proposed digital RRI prevention and self-management intervention would influence the stakeholders which include Run Wales RLs. It is argued that any developments that occur within an organisation must involve stakeholders in order to improve efficiency and the outcomes of any decision making processes (Marques Miragaia et al. 2014). As per the MRC framework (Skivington et al. 2021a), it is recommended that all stakeholders who may be affected by a proposed intervention should be included in its development, therefore the objectives of this study are:

1) Explore what advice is currently provided to recreational runners regarding RRIs and RRI prevention and self-management by RLs in Wales.
2) Explore what is currently available to runners and RLs via the Run Wales/ Welsh Athletics web site regarding RRI prevention advice.
3) Map stakeholders' views of potential benefits and barriers to the end-user (recreational runners) in a digital RRI prevention and self-management intervention.

8.3 Method

8.3.1 Study design

The design for this study was semi-structured one-to-one online interviews. It was thought that RLs may be more comfortable sharing their personal thoughts and feelings in one-one interviews as they were part of the NGB of Welsh Athletics (Guest et al. 2017). Online interviews were conducted due to the COVID restrictions which were implemented due to the pandemic which limited face to face contact (Welsh Government, 2021). Other advantages to the online method included participants not having to travel and keeping costs down. Semi-structured interviews allow for the researcher to have a list of questions or a topic guide to guide the interview but allows scope for the participant to raise issues that the researcher may not have considered (Clarke and Braun 2013). This approach also allowed more in depth exploration of the issues, allowed for follow up questions to be asked and allowed for clarification and more full responses than a structured interview or a survey method would (Bowling 2002). The online method was used due to COVID restrictions which were introduced in March 2020 limiting face to face contact. Interviews were semi-structured allowing the researcher to fully explore the issues being discussed.

8.3.2 Sampling and Recruitment

Purposive sampling was used to directly target the specific population of interest for this study. Purposive sampling involves targeting participants who can provide in-depth insights into the topic of interest (Clarke and Braun 2013). Purposive sampling is deliberate non-random way of sampling aiming to sample a group with a particular characteristics (Bowling 2002). In this case the target population were Run Leaders (RLs) accessible to the researcher via Run Wales. Run Wales is a pan-Wales organisation capturing all social running groups in Wales. Participants were all stakeholders at Run Wales who held the role of Run Leader.

The researcher contacted a Participation Officer (PO) from Run Wales who was a gatekeeper to the contact information of RLs in Wales. The PO is responsible for promoting and developing the social running programme of Run Wales, supporting the team and wider Development and Participation team across Wales (Run Wales, 2021). The PO disseminated an email with the details of the study to thirteen Run Champions across Wales so that the email could be disseminated to Run Leaders across Wales. The Run Wales web site states that Run Champions promote social running opportunities in their area and encourage individuals to sign up to running groups or to form running groups in the community, while also sharing their knowledge and experience of running (Become a Run Champion, 2017). Individuals who were interested in participating then self-selected themselves for the study by contacting KW directly via email. Once the potential participants contacted KW they were sent a PIS (Appendix 18) which outlined the aims of the study and reassured potential participants regarding anonymity and storage of data. Potential participants were also emailed a consent form (Appendix 19) to be completed and returned digitally to KW should they decide that they wanted to take part in the study. Once participants agreed to take part in the study and had returned their signed consent form via email, KW contacted participants to arrange a convenient time and date for the interview. Recruitment was determined by reaching saturation point (Hennink et al. 2019).

To be included in the study participants had to be over the age of eighteen and a current RL with Run Wales, leading runs of recreational runners or providing support and advice to run leaders who organize running sessions for recreational runners. Individuals who were not currently involved in leading running groups or facilitating groups as an RL were excluded from the study. Four participants were recruited and consented to take part in online interviews.

8.3.3 Interviews

An interview guide was developed for the interviews with an initial outline of the topics to be discussed (Clarke and Braun 2013). A topic guide (Table 28) was developed by KW to enable the interviews to remain close to the aims of the study but to allow exploration of any relevant points made by interviewees. The interview guide was discussed with the research supervisors prior to any interviews taking place. Pilot interviews were not performed due to limited scope for formal piloting, however after each interview the interview guide was reviewed to ensure that the data being collected addressed the research question (Clarke and Braun 2013). The interview schedule developed, and insights were taken from one interview to the next so that the interview technique evolved through the process.

Table 28 Topic guide for interviews with Run Leaders

Introduction 1. What is your current role in Run Wales? 2. What advice is currently given to recreational runners by Run Leaders? Where are they advised to go for this information? 3. As a run leader/run champion do you direct runners to any online sources of injury information?
4. What is currently available to the end user via the Run Wales/ Welsh Athletics web site regarding RRI prevention advice?
The Ideal Injury Prevention and Self-Management intervention 5. What does the interviewee feel would benefit the end user of an online RRI prevention programme? 6. How would the interviewee want to see an online prevention programme presented to end users? 7. Do you think it would be something recreational runners in Wales would use? 8. Do they see any barriers or problems?

Due to COVID-19 restrictions interviews were conducted online via the Zoom platform. The Zoom platform had previously been approved by Cardiff University for research data collection. For each interview KW organised a Zoom meeting which generated a unique Meeting ID number and a password. Prior to each interview participants were provided with the Meeting ID and password for their interview. This information was not shared with anyone else, and participants were asked not to share this information. At the start of each interview participants were admitted to a virtual waiting room, KW would then admit the participant to the meeting. KW confirmed this again prior to each interview. Prior to beginning each interview KW obtained verbal consent from each participant. KW gave an introduction at each interview: greeting each participant, thanking them for taking part, explaining the project and its purpose, giving the opportunity for each participant to decide whether they still wished to continue and to ask questions (Clarke and Braun 2013). All interviews were audio recorded via Zoom so that there was a precise record of each interview (Clarke and Braun 2013). Each participant was asked if they agreed to the interview being recorded (Bowling 2002). After the interviews were completed, each recording was saved as a file on KW's computer. Each interview file was stored on the computer under unique participant code on a password protected computer only accessible by the researcher (KW) .

Eight questions were asked, with the first question being an opener to enable the researcher and interviewer to develop a rapport and build trust with each participant (Clarke and Braun 2013). Following the initial interview, after the recording had stopped the interviewee brought up a point about runners having personal responsibility which was then incorporated as a potential additional question if it wasn't already raised by remaining interviewees.

Four participants took part in four interviews. Table 29 shows the length of each interview.

Table 29 Length of each participant interview

Run Leader	Length of interview
1	19 minutes
2	14 minutes 22 seconds
3	15 minutes 21 seconds
4	15 minutes 36 seconds

Once each interview was transcribed KW sent the transcript to each member for member checking. Member checking allows participants to ensure that their views were accurately represented in the transcription of the audio (Clarke and Braun 2013). It also enables participants to decide whether they want any information reacted or if they wish to withdraw their data from the study. Member checking can also be seen as a form of reliability as it aims to determine that the results are credible (Clarke and Braun 2013).

Participants were informed of the member checking process within the PIS and before and after each interview. To improve rigor further, a transcript was sent to a PhD colleague who agreed to read it and highlight any themes that KW may not have identified. Example of an interview transcript can be found in Appendix 24.

8.4 Data processing and analysis

On completion of each interview recordings were transcribed verbatim. Participants names were anonymised. Other identifying information of participants or other individuals mentioned in passing during the interviews were anonymised. By transcribing the interviews KW was able to start making initial notes and insights that evolved from the data set. The process of transcribing data yourself can lead to a closeness to the data that can jump start the analytical process (Castleberry and Nolen 2018).

8.5 Thematic analysis.

Thematic analysis (TA) was the method chosen for analysis of the data set. TA enables qualitative researchers to identify, analyse and report themes within a data set (Castleberry and Nolen 2018). The TA process used by KW has been described in greater detail in previous chapters (Chapter 6). The TA followed the same 'framework' of 1. Reading and familiarisation, 2. Coding across the data set, 3. Identification of potential themes, 4. Revision of themes, 5. Results.

Once initial notes had been made KW started initial coding. This involved identifying aspects of the data set that related to the aims of this study: establish the advice given to runners regarding RRI prevention and self-management by RLs, establish what is currently available to runners regarding RRI prevention and self-management via the Run Wales website and to map views of RLs as to what they think would benefit runners in Wales in a proposed digital RRI prevention and self-management intervention.

The coding approach involved identifying all instances of interest that related to the aims of the research question (Clarke and Braun 2013). Pre-existing knowledge of RRI prevention and self-management enabled KW to identify these instances and to apply them to the research question. Initial attempts were made at coding and subsequently KW went back through the data set to re-code and re-identify potential themes. Codes were developed and refined (Castleberry and Nolen 2018). The codes enabled identification of patterns within the data which could become candidate themes.

Themes were reviewed and then broadened. Subsequent review of themes resulted in creating a central organizing concept. Identified themes were named and given a definition to focus the boundary of each theme (Clarke and Braun 2013). Themes were distinctive but also worked together to answer the overall research question (Clarke and Braun 2013). Once themes and sub-themes were developed analysis was performed. This involved selecting extracts which illustrated the themes (Clarke and Braun 2013). TA continued to take place during this phase as KW found that some items did not truly fit into the narrative or definition of the themes and opted to remove them from the overall analysis or to merge extracts into a theme where they were a better 'fit'. Following this phase and to develop the discussion for this study, the themes were linked to the existing literature (Clarke and Braun 2013). The final analysis of the data set follows in the discussion section.

8.6 Results

Participants that took part in this study were all involved in running participation with Run Wales. Five Run Leaders who were active RLs contacted KW to say that they were interested in taking part in the study however only four participants were able to take part. One participant had agreed to participate but on follow up emails there was no further contact to arrange an interview date. The sampling pool of for participants in this study is relatively small therefore a sample of four to five participants was justified in this case, as there are a limited number of participants with the necessary characteristics for this study.

All participants were female and aged between thirty-five and fifty-nine. All participants resided in convergent areas of Wales: Rhondda Cynon Taf, Merthyr Tydfil, Neath Port Talbot and Denbighshire (Appendix 22). A table of participant demographics has not been included, due to the small pool of Run Leaders who were contacted, as it was felt that individuals who did not participate in this study could potentially identify the participants, therefore compromising the study and participant anonymity. The interviews were all held online between February and March 2021 while COVID restrictions were still in place.

Central themes were identified using thematic analysis. These themes will be explored in more detail in the results section. The themes are as follows:

1) Information provided by RLs,

2) Sources of information,

3) Proposed intervention,

4) Potential risks of the proposed intervention.

8.6.1 Stakeholder experience

Participants in this study were based across Wales: Wrexham, Merthyr, Rhondda Cynon Taf and Neath Port Talbot. All participants were RLs and had experience of leading social running groups. Two of the participants had a role in supporting existing and RLs. The identified themes will now be described in more detail with supporting stand out quotes.

8.6.2 Key Theme 1: Information provided by Run Leaders

Participants reported that they would provide runners with advice on doing exercises to support their running:

P1: 'doing strength training and about doing alternative training outside of running to make sure that you're prepared and you're strong and you're actually prepared for the actual running side'

If a runner approached an RL about an injury one RL described how they would provide basic information on stretches:

P4: 'if it's something like a pulled hamstring…. an ache in their calf and things like that I would go through all the stretches and things like that with them….'

One RL reported they would advise runners about trainers:

P1: 'And little things like um, as you're building up the mileage so looking at your trainers, I always advise half a size bigger'

RLs reported that they were limited in the information they could give to runners so would often signpost runners to qualified professionals:

P2: 'we always encourage….professional advice… we do signpost um to various bits and pieces……. but we always follow it up with please, please do see a professional'

P3: 'I'd always point them in the direction of the GP (general practitioner) or getting professional advice really because even although we're first aid trained by no means are we trained to give any advice.'

RLs were aware of the limitations to their RRI knowledge demonstrated and were wary about providing incorrect information:

P3: 'I always feel that you know you may have experienced it, but it doesn't necessarily mean you've got the knowledge of their particular problem and I think you could so easily do things wrong or give the wrong advice'

P3: 'ultimately I would always say get it checked out by someone professional personally just to cover our backs'.

8.6.3 Key Theme 2: Sources of Information

This theme explores the types of online advice that stakeholders would direct runners to if they were approached for advice on RRI prevention or management. Participants reported that they would use information gained form their LiRF qualification to advise on training and stretching:

P4: 'I did the Run Leader course there's really good um sort of advice on training and stretching on there so I would send them a link with that'

One participant reported directing runners to seminars run by Welsh Athletics and Run Wales:

P3: 'I think there's a few webinars they've out on about well-being and just general how to keep healthy and strong……….a strength and conditioning one…….. a self-management one as well as you know an injury management one'

However, another participant reported that this information wasn't always available via Run Wales' web site:

P2: 'I don't think there's anything at the moment.....I don't think there's anywhere at the moment. There might be on Welsh Athletics, but Run Wales hasn't no.'

Two participants stated that they would use google but were aware of its limitations.

P3: 'I google and obviously that can lead you down some interesting paths can't it of self-diagnosis.'

Running magazine websites were deemed as acceptable sources of online information but with the caveats that they would not specifically tell runners to go to those websites in case the information provided to the runner was incorrect for their situation.

P1: ' things that are on like the Runners World website, the Trail Running Magazine website, um those sorts of things where they're reliable sources I would sort of send them to there first……. I wouldn't endorse something specifically.

8.6.4 Key Theme 3: Proposed Intervention

Participants described the content that they felt would be most beneficial in the proposed intervention. Participants felt that there should be educational content which advised runners on the best exercises to aid strengthening for running and to aid prevention of RRIs.

P1: '….so having the prevention side but also if you feel a few niggles what can you do?..... what exercises you can do to help with that'

P3: 'I think it would be really good if we could have …… what sort of strength exercises they should be doing, pre couch to 5k even um just so they get in their heads that stretching and strength is all a part of running'

Participants also wanted to see education about the importance of exercises.

P2: 'I think educating is probably more key to it…….. if I know that doing this exercise is going to prevent me from hurting later on then yeah it sort of clicks in then doesn't it?'

They also wanted to see advice on nutrition:

P2: 'I think if we could have bits of information you know like a nutrition side that said right your muscles are going to feel better if you eat or drink like this'

Participants wanted to see advice that was specific to the novice population. This could reflect their experiences as Run Wales RLs as they would be most likely to be coaching and leading novice runners on beginner running programmes.

P3: 'you've got to kind of make it something for the new runners so something almost like a couch to 5k app but it's a running fitness app or with couch to 5k they've got built in…… on the days they're not running they'll be doing some exercises around it'

It was important for participants that any intervention would contain trustworthy information but that it would also highlight to a runner when they needed more advice and a method of signposting to medical intervention:

P1: 'Yeah again you know I think it's useful as long as you know then you say if you've been experiencing this for a long time you need to go and see your GP.'

P4: 'almost a tick box even to point them in the right direction….. So if you're not sure….they've got this injury advice line….. it's going to tell you what sort of thing you should be doing , if it's just rest or you're going to seek medical advice.

Regarding format and presentation participants were in favour of smartphone apps. This was for reasons including ease of access, being able to access the platform anywhere and for the fact that many runners are already using apps such as Couch to 5k.

P2: 'I think if you could do some sort of like maybe online learning which could be done through an app'

P3: 'The apps seem to go well, the girls really like the couch to 5k apps or anything that's an easy to click onto, easy to follow and easy to almost click that you've done it as well, you've got that progress that you can see you're making.'

Two of the participants were in favour of videos to present information alongside written content to aid understanding of the video content. Websites were seen as a possible barrier that might prevent runners from using the intervention.

P1: '….videos are a really good way of seeing an exercise in action rather than written word….. Yeah I think videos would be the way to go.'

P1: 'I think as long as it's clear and it's like you said it's video based rather than word based and practical and easy to navigate and just really straight forward'

8.6.5 Key Theme: Potential Risks of The Intervention

The main issues that participants foresaw with the proposed digital intervention is that misinterpretation of the presented information could occur:

P2: 'people do misinterpret information like this stuff so, but that would be the only worry that someone's looking at a shin injury when it's probably their other arm or….LAUGHS…'

P1: 'I think it would be useful as long as there's like a disclaimer saying you know you undertake this as your own decision basically.'

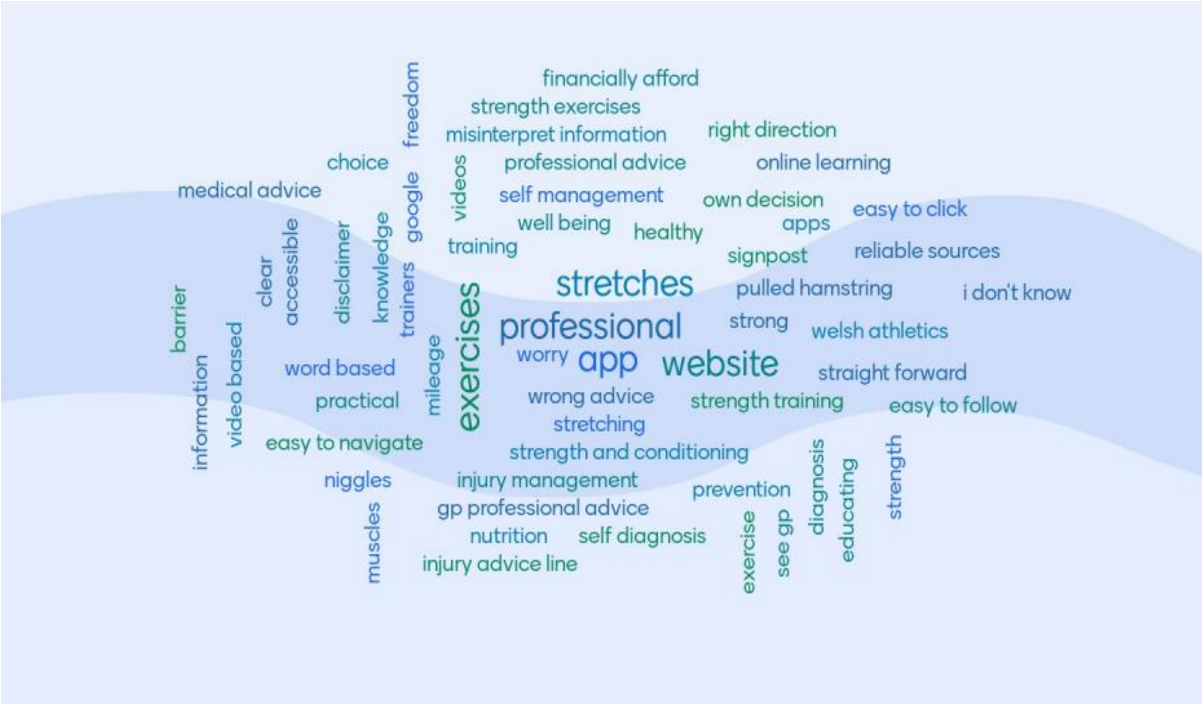
P3: 'the…. Problem…. when you put an app out there you've got no kind of….idea of who's accessing it, no idea of what their fitness level….. need to kind of gauge where they're at to make sure it's the right starting block for them, or you make it completely accessible to all, I don't know…..how that would work'

The second issue was that participants felt that the intervention itself could introduce barriers to the uptake of information. These barriers were in the form of too much choice which would result in confusion over what advice to follow, that exercises would take time that would make runners ambivalent towards using the app or financial barriers if runners had to pay for the intervention.

P3: 'if you give them too much kind of choice and freedom and they're like ooh I don't know what to do'

P4: 'you also have to think about financially can these women afford'

P3: 'Web sites will dip in and out of but again it's another barrier, if you've got to go onto a website every day or you know once a week to look at what you're doing'



<u>Figure 15 Word cloud representing qualitative data collected regarding participants views on the proposed intervention</u>

8.7 Discussion

The aims of this study were to explore the views of RLs with Run Wales on the RRI prevention and self-management information RLs provide to runners in Wales, their sources of RRI prevention and self-management information and their views on a proposed digital RRI prevention and self-management intervention. Following interviews with 4 participants the data was thematically analysed and key themes identified. These themes were 1) information provided to runners, 2) sources of information, 3) the proposed intervention and 4) potential risks of the proposed intervention. Figure 15 is a word cloud representing participants views on the proposed intervention.

8.7.1 Information provided to runners.

Participants described the type of advice that they might provide to recreational runners to support them in their running. This included promotion of exercises and cross training, advice on trainers and basic injury advice. The advice being provided by participants in this study is reflected in the literature. Previous research has found that coaches and running leaders see strength exercises as important for RRI prevention (Johansen et al. 2017, Linton and Valentin 2020). The responses of RLs in this study are also reflected by findings from previous studies in this thesis (Chapter 6 and Chapter 7) where both recreational runners and practitioners describe exercises as a way to prevent and self-manage RRI. As already discussed elsewhere in this thesis, strength training has been shown to have a beneficial effect on the prevention of sports injuries (Lauersen et al. 2014a; Lauersen et al. 2018), which is promising for promising for recreational runners and stakeholders who support them. Therefore, in the development of an RRI prevention and management intervention it would be logical to include some guidance on appropriate strength exercises for runners.

Participants reported that they provided runners in their groups with advice on stretching. This finding is similar to previous studies which have found that coaches and RLs will advise stretching as an RRI prevention strategy and will instruct stretches as part of their running sessions (Linton and Valentin 2020). The benefit of stretching for sports injury prevention has been questioned with systematic reviews finding that that stretching was not superior to strength training in the prevention of sports injuries (Lauersen et al. 2014a; Lauersen et al. 2018). Generally, the advice given is in line with UKA (United Kingdom Athletics) LiRF course describing flexibility/stretches as being beneficial for injury prevention. However, it is not clear from the materials what evidence this information was based on.

As evidenced from the responses of RLs in the current study and those of recreational runners in Chapters 5 and 6, the running community (runners, coaches and RLs) continue to recommend stretching as being an RRI prevention strategy. Linton and Valentin (2020) recommended further research as to why runners, coaches and RLs perceive stretching as the most beneficial injury prevention and management strategy. It may be that RLs provide this information as it is provided within the educational materials that for the LiRF course which is provided by the NGB of Welsh Athletics. It could also be argued that stretches are not inherently harmful to runners and may still have a beneficial effect to maintaining ROM and mobility, therefore any future RRI prevention and management intervention could still consider including advice on safe stretching. The findings of the current study and of previous research support the argument that RLs could benefit from an evidence-based resource to direct recreational runners towards when they are looking for information on prevention and management of RRI.

Other types of information provided by RLs to runners in the current study included information regarding running shoes. It has previously been found that RLs and runners regard footwear as having an impact on injury prevention and the development of RRI (Saragiotto et al. 2014b; Wilke et al. 2019; Hofstede et al. 2020; Linton and Valentin 2020). RLs and running coaches have been found to provide advice on footwear as a way to prevent RRI (Linton and Valentin 2020) which reflects the opinions of participants in the current study. However, it should be noted that the belief that running shoes have an influence on prevention and development of RRI is not consistently demonstrated in literature (Nielsen et al. 2014a; Malisoux and Theisen 2020).

Overall, advice given by RLs in the current study is mixed in terms of whether it is supported by evidence or based purely on anecdote and personal experiences of the RLs. Some of the advice provided, such as that around shoes and stretching is based on personal experience, simplistic and not based on scientific evidence. This is where a resource such as a digital intervention could benefit RLs as they would be able to direct runners to a resource that such could provide appropriate RRI prevention and management advice.

Participants were clear that if runners approached them for advice that they would signpost them towards HCPs, acknowledging that they were not in a place to give qualified advice. This signposting approach is like that of running coaches and RLs in Linton and Valentin's (2020) study. They found that coaches and RLs regarded HCPs as being the most reliable source of RRI prevention and management advice. In the current study there appeared to be some conflicts in the responses that participants gave, in that they were happy to give advice based on their own experience e.g. with respect to the benefits of cross training and the benefits of having suitable trainers, however they were clear that they were limited in the advice that they could provide. It may be that RLs are happy to provide non-specific, generalised advice with regards to basic training and the basic requirements of running but draw a line when runners in their groups ask for more specific RRI prevention and management advice. Based on the results from the current study, RLs would benefit from the proposed intervention as an information resource that they could confidently signpost runners to.

There were common themes about fears of giving out the wrong advice to runners and concerns that the dissemination of what could be incorrect advice could lead to legal ramifications for themselves as individuals and for Run Wales. These fears may have some foundation within sports coaching and it has been reported that coaches are concerned about the prospects of legal liability in relation to negligence and sports-related injuries (Partington 2017). Fears around legal liability and the reliability of the information they are giving and provided with have the potential to limit information on RRI being provided to runners in running groups. Limitations in the advice that participants in the current study were prepared to give could be due to the education that new RLs receive on the UK athletics LiRF course. New RLs attending this course are given basic information on sprains, strains, pain along the shin, tight calf muscles and pain in the Achilles tendon (British Athletics, 2019). Attendees on the LiRF course are also taught that causes of RRI include poor footwear, poor running style, doing too much too soon, not being strong enough for the running activity, not enough rest between sessions and returning too soon after a running injury (British Athletics, 2019). Some of this advice is informed by evidence and some of it is not. To reduce fears of litigation and of causing potential harm via providing incorrect information, RLs would benefit from a trustworthy, evidence-based intervention which they could direct runners to who are requesting RRI prevention and management information.

8.7.2 Sources of information

The main sources of online information used by participants in this study for advice on RRI prevention and self-management were Run Wales, Google and web sites. As discussed previously with regards to the content of the LiRF course and the responses of participants, there appears to be a gap in good quality, evidence-based information that RLs are able to provide to runners regarding RRI prevention and self-management. Therefore, an intervention or that could utilise and allow easy access to existing Run Wales educational webinars while also providing a resource of educational RRI prevention and self-management information could be a great benefit to RLs and runners.

Participants cited Google as a potential source of online information that they would use. However, they acknowledged its limitations as a source of advice. Participants also named specific websites related to running that they would use themselves or possibly direct runners to for information on injuries. The Runners World website was referenced by two of the participants as a site they would find useful. Online media has previously been cited as being used by runners to glean RRI information for prevention and self-management (Petersen et al. 2022). There have been studies which have looked at the reliability of advice on web sites following when using internet search engines (Impicciatore et al. 1997; Scullard et al. 2010) . One study examined the reliability of advice given and out of 500 sites almost half failed to answer the question and 39% gave the correct information with government websites being found to be the most reliable. (Scullard et al. 2010). Reliability of advice sourced from the internet is therefore questionable and the advice given on one topic can be variable. In relation to sports injury prevention, smart phone apps have been found to be lacking in the amount of scientific information contained within them with only four out of 18 apps matched with scientific evidence (van Mechelen et al. 2014). Linton and Valentin (2020) reported that RLs and coaches deemed web sites to be less reliable than information provided by HCPs. Therefore, there is a need for digital RRI interventions, whether they are web-based or app-based, to be informed by the evidence base and expert opinion, so that RLs can direct runners to an intervention they know is reliable and trustworthy.

8.7.3 Proposed Intervention

Participants were asked for their views on the proposed digital intervention: the content that they felt would benefit runners, how they saw such an intervention being presented to users and if it was something they thought runners would use. Participants felt that the proposed intervention should be educational and include advice on exercises, injuries, training, and advice specifically for novice runners. Participants felt that the intervention should be trustworthy with the ability to signpost runners to HCPs when necessary. Participants also described the preferred format of the intervention and how content should be presented.

Participants saw the intervention as an educational tool for runners. A lack of knowledge among coaches and Run Leaders regarding prehabilitation for RRI has been cited as a barrier to providing information regarding strength exercises to runners (Linton and Valentin 2020). This lack of knowledge from coaches and RLs could potentially lead to a wider lack of confidence regarding strength exercises as a strategy for RRI prevention among runners. Therefore, if runners, coaches and RLs can be provided with an educational tool regarding the benefits of strength training for RRI prevention and the type of exercises that can be performed, it can be argued that this increase in knowledge will lead to an increase in confidence and self-efficacy for performing strength training and thus lead to a change in behaviour that is towards active RRI prevention.

An educational resource could also help to dispel myths and misconceptions surrounding RRI prevention and management. In the current study participants refer to advising stretches and performing stretches as being an RRI injury prevention strategy. Previous studies have also found strong beliefs among the running community that stretches are an important part of RRI prevention (Saragiotto et al. 2014b; Fokkema et al. 2019b; Linton and Valentin 2020). Again, as discussed there is no strong evidence for stretching as being an effective strategy in the prevention of sports injuries (Lauersen et al. 2014; Lauersen et al. 2018). Educational materials provided by governing bodies still advise new coaches and run leaders to advise stretching as a means of RRI prevention. Therefore, it is argued that an evidence-based educational resource or intervention could have the potential to dispel these commonly held opinions in the running community and via the dissemination of knowledge, create behaviour change towards more evidence-based forms of RRI prevention and management.

Participants in this study felt that content on any proposed digital intervention should be tailored towards the novice population of recreational runners. This is in line with other literature recognising that novice runners may have less experience and are more likely to become injured (Videbaek et al. 2015). It has also been found that the duration of RRI is longer in novice runners when compared with more experienced runners (Nielsen et al. 2014c; Fokkema et al. 2019a). High levels of absenteeism and utilisation of health care was found among runners on a 'Start To Run' programme, prompting authors to recommend that beginner running programmes should also pay attention to prevention and treatment of injuries (Smits et al. 2016b). It is argued that for RLs who regularly come into contact with novice runners during beginner running programmes such as Couch to 5k, an intervention that contains educational content specifically for novice runners could be an enhancement for those who are beginning to run, help them to prevent RRI and to self-manage if they develop an RRI.

In keeping with previous parts of this thesis, it was important to RLs in this study that content of the proposed intervention was trustworthy and reliable and that would have the ability to signpost runners to seek face-to-face medical assistance if required. The reliability of information online and via smartphone apps has been found to be questionable with one study finding that none of the apps that claimed to be RRI prevention apps were based on scientific evidence. (van Mechelen et al. 2014). The development of content for any digital RRI prevention and self-management intervention needs to be grounded evidence-based information, along with the consensus of expert knowledge. This approach has been used previously in the development of a tennis injury intervention (Pas et al. 2018) using the Knowledge Transfer Scheme (KTS) framework (Verhagen et al. 2014a). The KTS involves a five-step process in the development of an intervention. A problem is identified, evidence is synthesised and a knowledge transfer group is developed consisting of researchers, practitioners and stakeholders to translate the evidence into practical actions and contribute more information which can then be used to develop the product which can subsequently be evaluated (Verhagen et al. 2014a). The MRC framework, which is the framework being used for this thesis, involves synthesis of the evidence alongside involvement of stakeholders and end users (Skivington et al. 2021a). By developing an intervention in such a way, it enhances the trustworthiness of an intervention which would subsequently lead to stakeholders such as RLs feeling that they can reliably recommend the intervention to their social group runners.

Participants were keen that any proposed intervention for recreational runners should have the ability to indicate to runners when they need to seek face-to-face qualified medical assistance. This finding is supported by the findings of previous studies in this thesis (Chapter 6 and Chapter 7) where both runners and practitioners felt that any intervention should have the ability to signpost runners to HCPs when necessary. Previous research has also found that coaches and RLs see advice from HCPs superior to that of any information found online (Linton and Valentin 2020). One participant in the current study suggested that it would be helpful to runners to have an alert system to let them know when they needed to adjust their training schedule or introduce RRI prevention strategies. Participants wanted a form of medical back up to indicate to users when they should seek medical advice rather than depending on a digital intervention. There is also the potential concern that a more serious health conditions could be missed by a digital intervention or that an individual inputs incorrect information into the intervention so that the wrong information is given. To avoid such scenarios a signpost and alert system within an RRI prevention and self-management intervention, as suggested by participants in this study, would help to avoid near misses and direct runners to appropriate advice from HCPs. There are obviously legitimate concerns that an intervention could result in exacerbation of an existing RRI, under-diagnosis and over-diagnosis, therefore in the development of a digital RRI prevention and management intervention, developers should be aware of potential for negative outcomes, and to work towards an intervention that minimises harm as far as is possible (Parker et al. 2017).

Run Leaders suggested that the intervention could provide specific advice on injuries, exercises or whether to see a GP or other HCP based on information that was given to the intervention by the runner. There could be potential for Artificial Intelligence (AI) or machine learning within the proposed intervention to enable it to provide the functions described by Run Leaders here. Within sport there is already a precedent set for machine learning and AI within game analysis, outcome predictions, tactics and performance analysis (Van Eetvelde et al 2021). A key component of predicting injuries and preventing them is to understand injury risk factors and how they interplay. Running injuries are as a result of the interplay of multiple risk factors and inciting events which means any AI intervention requires a comprehensive model (Bahr and Krosshaug 2005). There is potential for AI/machine learning within a digital intervention to predict RRI and identify exercises that would benefit an individual runner, but any algorithm would need to learn the relationship between whether an injury developed or not and the possible contributing factors to RRI e.g. training load, previous injury, running experience (Van Eetvelde et al 2021). The idea of the proposed intervention being able to predict/diagnose RRI and provide appropriate advice/exercises was also described by recreational runners in the focus group study (Chapter 6). However, in contrast to these findings, practitioners who took part in the focus groups in Chapter 7 were not in favour of the proposed intervention diagnosing or predicting RRI. Therefore, this aspect of any future intervention will need further data collection and assessment to establish whether there truly is scope for AI in iterations of the intervention.

With regards to the platform that participants wanted to see RRI prevention and self-management information presented on, they were in favour of a smartphone app over a web site. The widespread use of smartphone technology means that new ways of communicating and searching for health information has been developed (Bailey et al.2014). It has been reported that 95% of households in the UK own a mobile telephone (O'Dea, 2022). With this level of mobile phone ownership, it would be possible to connect to a high proportion of runners via a smartphone app as the preferred method of communication. However previous research has found that there is a divide between different communities regarding mobile phone use. Mobile phone ownership in the UK is reported to stand at 95% of adult users (Statista 2022). Despite the increase in mobile phone usage, internet and 4G mobile coverage is still reported to be limited in the UK's rural areas when compared with urban areas (Baker and Hutton 2022). The development of any digital RRI intervention, whether it is app based or web based, will need to consider inequalities on internet coverage between rural and urban areas so that inequalities of access to RRI prevention and self-management information do not occur.

Participants wanted the format and presentation of a proposed digital intervention to be easy to use. Participants showed concern that if an intervention wasn't easily accessible or navigable that this would create a barrier to the use of the intervention. Participants also wanted the information to be directly relevant and to not have to read through information on other injuries and issues. A lack of ease of use in a digital intervention could be a potential barrier in its use and would therefore hinder the communication and uptake of reliable RRI prevention and self-management information by runners. Therefore, in the development of any digital intervention, ease of use and accessibility to the necessary platform needs to be considered, alongside the most optimal way for the content to be presented to runners.

Participants were in favour of video-based content as can be seen from the extracts below. Participants also felt that videos on specific topics of RRI prevention and self-management e.g. warm-up would be beneficial to runners. Like the participants in the current study, previous research has found that digital interventions which include video based content is an acceptable method of delivering rehabilitation alongside face to face physiotherapy (Dunphy et al. 2017; van Reijen et al. 2018) with app based content inclusive of videos coming out more favourably than written content (van Reijen et al. 2018) . In the study by Dunphy et al. (2017) participants wanted to see improved usability in the way exercises were described, suggesting that videos with additional written content would enhance the usability. This is in contrast with some participants in the current study who felt that video content would be understood better than written content, however in the future development of any digital intervention for RRI prevention and self-management both types of content need to be assessed for their usability. Therefore, further studies on acceptability and feasibility of a developing digital RRI intervention need to be performed to establish the optimal mode of communicating such information to runners and those with additional needs to communication.

8.7.4 Potential risks of the proposed intervention

Participants were asked what they felt could be potential risks of the proposed intervention. Participants expressed concerns that there may be misinterpretation of the information provided by the proposed intervention which could then have consequences. There were also concerns runners could potentially use information that is not appropriate for their situation. As highlighted above in this section the development of any RRI intervention should aim to minimise concerns around misinterpretation and potential for harm (Parker et al. 2017). Participants highlighted several other issues with the proposed intervention such as time and cost. They were also concerned that runners would have 'too much choice and freedom' resulting in runners not being sure how to use the intervention.

As discussed previously there may be some foundation to their fears of litigation following dissemination of information. It is noted that as digital healthcare and Mobile Health apps have developed that health professionals, app developers and those who recommend an app would want legal guidance regrading legal compliance and the avoidance of litigation (Yang and Silverman 2014). There are justified fears surrounding the use of a health app such as a loss of personal privacy and details and exacerbation of symptoms due to under-diagnosis or over-diagnosis (Parker et al. 2017). When developing a health care app, those involved need to be aware of the potential risks such as those that have been discussed and the negative outcomes whether these are commercial, technical or health related (Parker et al. 2017). Therefore in the development of any digital intervention, developers needs to be aware of current legislative guidance and any industry self-regulatory codes and policies so that legal and industry standards are adhered to and consumers and end-users are protected (Parker et al. 2017). There would also be the added benefit of providing RLs with an intervention that uses trusted sources, thereby improving their confidence in providing RRI prevention and self-management information runners.

The issues raised above will all have an impact on acceptance of the proposed intervention and intrinsic motivation to use the intervention. If potential users of a digital intervention are time limited due to lifestyle, family, and work commitments then they may perceive any time requirements from an intervention as being a barrier and will therefore be less accepting of the intervention. For an intervention to be adopted there needs to be perceived ease of use with the intervention being perceived as requiring very little effort (Venkatesh and Bala 2008).There are also tenets which contribute to the perceived ease of use of an intervention such as computer anxiety, computer self-efficacy and computer playfulness and objective usefulness as described within the TAM3 model (Figure 13 page 168). If there is a high perceived ease of use then the proposed intervention is more likely to be adopted.

Concerns regarding time and potential confusions over the content of the proposed RRI intervention can be seen to be participants' perceptions of the ease of use of the technology, particularly with regard to computer self-efficacy and objective usefulness of the intervention (Venkatesh and Bala 2008). This has the potential to negatively impact their attitude towards the intervention which would then their intention to use the intervention is less likely. The development of any RRI digital intervention will have to consider how to eliminate the potential barriers as far as is possible so that intention to use the intervention by runners is enhances via increasing the enhancing the PU and PEU of the technology.

With regards to cost as a barrier, it highlights another unintended consequence regarding potential inequalities created by the intervention (Brewer et al. 2020). The intervention could create differences for those who do not have resources e.g. access to equipment, access to a gym, access to adequate space to perform exercises. When designing new digital interventions there needs to be an awareness and understanding of the challenges faced by disadvantaged groups such as those in deprived socioeconomic areas.

8.8 Limitations

The main limitation of this study is the small number of participants. There was a very small response to the recruitment email sent out via Run Wales to Run Leaders. The interviews were all held online between February and March 2021 while COVID restrictions were still in place therefore it may be that people were starting to experience the phenomenon of 'Zoom fatigue' (Nesher et al. 2021). All work interaction and family interactions were still taking place largely in the online space via platforms such as Zoom, and it may be that people were reluctant to take part in another activity that required them to take part online.

Saturation point was reached based on participants largely repeating very similar content and knowledge of RRI prevention and management. Therefore, it was deemed that more participants would not provide additional insights. The findings of this study are also limited to this subset of Run Leaders from Run Wales and cannot be generalised to the wider population of Run Leaders across Wales and the UK. Participants were all from Run Wales and had all completed the LiRF course so views on RRI prevention and self-management may have been limited to the views that are widely shared among the Run Wales organisation.

Future research could include a wider population of Run Leaders from across the UK and also incorporate the views of running coaches from clubs. A focus group format could be used to encourage rapport from a group and gain a wider range of opinions via a larger discussion. For the further development of the proposed digital RRI prevention and self-management intervention, the findings of this study need to be considered as participants in this study are stakeholders and therefore have the potential to be impacted and influenced by any future intervention.

8.9 Conclusion

As stakeholders RLs have a role to play in the development of a proposed digital RRI prevention and self-management programme. Currently RLs in Wales are providing some limited advice to recreational runners in Wales but ultimately advise runners to seek qualified advice for the diagnosis and treatment of any RRI. RLs felt that a digital RRI prevention and self-management intervention in the form of a smartphone intervention would be useful to runner in Wales and RLs overwhelmingly welcomed the idea of a proposed digital RRI intervention. RLs saw the intervention as being an educational resource primarily for novice runners while also providing advice on exercises to help runners become stronger and to prevent injuries. Unintended consequences foreseen by RLs in this study centred around possible misinterpretation of information which led participants to call for a function within the intervention to be able to signpost and alert to runners when they should seek face-to-face advice. RLs also highlighted barriers to use of the intervention such as time and cost. The development of any digital RRI prevention and self-management intervention needs to ensure that inequalities in health are not compounded and that access to reliable, evidence based RRI prevention and self-management information is available to all runners of all socioeconomic backgrounds in Wales. The next chapter will now discuss all the findings of this chapter and previous chapters and how they affect the development of the proposed digital RRI prevention and self-management intervention.

Chapter 9: Overall of discussion of findings and Conclusion

The main aim of this thesis was to develop the content of a proposed digital RRI prevention and self-management intervention using the MRC framework for the development and evaluation of complex interventions (Craig et al. 2008) with the thesis focussing on the development phase of the framework. This study aimed to fully engage with all relevant stakeholders (runners, clinicians and NGBs) as the first stage towards development of a digital personalised RRI prevention and self-management intervention for recreational runners.

In accordance with the recently updated MRC complex intervention development framework (Skivington et al. 2021b). The objectives of the study were as follows:

1. Conduct a scoping review to evaluate the randomised controlled trials which develop and evaluate current digital RRI prevention and self-management platforms available to runners.
2. Map the experiences and current RRI prevention and self-management strategies used by recreational runners together with their use of digital technology in their running practices.
3. Explore the views of recreational runners regarding the content and possible platforms for a proposed RRI prevention and self-management intervention, using the findings to establish approaches to inform development of the digital intervention.
4. Explore the views of other stakeholders (e.g. health practitioners, coaches and Run Leaders from the National Governing Body (NGB) of Welsh Athletics) regarding the content and possible platforms for a proposed digital RRI prevention and management intervention, using these findings to help develop the approaches that should be used in development of the intervention.

A mixed methods approach was adopted to evaluate current evidence for digital RRI prevention and self-management interventions and to establish the views of all potential stakeholders (runners, health practitioners and Run Leaders who may be targeted by any future digital intervention for the prevention and self-management of RRI. The objectives were divided into Phases as follows which were described in Chapter 1 and depicted in Figure 1 (page 4). A summary of the findings of each chapter will now be given.

9.1 Summary of the findings

9.1.1 Phase 1: Scoping review

The first phase of this project was a scoping review of evidence relating to online programmes for the prevention and management of RRI. The main aim was to 'Identify current evidence for digital RRI prevention and self-management interventions for recreational runners'.

The main findings were that while there are currently some available online interventions for the prevention of RRI among recreational runners, they vary widely in study design, quality and the theoretical basis. There were differences in how the interventions were developed, with only one study using a developmental framework and other studies using the most up to date scientific evidence. The delivery of the interventions also varied between studies as well as the definitions of RRI and recreational runner. This resulted in a large amount of heterogeneity between the studies. The scoping review also revealed that there were no online interventions directly referring to self-management of RRI developed for recreational runners. During the searches there were digital online self-management interventions for specific musculoskeletal conditions identified but the studies did not fit the inclusion and exclusion criteria set out in the review, so they were not included. Again, this emphasizes the gap for a digital online prevention AND self-management intervention for recreational runners.

There is no concrete evidence as yet for the effectiveness of online RRI prevention programmes for recreational runners. The studies included focused on online interventions to prevent RRIs in recreational runners. There was no agreement found between the studies as to whether the online interventions prevented RRI and/or reduced the incidence of RRI or if they led to runners adopting preventive behaviours for RRI. The interventions in the 4 studies reviewed varied greatly. The main mechanism behind the interventions was behaviour change, educating runners so that they would adopt behaviours that would prevent RRI (Adriaensens *et al.* 2014, Hespanhol, van Mechelen and Verhagen, 2018, Fokkema *et al.* 2019, Hollman *et al.* 2019)

Interventions included in the scoping review used best evidence in terms of training behaviours for preventing RRI and mitigation of potential risk factors. However, none of the studies, except for one, used an intervention development model in the form of the Knowledge Transfer Scheme (KTS) which requires a review of the evidence and involvement of stakeholders in a Knowledge Transfer Group. Whilst three of the interventions combined evidence and practice based knowledge, it is argued that a gap still exists in the research for the development of a digital RRI prevention and self-management intervention for recreational runners, which uses a systematic developmental and evaluation framework involving all stakeholders who are directly affected by the proposed intervention. Following this scoping review, it was concluded that any digital RRI prevention and self-management intervention needs to be developed using the best available evidence relating to the prevention and management of RRI in recreational runners. It also needs a study of the population involved, in the form of a quantitative survey, as well as in-depth qualitative research with all stakeholders (runners, health practitioners, and those representing the NGB), reflecting a mixed methods approach.

9.1.2 Phase 2: Exploring the Views of Recreational runners regarding RRI prevention and self-management.

This aim of this phase was to explore how runners currently incorporate digital technology into their running training, RRI prevention and management and to map runners' views on the content of a proposed digital RRI prevention and self-management intervention. A secondary aim was to identify how recreational runners in Wales currently prevent and manage RRI.

9.1.2.1 Part 1 Quantitative survey with recreational runners

The first part of this phase involved an online survey which was sent out to runners throughout Wales. The survey mapped the use of digital platforms and smartphone apps by recreational runners in Wales and their views on running injury prevention, self-management and a proposed ‘Ideal RRI prevention and self-management’ app.

A total of two hundred and thirty-two (232) male and female runners completed the survey from across Wales. Findings of the survey were analysed to make inferences about runners ‘use of digital technology. Most of those runners surveyed monitored their training, with most runners using a GPS watch or smartphone app to do so. Runners with 3 months to 2 years running experience were found to be using more apps to monitor training than runners with under 3 months experience and those with more than 2 years’ experience. . This could indicate that novice runners are testing out apps initially to identify what works for them within a digital platform. It may also be the case that novice runners only start to use apps when they feel they have been running long enough and aim to continue running. This could also be due to novice runners not wanting to invest in apps or other technology until they feel they have been running long enough to justify the expense or time investment. Runners in this survey did not report using digital technology to prevent or manage their injuries. Monitoring training characteristics provided by running smartphone apps, such as volume and rest could be argued to be forms of RRI prevention, especially when it has been reported that 60% of RRIs are due to training error (Hreljac 2004b).

The current study suggests that runners in Wales do not actively use technology to prevent and manage RRI via the monitoring of training volume and rest days, but it could be that they do not make the link between these functions on their technology, instead using the technology and statistics for motivation via competition and goal setting, which is reflected in the survey findings. This demonstrates a potential educational/information dissemination gap that could be filled with a well-developed digital intervention that could educate recreational runners in how monitoring training and rest can help prevent and manage RRI.

Online resources that runners found most useful for RRI prevention and self-management information were NHS sites, online videos and physiotherapy web sites. Runners aged 35-44, running less than 10 miles a week were more likely to find these online resources useful. These findings give some insight as to who future interventions should be targeting or how information within the proposed intervention needs to be tailored.

Survey participants were in favour of a proposed digital RRI prevention and self-management intervention with no statistical differences found between sub-groups. This great interest across sub-groups of runners could be due to current technologies only taking account of tracking of training data and little attention to RRI prevention and management.

The type of information that runners wanted to see included RRI prevention information, exercise content for resilient running and a self-diagnosis tool to help them identify what injury they may have. However, inferential analysis did not identify any strong associations between sub-groups of runners and the content that they wanted to see within the proposed intervention. Survey participants also wanted this information to be presented within the intervention by HCPs and for the information to be evidence based.

Alongside their wide use of digital technology and their positive response to the idea of a digital RRI prevention and self-management intervention, it can be concluded that runners in Wales were in favour of a proposed RRI prevention and self-management intervention. There were also some indications from this survey as to how the proposed intervention should be tailored and the type of technology that should be implemented. To explore these findings further to establish the content and platform for a proposed digital RRI prevention and self-management intervention, the next part of this phase focused on gathering more in-depth understanding of the approaches currently used by runners regarding RRI prevention and self-management and their views on the proposed intervention via qualitative focus groups.

9.1.2.2 Part 2: Qualitative focus groups with recreational runners

The aim of this study was to map the views of recreational runners in Wales in relation to RRI prevention and self-management and gain runners' views and opinions on what should be included (or omitted) in a proposed digital RRI prevention and self-management intervention and identify what runners perceive to be barriers to the use of such an intervention. Following thematic analysis of the data set, the themes identified were as follows:

1) A Smart Intervention

2) Information is Key
3) Inspiring Behaviour Change
4) Perceived problems

Focus group participants indicated that they wanted the proposed intervention to be a 'smart intervention' with many in favour of the intervention being in the form of a smartphone application. Smartphone apps were seen as favourable due to the ease of access and the potential for the intervention to connect to other apps such as Garmin and Strava. Accessibility was important to runners. This was interpreted in two ways: to be able to access the intervention anywhere but for the content within the intervention to be easily understood. Runners wanted the app to have the ability to tailor information towards their individual requirements or current injury situation. Runners wanted the proposed intervention to be able to make an RRI diagnosis while also having the capability to advise runners to seek face to face health advice if the intervention deemed it necessary. This would be dependent on information entered by runners which would then be interpreted by the intervention.

Runners saw the intervention as an educational resource that could provide practical content around training and recovery e.g. video content of exercises for prevention and rehabilitation of RRI. This desire for knowledge and education could relate to runners' self-efficacy regarding their knowledge around the topics of RRI prevention and self-management. Education and practical knowledge via the intervention has the potential to enhance runners' self-efficacy in these areas, leading to greater autonomy in performing RRI prevention and self-management behaviours. Greater knowledge and education would also lead to a greater intention and adherence for these behaviours.

Trustworthiness of information was important to runners with runners expressing mistrust of currently available online sources, with concerns that the information could be incorrect and cause harm. Runners wanted information within the proposed intervention to be evidence based and endorsed by experts such as HCPs. By asking for an evidence-based resource, runners are demonstrating a desire for RRI information that is reliable, appropriate and safe. Providing trustworthy, evidence-based information could have an impact on the potential barriers to performing RRI prevention and self-management behaviours e.g., lack of time, low self-efficacy and adherence.

The findings from focus groups with runners indicated that the intervention should be embedded in behaviour change theories. The proposed intervention could facilitate adherence and habit formation towards RRI prevention and self-management behaviours with the result that runners engage in less injurious and more sustainable running habits. Runners also expressed a desire to be able to assess their own injury or risk of RRI via the proposed intervention which again captures the idea of runners being able to intuitively know when to adapt their running behaviours.

Runners in this focus group study acknowledged that there were potential issues with the proposed intervention and expressed these in terms of the potential for runners misinterpreting information provided by the intervention or a lack of engagement or adherence with advice provided by the intervention. Both of these concerns indicated the potential risk for the intervention to cause harm to runners. Ways in which to mitigate for these potential risks are discussed later in this chapter.

A key point from these focus groups is that face-to-face contact with HCPs such as physiotherapists was seen to be important to runners. Physiotherapists were seen as reliable sources of RRI information and therefore some runners described how they would defer to knowledge previously gained from contact with physiotherapists, or if they were experiencing a new injury they would make an appointment to a trusted physiotherapist. This highlights that despite online sources being readily available at no cost to themselves, runners still seek out advice from qualified HCPs. This may be due to the limitations of online resources as described by runners, in that the online sources can be incorrect or conflicting. By seeking out face-to-face contact with physiotherapists they are seeking out what they deem to be trustworthy information for their RRIs. This may be why, when asked about content for a proposed RRI intervention runners were keen that the intervention would be able to signpost them to HCPs if necessary. Despite being in favour of a digital RRI intervention, runners still consider face-to-face assessment from HCPs to be important.

When considering the development of digital RRI prevention and self-management interventions, the perceived trustworthiness and usefulness of the information needs to be considered. Information may need to be referenced and evidenced or even endorsed by HCPs such as physiotherapists and sports doctors for runners to be able to perceive the usefulness and trustworthiness of the intervention. Digital interventions could also provide a database of qualified HCPs and the most appropriate professional to see for their complaint.

Overall runners were in favour of the proposed intervention. They wanted the intervention to include information on approaches to prevention and management such as exercises, and information on training and nutrition. It was important to runners that the intervention was evidence-based, so that it could be trusted, have the ability to diagnose an RRI but to also indicate when runners should seek out face-to-face contact with an HCP. These findings provide great insights, but the development of an intervention required involvement ALL stakeholders who have a role in supporting runners, which lead the thesis onto Phase 3 which involved stakeholders including health practitioners and RLs from the NGB of Welsh Athletics.

9.1.3 Phase 3: Exploring the views of other stakeholders.

Development of complex interventions also need to consider the views and expert opinions of ALL stakeholders who play an active role in supporting the target population. To this end it was felt that practitioners who were involved in the assessment, management and coaching of recreational runners should be approached for their views on RRI prevention and management and their thoughts in the proposed digital intervention. This group was targeted for Part 1 of Phase 3 of this study. Other stakeholders identified as having a key role in supporting runners in Wales were Run Leaders (RLs) who provide running advice and support via social community running groups, therefore this group was identified for Part 2 of Phase 3.

9.1.3.1 Qualitative focus groups with practitioners

Participants in the online focus groups for this part of the study were physiotherapists, strength and conditioning coaches and personal trainers who have had involvement in treating and training runners were recruited to take part in the focus groups. Following analysis of the transcripts via thematic analysis the key themes identified were:

1) Approaches to RRI prevention and management,

2) Barriers to RRI prevention and management,

3) Use of digital interventions to prevent and manage RRI,

4) Content and Format of The Ideal App

5) Unintended consequences of the proposed intervention.

Approaches used by practitioners centered around preparing runners for running via exercises, education around prevention and self-management, recovery strategies and helping runners to monitor and manage their training loads. These approaches can be seen to address some of the common risk factors which are documented to contribute to RRI such as training error and previous injury. Readiness to run as a sub-theme appeared to be aimed at identifying areas of weakness/poor mobility that runners might have via functional assessment and then addressing those issues via exercise prescription. Training load management and recovery as sub-themes appeared to address issues that may exist for runners around training errors, ensuring that runners do not progress training variables too quickly and encouraging runners to take adequate rest to recover from running.

Perceived barriers to RRI prevention and management were similar to those cited in the focus groups with runners, such as time and access to appropriate knowledge. Time as a barrier was also highlighted by runners in the previous study. Practitioners cited runners' beliefs and perceptions around RRI prevention and management as a barrier, indicating that practitioners and runners may not always agree on the way to approach RRI prevention and management and that there may be areas of potential conflict of views.

Practitioners used a number of digital interventions such as websites, social media and smartphone apps to help runners prevent and manage RRI but none of the participants named a digital intervention that was specifically designed with that intention. Participants' use of digital interventions seemed to be focused on their own education about RRI intervention and self-management. The interventions they used to help runners were mainly around helping runners monitor and progress training loads if they were returning from injury or were novice runners. Social media apps were recommended by practitioners to runners based on personal experience rather than on whether the app was evidence based or had been evaluated and were not always specific to RRI prevention and self-management.

In the proposed digital intervention, practitioners saw such an intervention as having an educational function as well as providing information that supported running in the form of wellness information e.g. nutrition, hydration information and exercises that would help prevent and manage RRIs. Practitioners reported that it would be useful to be able to signpost runners who were patients to such an intervention but what was really important for practitioners was that the intervention would signpost runners towards face-to-face medical intervention when necessary.

When asked about the possible risks of the proposed digital intervention, participants cited misinterpretation, liability and litigation, potential for harm and runner recall and inaccuracies. Practitioners showed concerns that the proposed intervention could cause harm to runners due to misdiagnosis, whether that misdiagnosis was due to inaccurate information being provided by the runner, a runner misinterpreting the advice provided or that the advice given directly caused runners to be harmed due to the intervention's inability to recognize when a runner needed to seek medical attention. These concerns can be seen to feed back into a previous sub-theme where practitioners were keen for the proposed intervention to signpost runners towards HCPs when necessary. Due to these fears around harm and misdiagnosis, practitioners wanted the importance of face-to-face assessment to be emphasised via the intervention.

Overall practitioners were in favour of the proposed RRI prevention and self-management intervention, seeing it as an educational tool that could provide some useful content in the form of exercises for RRI prevention and self-management alongside some general wellbeing advice for runners. Practitioners were however very strong in their views that diagnosis via the intervention was problematic, and that the intervention should not replace face-to-face assessment and management.

Following the focus groups with practitioners it was felt that it was necessary to gain the views of those who work directly with runners in the form of Run Leaders (RLs).

9.1.3.2 Qualitative interviews with Run Leaders

Results from interviews with RLs from Run Wales (the social running programme of Welsh Athletics) sought views on proposed digital RRI prevention and self-management intervention aimed at recreational runners. Following analysis and coding of the transcripts the following themes were identified:

1) Information provided by RLs,

2) Sources of information

3) Proposed intervention

4) Unintended consequences.

Information provided by RLs was based on information that they had gleaned from the Leadership in Running Fitness course (LiRF). They reportedly felt comfortable providing information on the benefits of cross training, strength training and the benefits of sourcing appropriate running shoes but acknowledged their limitations and would signpost runners to HCPs. RLs were wary of providing incorrect information and again would signpost to HCPs to avoid this. The sources of information that RLs used for RRI prevention and self-management information were Run Wales and online search engines such as Google. Within the proposed intervention RLs wanted to see an educational intervention that could be trusted by both RLs and runners to provide reliable information. Concerns around the intervention were that runners may misinterpret the information provided by the intervention and that the intervention itself could provide barriers for runners in terms of cost or in time.

In summary, RLs were largely in favour of the proposed intervention. They saw it as being an educational resource, in particular for novice runners but they wanted the proposed intervention to be trustworthy if they were to recommend it to runners in their groups. For RLs the perceived unintended consequences of the proposed intervention surrounded misinterpretation which they felt could lead to more problems for runners using the intervention. They also felt the intervention could present barriers in the form of time and cost. This stakeholder group were the first to mention cost as a possible consequence of the intervention.

9.2 Research implications informing future intervention development.

This section will discuss the findings across all studies, reflect on the level of agreement between stakeholders and how these results inform the future development of a digital RRI prevention and self-management intervention.

9.2.1 Education

The intervention as an educational resource is clearly perceived as important by the runners, HCP, trainers and RLs. As discussed in the literature review, education is already used as an approach in both the prevention and management of RRI and there is some promising evidence for education as an approach. The focus groups with runners revealed that a lack of knowledge regarding RRI prevention and self-management was a barrier to prevention and management behaviours, and both practitioners and RLs saw the value of any future intervention as an educational tool. By providing an educational component to the proposed intervention it is argued that a barrier is being removed and self-efficacy in RRI prevention and self-management behaviours is being elevated. Self-efficacy is an individual's belief that they have the knowledge and skills to perform a behaviour and those who have a higher self-efficacy will be more likely to engage in the behaviour and have greater motivation for the behaviour (WHO, 2009).

The education components could be linked to what all participants in this study wanted to see in the proposed intervention, including injury prevention information, training and recovery, safe return to running after injury and exercises to complement RRI prevention and self-management. These educational components potentially address risk factors that are documented to contribute to RRI e.g. training error, previous injury. Education could be provided within the proposed intervention regarding training so that runners avoid progressing training variables such as volume and pace too quickly. This could potentially result in behaviour changes which lead to more sustainable training practices, addressing the risk factor of training error. An educational programme which could help runners who have been injured in the form of a Return to Running Programme could also address the risk factor of previous injury.

Both runners and practitioners wanted to see exercise information within the intervention, whether that was in the form of exercises to prevent RRI or exercises which could be used to manage specific RRIs. By providing information and instructions on exercises to prevent and manage RRIs, runners' self-efficacy towards performing with these exercises would be increased and motivate them to engage with prevention and self-management behaviours for RRI. It may be that in the development of the intervention there needs to be a clear delineation of content which addresses RRI prevention and content which addresses RRI self-management, or it could mean that two different interventions are developed with one focused solely on prevention and the other focused on self-management.

Previous injury as a factor could be addressed by education around training, return to running, benefits of recovery, education around healing times for specific RRIs and rehabilitation strategies that could benefit the issues linked to a previous injury e.g. via functional assessments. Practitioners in this study were already using functional assessments to assess recreational runners' readiness for running. Within the proposed intervention, a self-assessment section could help runners identify potential areas of weakness or those areas affected by previous injury, therefore addressing whether the runner is ready for running. The intervention could then provide suggestions to runners as to how to address these areas. This type of content is supported by the current study as can be seen from the results previously reported in Phase 2 of the study which aimed to establish the content that recreational runners wanted from the proposed intervention.

9.2.2 Tailoring

Findings from the survey indicated that there was a relationship between being a less experienced runner, running lower average miles per week and finding online resources such as web sites and online videos useful for RRI prevention and management information. This indicates a need to tailor information within the intervention towards novice runners who may be in need of trustworthy, reliable information as they start their running journey. There was also a relationship found between age and the number of apps that runners currently use with runners in older age categories being found to not use any applications at all. Therefore, when tailoring and marketing this information it may need to be considered which age categories are more likely to use the proposed intervention. Runners in the focus groups (Chapter 6) were keen that the intervention had a tailoring aspect to it, in essence being able to input information into the intervention and for the intervention to provide bespoke information for the individual runner. In contrast practitioners who took part in focus groups (Chapter 7) felt that tailoring the intervention towards individual runners could be challenging. Some practitioners reported that you could identify specific groups such as novice runners, menopausal women, post-partum women and masters runners and provide information that would be relevant to those groups. This creates almost a 'happy medium' where the advice is not necessarily bespoke, but the information provided is a 'best fit' for the runner providing RRI prevention and injury prevention information that addresses risk factors such as age, experience level, sex and injury history.

9.2.3 Theoretical underpinning

The results of these studies indicate that any future intervention for the prevention and self-management of RRI should be underpinned by behaviour change theories. As discussed in Chapter 2, risk factors for RRI include training error and previous injury. The proposed intervention could address behaviours around training and previous injuries to help runners prevent and manage RRI. As indicated in the studies with all stakeholders, this could be in the form of providing advice on appropriate training and recovery, exercises to address any existing musculoskeletal issues and return to running programmes to help runners safely return to running. Other studies have used behaviour change theories such as the Theory of Planned Behaviour (TPB) to model their interventions (Adriaensens et al. 2014; Hespanhol et al. 2018a; Fokkema et al. 2019e).

The findings also demonstrated that one of the barriers to RRI prevention and management for runners is a lack of knowledge which subsequently leads to a lack of confidence. By providing an intervention to runners that consists of useful, evidence-based education and knowledge around prevention and management of RRIs, the barrier around lack of knowledge would be addressed. This would lead to an increase in perceived confidence in performing the related behaviours and potentially lead to more positive attitudes to RRI prevention and self-management, leading to a change in behaviour for runners that may be less injurious or help to successfully manage injury. Therefore, an intervention embedded in constructs such as the TPB and Self-Determination Theory (SDT) has the potential to increase runners' motivations towards RRI prevention and management behaviours.

By removing barriers and increasing knowledge surrounding RRI prevention and self-management interventions, runners will potentially be more motivated and empowered by the intervention. Empowerment is defined by the World Health Organisation (WHO) as "a process through which people gain greater control over decisions and actions affecting their health" (2009) so, by developing an intervention that helps runners take control over decisions and actions related to RRI they will be empowered. This would enhance runners' autonomy surrounding RRI prevention and self-management and therefore motivate them towards behaviours that are beneficial to their running and their RRIs. A recent qualitative study found that runners want to determine, based on their feelings, when to alter training programmes, take additional prolonged rest or other measures (Verhagen et al. 2021). Providing runners with an intervention that contains evidence-based information based on what stakeholders from this study feel would be most useful will improve runners' competence in performing RRI prevention and self-management behaviours. The intervention could arguably involve runners more actively in the learning process regarding RRI prevention and self-management which could lead to deeper information processing of relevant information (Halperin et al. 2018), feeding back into the role of the intervention as an educational resource.

Verhagen et al (2021) reported that most interventions for athletes aimed at injury prevention are made for athletes and not with athletes, having no focus on developing self-efficacy and empowerment. Therefore, any future intervention needs to help runners develop self-efficacy regrading RRI prevention and self-management behaviours and empower runners' decision making related to prevention and management of RRI.

Future development also needs to consider theories that would enhance Technology Adoption of the intervention. As described in Chapter 6, the 3rd iteration of the Technology Acceptance Model (TAM 3) (Venkatesh and Bala 2008) describes the determinants of end-users behavioural intentions towards technology. This model could help identify runners' intentions to use the proposed intervention. Using a theoretical model such as TAM3 could support adoption of the intervention as it would identify aspects that would enhance the perceived usefulness and the perceived ease of use of the proposed intervention. Research has already examined factors that affect adoption of technology by runners (Weisner et al 2018). These factors include motivational aspects for technology such as monitoring exercise levels, self-motivation and personal health aspects. These feed into outputs and relevance described in TAM3 which feed into behavioural intention and subsequent use of technology (Figure 13). Weisner et al (2018) also reported privacy concerns by runners regarding monitoring technology, which would feed into the computer anxiety and perceptions of external control within the TAM3 model. Qualitative research has also identified that perceived ease of use is important to runners in application design (Lacey et al 2022). It was not within the scope of this study to explore computer anxieties, playfulness and self-efficacy regarding the proposed intervention. However, future development of the intervention should use a model such as TAM3 to support adoption and implementation of the intervention. Further research could also be performed to help inform tenets of the TAM3 that relate to computer self-efficacy, playfulness and anxiety which would then inform behavioural intention for end-users of the proposed intervention.

9.2.4 Promoting the role of HCPs.

The importance of HCPs in RRI prevention and self-management was a theme that ran through all the qualitative studies with runners, health practitioners as well as the survey with runners. The idea would be that this function would encourage users to seek face to face HCP advice where necessary either via a disclaimer that the advice in the app did not replace face to face advice or via the use of information inputted into the app which would then be identified by an algorithm to indicate to runners that they required face to face HCP assessment. This could also address some of the risk that participants across the studies perceived within the proposed intervention such as misdiagnosis, potential for harm and misinterpretation of information provided by the intervention. By providing a function which directs users towards HCPs or reminds them that face-to-face HCP contact is an option, it could be argued that the signposting function helps to diminish the potential risks of misdiagnosis and harm. HCP contact was still very important to runners and stakeholders so it would be important to incorporate this provision into any future intervention.

Although runners in this study were keen on the intervention providing a diagnostic tool for RRI, it was very clear from the focus groups with practitioners and RLs that this was not something that they saw as being feasible due to fears around misdiagnosis and the potential for harm. Practitioners and stakeholders strongly felt that it would not be possible for the intervention to provide this function in a safe manner and felt that signposting to HCPs for face-face assessment and advice was important. It appeared that practitioners didn't want to let go of the diagnosis aspect of RRI management and were in some ways ambivalent towards this function within the digital intervention. However, the runners in this study were not proposing anything new in terms of their desire for a self-diagnostic function. Pre-digital self-diagnostic tools such as home pregnancy tests and blood pressure monitors paved the way for self-diagnosis but in the digital era the range of technologies available that allow lay people such as recreational runners access to information to allow them to self-diagnose has expanded (Lupton and Jutel 2015).

There are a growing range of self-diagnosis tools available on the internet. Runners in the survey and focus groups did not name any particular self-diagnostic tool, however they did use websites which would provide them with the information to make an informed decision about RRI prevention and management. Practitioners were able to name some digital tools such as yoga apps and NHS tools used to provide runners with information. Run Leaders were unable to name any such self-diagnosis or digital tool for runners. Therefore, there appears to be a gap in the digital landscape, whether that is on the online space or in app form, where a digital RRI prevention and management tool could be beneficial to ALL stakeholders.

Practitioners and Run Leaders felt that any symptom checker or self-diagnosis tool required the correct information to be inputted into it to allow the 'correct' diagnosis to be made and therefore the 'correct' information to be given. This has been highlighted in a previous study evaluating symptom checkers which noted that patients may struggle to use words to describe their condition or use different terms (Semigran et al. 2015). Previous research which analysed health apps found that the apps they reviewed would frequently give direct warnings not to act on the information accessed via the app and to seek medical advice with the apps also refuting that the app was even directed at self-diagnosis (Lupton and Jutel 2015).

Runners may have been keen to have a self-diagnosis tool as it would provide them with autonomy and a sense of power over potential injuries. It has been argued that possessing the authority and legitimacy to make a diagnosis and subsequently how a condition should be treated, is a source of power (Lupton and Jutel 2015). A diagnosis 'legitimises a patient's complaint, organises symptoms and gives sense to them…..and distributes resources such as…therapies'(Lupton and Jutel 2015). It is argued that diagnosis defines the lay-medical professional relationship. The lack of agreement between recreational runners and clinicians/coaches/stakeholders regarding a self-diagnosis tool in an RRI prevention intervention highlights the 'uneasy space between the engaged patient and the expert medical professional' (Lupton and Jutel 2015). However, overall medical authority would still lie with the HCPs who manage runners as they remain gatekeepers for sick leave, investigations and other healthcare resources (Lupton and Jutel 2015).

In contrast it could be argued that providing a self-diagnosis tool could be risking medicalizing RRIs which can often be due to behaviours which lead to RRI such as excessive training and a lack of recovery rather than a runner having a specific illness or medical condition. Medicalisation via a self-diagnosis tool could also place emphasis on 'expert control' (Busfield 2017) and lead to increased anxiety and 'cyberchondria', potentially encouraging users to seek care unnecessarily and increasing healthcare spending (Semigran et al. 2015). Self-diagnosis tools could reduce emphasis on self-management by runners which potentially defeats the purpose of the proposed intervention.

The authority to give a label to a condition and assert how it should be managed, is a source of power and that this power and authority maintains the status of medical and health professions (Lupton and Jutel 2015). As healthcare has become more consumerist patients have been empowered and engaged with the diagnostic process, taking a more active role in self-management rather than passively accepting advice (Lupton and Jutel 2015). It could be argued that practitioners in this study are maintaining power and authority by advocating for a signposting aspect within the proposed intervention. What this also demonstrates is that the involvement of HCPs in the development of any future digital intervention for RRI prevention and self-management is vital so that if any diagnostic functions are modelled, the development of any algorithmic decision making is transparent and accountable (Henwood and Marent 2019). By making the design process transparent via involvement of all stakeholders including HCPs, practitioners may be less ambivalent towards the possibility of a diagnosis function. And as noted by runners in this study, there is a great deal of medical information online which could be provide misinformation to runners. The liberalization of the patient role has changed how people obtain a diagnosis and this is due to the vast amount of medical and health information which is readily available to runners online via websites, apps and social media platforms (Lupton and Jutel 2015). Previous research has found that it is important to runners where they get their information from (Verhagen et al. 2021) An evidence based digital intervention designed in collaboration with HCPs as well as other stakeholders would provide a platform that could steer runners away from online misinformation regarding RRI prevention and self-management.

9.3 Format of the intervention

The findings of this study show that runners are avid users of digital technology in monitoring their running practices. The survey reported in Chapter 5 found that 97% of participants monitored their training and this was predominantly via smartphone apps and GPS watches. Runners who took part in the focus groups also reported using online sources for RRI prevention and self-management information. This demonstrates that runners in Wales are already familiar with using digital technology to support their running practices. Clearly digital technology has some acceptance with runners, but the survey found that runners in Wales are not using this technology to prevent and manage RRI, but rather use it for virtual competition and challenges, affirmation from followers on social media and goal setting. Therefore, there is a gap that exists for an evidence based digital RRI prevention and self-management intervention, which goes beyond the existing typical use of technology.

Almost overwhelmingly, when asked about the format for the proposed diagnostic tool, all stakeholders within the qualitative arms of the study were in favour of a smartphone app. Findings from the survey indicate that most runners, from novice to experienced are already familiar with using smartphone apps for running. Reasons for the intervention to be in the form of a smartphone app included ease of access, being able to access the app from anywhere and simplicity of use. Some participants felt that there should be an option to access the intervention via a web platform. But for ease of access a smartphone app was the most favorable format for the intervention. Apps offer mobility and an ease of access, they can be easily downloaded and carried around to be referred to by the user when deemed necessary, differentiating it from other digital technologies (Lupton and Jutel 2015). Smartphone apps have a great deal of features which appeal to users: the mobility, ease of access and use of apps is what can differentiate them from using a PC to access a website (Lupton and Jutel 2015). The simple format and GPS location on smartphones supports the mobility advantages. Runners would also have access to any updated information that could be shared within such an app. An app could be a resource that practitioners or coaches could recommend to runners. Run Leaders could use it as an immediately accessible resource during group runs. However, the results of the survey (Chapter 5) indicate that the way the app is developed and tailored needs consideration in relation to gender, age category, running experience and average miles per week. The survey indicated that women in the sample are less likely to use a smartphone app to monitor training than men. If the intervention is to be in the form of a smartphone app the way the information is marketed and tailored needs consideration to ensure that women do not miss out on useful RRI prevention and self-management information. The survey also indicated that respondents running 6-10 miles per week were not using smartphone apps to monitor training. Again, this means that in the development of the intervention, there needs to be an element of tailoring of the intervention and its platform to appeal to this group. Running 6-10 miles a week could be indicative of this sub-group being relatively novice, a group which are known to be at risk of RRI, therefore tailoring the intervention is some way to novice groups is vital to aid prevention and self-management of RRI and keep this group running.

There is some evidence around the benefits of an app versus a printed resource. An ankle sprain prevention app has been found to have higher satisfaction levels than a written booklet (van Reijen et al. 2018). The authors also reported that users of the ankle app reported the app to be easy to use with other benefits to the app including phone portability and the inclusion of instructional videos. The findings of the ankle app study reflect the findings of the current study in that all stakeholders felt that an app would be preferable and that videos to demonstrate videos would be helpful.

The findings of this thesis provide an insight into what end users require for the proposed intervention to be acceptable. In the development of any intervention it is important to understand why and how stakeholders would implement the technology , with acceptability of the proposed intervention lying in its perceived value and ease of use (Ketikidis et al. 2012). The acceptability of the proposed intervention can only be established via further studies of once it is developed but the current findings indicate that an app which is simple to use featuring both video and written content on prevention and self-management information for RRI is desirable for all participants.

9.4 Differences between runners and practitioners

Both runners and practitioners had strong opinions over certain elements. For example, some runners in the focus groups professed to stretch for two hours after every run or to blame lack of stretching for their injuries. Whereas practitioners felt that runners put too much emphasis on stretching and that any intervention should help to 'bust myths' around activities such as stretching. Despite strength training being found as superior to stretching alone in one systematic review (Lauersen et al. 2014a) research has found that runners see stretching as an important factor in injury prevention (Saragiotto et al. 2014d). This is supported by the survey findings (Chapter 5) and focus group results (Chapter 6) from this study. Clinicians such as physiotherapists may have strongly held beliefs about stretching and its benefits in preventing and managing injury. This is reflected in the responses of clinicians in the focus groups of this study feeling that there are 'myths' that need to be busted regarding RRI and injury prevention. However even though there is limited evidence to suggest that stretching is a factor in RRI prevention and self-management, there is also no clear evidence to the contrary. Factors that are widely found to be key in the development of running injuries include training loads and previous injury, there is no evidence to suggest 'too much stretching' or 'not enough strength training' is responsible for the development of RRI or for the prevention of it. To challenge strongly held beliefs could trigger ambivalence in runners who believe that stretching has a positive effect on their running and to ask runners to stop a benign activity that is benefiting them physically and mentally could detrimentally affect the therapeutic relationship between runners and practitioners who treat runners. It is reported that patients feel more trust in HCPs if they are able to discuss information they have found via digital means while also seeking opinions from HCPs (Farnood et al. 2020). Results demonstrated some polar opposite biases between runners and practitioners and entrenched views on both sides but it has been argued that creating an open atmosphere, that can encourage patients to discuss information they have discovered can enhance the relationship between patient and HCP (Farnood et al. 2020). Therefore, that any iteration of a future digital RRI prevention and management intervention needs to focus on supporting and empowering runners to make autonomous decisions surrounding preventive behaviours of RRI rather than ‘educate them out’ of current behaviours that may still have some beneficial effect, while still fostering open, communicative relationships with HCPs when necessary

Runners saw a ‘self-diagnosis/symptom checker’ function as desirable within the proposed intervention. Previous research has found that patients find online sources of information such as the internet to be convenient and seen as a tool for the treatment of non-serious, simple self-diagnosis (Farnood et al.). However, an evaluation of symptom checkers for self-diagnosis and triage concluded that although symptom checkers can provide a range of possible diagnoses, tools can frequently be wrong with 58% of symptom checkers providing a correct diagnosis (Semigran et al. 2015). In contrast to the position taken by runners in this study, practitioners and RLs were against a self-diagnosis tool, instead being in favour of runners being signposted towards medical care, indicating that the intervention could have a triage function. The literature shows that symptom checkers fall into one of two categories: self-diagnosis or a form of triage to help patients decide if they need to seek medical care (Semigran et al. 2015). A triage function could have the ability to advise whether users should self-manage, seek care from an HCP and which HCP or if the user should seek emergency care (Semigran et al. 2015). This triage function could potentially reduce unnecessary visits to HCP, saving time and cost for both runners and health services (Semigran et al. 2015). A triage function could also reduce fears held by practitioners and RLs in this study regarding more serious RRIs and conditions being missed e.g. stress fracture, as algorithms could be developed with clinical evidence to help any intervention identify whether users require emergent care over self-management (Semigran et al. 2015).

The concerns of all stakeholders as discussed above cannot be ignored and ultimately any intervention should adopt a ‘do no harm’ approach. The content of a digital RRI prevention and self-management intervention should contain content that complements running behaviours in the form of activities such as exercises and stretches shown to benefit specific RRIs alongside information that has the potential to benefit runners e.g. advice on recovery, nutrition, sleep, hydration and structured training programmes but in reviewing the results of this study and considering the views of all participants, it is not recommended that the content of this intervention should include a self-diagnosis function. Instead, a triage function has the potential to be beneficial within the proposed intervention, as this could have the potential to advise runners to continue to self-manage or seek qualified face-to-face contact with an HCP to fully assess and diagnose their RRI.

Based on the findings of this thesis the Logic Model that was introduced in Chapter 2 has been completed (Figure 16). The Logic Model gives a visual representation of the work that has been undertaken for this thesis, the data and results that have been collated via the inputs, outputs. The implementations indicate the steps still required for further development and evaluation via the MRC framework (Skivington et al, 2021a). Implementations then lead onto short-, medium- and long-term outcomes and impact of the proposed intervention. The model also provides information on the possible external factors which will continue to influence development.

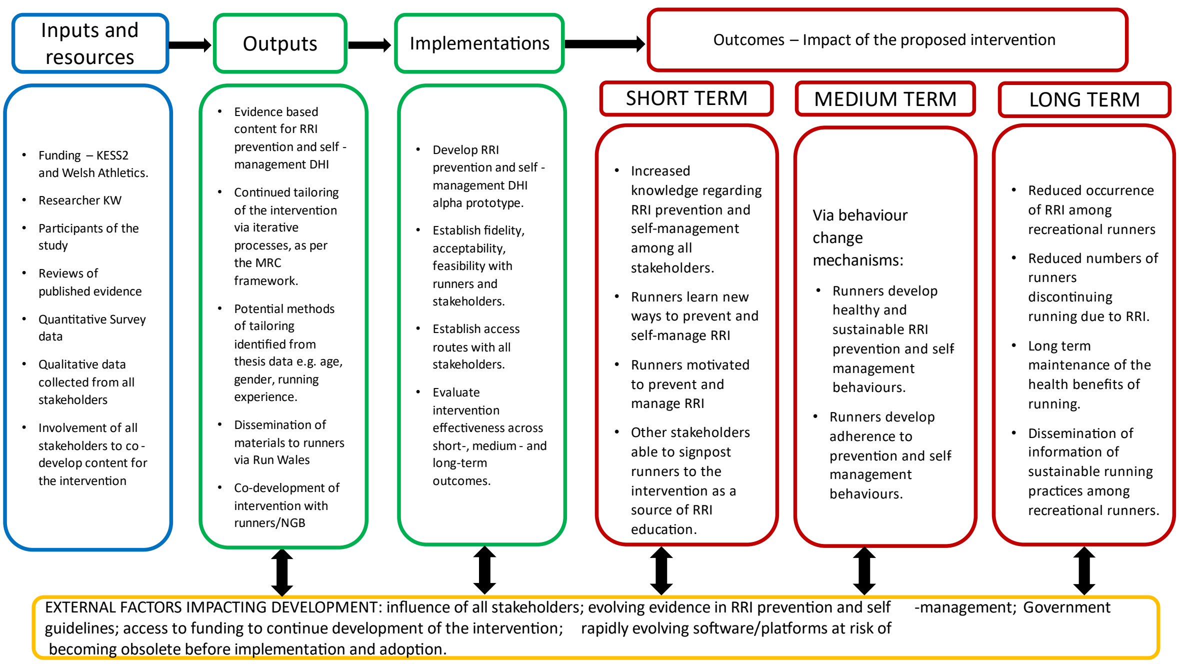


__Figure 16 Completed logic model following completion of thesis__

9.5 Risks of the proposed intervention

Clinicians, coaches, and stakeholders shared concerns about misdiagnosis and potential litigation regarding misdiagnosis with regards to the proposed digital intervention. However, what was not raised as an issue by runners in this study was security and privacy of information that apps and online spaces can generate about their users which can then be uploaded to developers' archives consequently becoming the property of the developers

(Lupton and Jutel 2015). The survey demonstrated that runners are already habitual users of digital technology, so are familiar with sharing their data and personal information with different apps and websites. Therefore, this could have been a genuine oversight by runners in this study or that runners have become so used to sharing personal details in the digital realm that they have stopped thinking about it as a security or privacy issue and accept it as a process of using a digital intervention. Demographic information is seen as critical for symptom checkers that have a diagnostic or triage function (Semigran et al. 2015). Demographic and symptomatic Information required by an intervention such as the one proposed in this study, to enable triage functions may trigger a threshold of privacy that some runners may be uncomfortable with and when presented with this scenario runners may find it more intrusive and personal. This is still conjecture and will need more enquiry with runners in an evaluation stage to identify the impact of collecting personal and demographic data from runners regarding health care needs.

As soon as people start sharing personal details with an app there is a responsibility on the developer to store it safely and maintain safety and privacy of that person and their information. Some reports have found a lack of transparency in what medical and health app developers do with the personal data, with some developers failing to explain how they used the data or making excessive demands for personal data from users (Lupton and Jutel 2015). In relation to the proposed digital RRI prevention and management app, the notion of self-diagnosis and symptom checking creates a scenario where personal information has to be collected to enable an algorithm to make a suggested diagnosis for the information that has been inputted. This information then requires storing in a safe way that maintains privacy. On one hand if runners were sharing information, that information could be used to further develop and improve an app. On the other hand, it requires great responsibility and funding to be able to store the information. These consequences and the security concerns and legislation around this will need to be considered before a proposed intervention is developed and piloted.

Consideration needs to be given as to how issues raised by participants regarding risks relating to misinterpretation, liability and litigation can be countered. The ethics, privacy and equity implications of digital interventions need to be considered throughout the development process (Ranney et al. 2022). A way to reduce misinterpretation by users and the consequences of this is to continue to employ a user-centred design (Schukat et al. 2016). A participatory design process involving all stakeholders and an interdisciplinary team at all stages would be one way to anticipate and prevent or mitigate for potential risks (Shukat et al. 2016). The iterative cycle employed by the MRC framework also means that problems can continue to be addressed and mitigated (O'Cathain et al 2019).

Risks highlighted by participants in relation to liability and litigation were also discussed. Any intervention developed would have to adhere to appropriate regulatory governance and guidelines related to data collection privacy and security (Shukat et al. 2016). Responsibility for problems such as security breaches should be a collaborative effort between clinicians, app developers and regulatory bodies (Hayhurst, 2014). Therefore, any future intervention would need to consider the relevant healthcare policies. In Wales, quality, safety and effectiveness assurances may need to be sought from the Healthcare Inspectorate Wales (HIW) (Healthcare Inspectorate Wales, 2023). In England this could come under the Car Quality Commission (Public Health England, 2017).

The iterative cycle described by O'Cathain et al (2019) uses qualitative and quantitative methods to assess medium- and long-term outcomes of the proposed intervention, alongside assessment of acceptability, feasibility, fidelity and any potential risks or possible harms from use of the intervention. This iterative approach and the way that fidelity, feasibility and acceptability of the intervention will be assessed is outlined in the Logic Model for the proposed intervention (Figure 16).

9.6 Digital Inclusion

What cannot be ignored in the discussion regarding digital platforms for sharing and disseminating RRI prevention and self-management are questions over equality of access to the internet and to smartphones. It is widely assumed that access to computers, laptops and smartphone apps is universal, but this is not always the case. To give an example in recent times, during the pandemic children were accessing schoolwork and lessons from home but it became clear that not all households had access to the necessary devices, let alone multiple devices for multiple children within a household.

According to the Senedd research website in May 2020 (updated May 2021) 13% of households in Wales did not have access to the internet (Senedd Research, 2021). The level of digital exclusion in Wales is higher than in the UK, with as many as 7% of the population, or **180,000 people**, not using the internet. These people tend to be the heaviest users of health services and it is noted by the Welsh Government that they risk being left behind in the digital health revolution (Digital Communities Wales, 2022). Digitally excluded people are likely to be older adults, people with disabilities or long-term health conditions, those with lower educational attainment, lower income individuals or families, people in rural areas and homeless people. It also includes Welsh speaking people and those who do not speak English as their first language and socially isolated/lonely people (Digital Communities Wales 2022). For people living in rural areas and not online, they are usually excluded due to problems in fixed line and mobile broadband services (Digital Communities Wales 2022). This would obviously limit access to any digital RRI prevention and self-management intervention for recreational runners living in these areas, although according to the Welsh government areas of Wales affected by 'not-spots' are diminishing.

Findings from the survey (Chapter 5) indicated that runners in older age groups (55-64 and 64 and over) were not using smartphone apps in their running practices and during focus groups with practitioners (Chapter 7), participants discussed that older adults may be less inclined to use an app or website with reference to those in their mid-forties and above. In Wales only 36% of people over 75 have basic digital skills compared with 87% of 16–49-year-olds (Senedd Research 2021). Only 58% of adults aged 65-74 have all five digital skills: managing information, communicating, transacting, problem solving, being safe and legal online (Welsh Government, 2019). In chapter 5 the average age of female runners was 44.6 and male runners was 47.6 so it can be argued that the majority of recreational runners in Wales will have the digital skills to be able to use any digital RRI prevention and self-management intervention. It should be noted in the survey that 33% of participants were over fifty and 2% were over seventy so any intervention for the prevention and management of RRI, digital or otherwise needs to consider accessibility for all ages of recreational runner, interventions cannot discriminate. In making information on the prevention and self-management of RRI accessible, it is not only the content or user interface that needs consideration but also investment in internet and mobile phone connections particularly in rural areas of Wales. As discussed above, people in areas of digital exclusion in Wales are often heavier users of health services, therefore for this intervention or any future intervention delivering health resources needs to remove barriers to digital access such as poor internet and mobile phone coverage.

The intervention will not be suitable for all runners, and this may provide an argument for digital interventions alongside face-to-face interventions such as RRI prevention and management workshops. The survey and focus groups with runners demonstrated that face-to-face contact is still seen as important and often a necessity to help recreational runners in preventing and managing RRI. All participants in the larger study (runners, practitioners and RLs) reported face-to-face contact and assessment as important. Participants were keen for any digital intervention to be able to highlight when contact with a health professional was necessary. Therefore, it is argued that this needs to be a feature of any RRI prevention and management intervention so that runners feel that they are being safeguarded. It is also proposed that any digital RRI intervention and management intervention should have a list of HCPs, what they do and the qualifications to look for so that runners can make an informed choice about the HCP they decide to consult.

9.7 Strengths and limitations

This study had a number of strengths. The main strength of this thesis is in its mixed methods approach. The methods of scoping review, survey, focus groups and interviews complement each other, and integrating the methods help to minimize the weaknesses of each of the other methods (Richards and Hallberg 2015). Mixed methods designs help to capitalise on the strengths of each method and increase breadth and depth of understanding. The multiphase approach also allowed flexibility which was needed to address the interconnected research questions (Creswell 2017). The multiphase mixed methods approach also complements the design framework laid out by the MRC framework for the development and evaluation of complex interventions (Skivington et al. 2021). Another benefit of this design is that it could provide an overall framework going forward to conduct more iterations to enable collection of more data to inform the further development of the proposed intervention (Creswell 2017).

It is felt that one of the strengths of the data analysis of the qualitative data was in the way it was conducted. The researcher KW chose to transcribe the data verbatim herself. This enabled KW to become immersed in the data and identify themes at an early stage. KW subsequently went on to analyse the data via thematic analysis and developed the themes and sub-themes. NVIVO was then used to aid coding and to double check and streamline themes. As a novice researcher thematic analysis was seen as an accessible beginner method of qualitative analysis (Clarke and Braun 2013). It was also felt that by transcribing and analysing the data KW wasn't distanced from the data (Clarke and Braun 2013). By using the method of analysis that has been documented in this thesis, KW was able to be immersed in the data (Clarke and Braun 2013). An opposing argument to this is a strength is that KW, as a runner and a physiotherapist, could have introduced bias into the results and subsequent findings.

Member checking, which is the process of sending transcripts to participants for them to check and indicate any issues or misrepresentation, helped enhance the trustworthiness of the qualitative data and that this enhanced the ecological validity of the data, as in the data collection resembled real world context and was therefore meaningful to the real world experiences of runners, practitioners and Run Leaders (Clarke and Braun 2013). Transcripts were also sent to PhD colleagues for them to read and identify any possible codes and themes that KW had not identified.

Including some groups of stakeholders (recreational runners, health practitioners, RLs from the NBG) in this thesis is a strength. Runners who were of all experience levels were included in this study which means that there were a wide breadth of experience and opinions on RRI prevention and self-management and the proposed digital intervention. It also strengthens the development of any future intervention as per the MRC guidelines for the development and evaluation of complex interventions (Skivington *et al.,* 2021).

As with any research study there are limitations to the design, the way the study was conducted, and the way data was analysed. The survey may have been biased in its questions towards self-management of RRI rather than prevention AND self-management of RRI. There is a possibility that survey and focus group findings could have been influenced by the pandemic as during this time there were many new runners due to restrictions on other forms of exercise, however in analysing the experience of runners taking the survey and participating in the focus groups this is not felt to have been a great influence on findings. On reflection the survey instrument itself appears to be biased towards asking runners about self-management of RRI. There was a lack of questions about runners' RRI prevention approaches. The survey could be developed and re-tested with recreational runners and larger groups of runners to generate greater quantitative data that could help understanding of what runners are doing to prevent RRI and generate data about the popularity of different RRI prevention methods.

Within the survey design it is noted that there was some ambiguity with regard to questions about self-screening and self-diagnosis within the proposed intervention. On reflection it is felt that two of the answer options were too similar for participants and therefore it appeared that participants were not overly in favour of self-screening/self-diagnosis within the intervention. This then conflicted with findings from the focus groups where runners were in favour of self-screening/self-diagnosis functions. The survey tool therefore needs further development if it is to be conducted on larger groups of runners. The survey tool also did not give participants wider options regarding HCPs that they would want the intervention to signpost to. Future development of the survey tool should still ask this question but provide answer options which allow participants to indicate which HCPs they would want to be signposted to. This would provide richer data for development of the intervention.

The study was only conducted with participants from Wales therefore external validity is a limitation and inferences made from this study cannot be applied to the wider population of the stakeholder groups who took part in this study (Findley, Kikuta and Denly, 2021).

The number of runners that took part in the survey was relatively small compared to other survey studies that have been conducted with runners. This is a potential limitation to the way that results regarding the RRI prevalence are generalized to the larger recreational population in Wales. The sample size may have limited the performance of logistic regression to establish whether variables were predictor of behaviour of runners regarding digital technology. However, the survey instrument itself was more complex and covers what runners would want from future interventions related to RRI prevention and self-management, which have not been covered by other survey instruments.

It is noted that there were some short focus groups within the qualitative study with recreational runners. This could have limited the depth of data and information that was collected from runners and may mean that saturation was not reached. In the continuing development of the proposed intervention it is recommended that more qualitative research be undertaken with larger samples of runners, possibly with redevelopment of the topic guide to aid extraction of data from runners.

Only four participants took part in the Run Leaders interview study. The study results therefore may not be fully representative of all RLs in Wales. However, saturation was reached during the interviews which strengthens the data and the findings.

Lack of experience of the researcher in the skill of qualitative data analysis may have limited insights from the data. This was overcome by including member checking and asking a PhD colleague to read through transcripts. Other forms of data analysis could have been used, however for this study it was felt that thematic analysis was appropriate and helped achieve the aims and objectives of the thesis.

9.8 Reflexivity

As the researcher, KW felt that their many roles needed consideration as to how they influenced the data collection and interpretation of findings. As Finlay (2002) states 'The researcher, the world and the researcher's experience of the world are intertwined' This is pertinent to the researcher of this study due to their many identities held within life: physiotherapist, researcher, and lifetime runner. It is possible that a non-runner conducting this study would have found different results and interpreted the data in a very different way, but it is believed KW's insights as a runner and physiotherapist helped inform some of the analyses and provided an extra layer of with empathy to the experiences and opinions of all the participants in this study.

KW had to be aware not to get overly involved in conversations about running that could detract from discussions. KW was aware that she would sometimes allow the participants to go off on a tangent away from the topics and had to direct runners back to the original discussion. A group of people who have passion about their past time clearly want to avidly discuss it, so KW made a concerted effort to keep the focus groups on track while trying not to dismiss the participants' lived experiences. The fact that the researcher KW has a background in running means that she was able to immerse herself in the data and in the topics while also taking care not to impose her own pre-conceived beliefs or experiences or through her background as a runner, however KW acknowledged that her identity as a runner may have introduced bias into the analysis and findings.

As a clinician, KW had to consciously avoid becoming involved in conversations about the prevention and treatment of RRIs as a physiotherapist so that views of the participants did not become influenced or changed in any way by her inputs. Both as a runner and clinician it was easy for KW to become immersed in the data but at the same time it was required that at times there needed to be an effort to be more reflective and detached from the data to avoid imparting her own viewpoints on it. KW also had to be aware of her own biases and opinions towards running, RRI prevention and self-management and set these aside as both a runner who has experienced RRI and as a clinician who has treated runners with RRI.

9.9 Implications

Following analysis of all findings it is felt that the future development of a digital RRI prevention and self-management intervention should be an educational resource that educates runners not only on activities that help prevent and manage RRI, but also educates runners on behaviours that support prevention and management of RRI. This could include advice on the benefits of a tailored running programme, return to running programmes post injury, the benefits of rest and recovery, advice on appropriate rehabilitation after an RRI. This type of content would address two of the main risk factors of RRI which are noted to be training error and previous injury. This content would help increase the self-efficacy and autonomy of runners in Wales towards behaviours that are evidenced to prevent and self-manage injury that are also endorsed by other stakeholders such as clinicians, personal trainers and Run Leaders. The findings show that stakeholders are in favour of this intervention being in the form of a smartphone app with a mixture of media (written and video) to present the information. Future development of any digital RRI prevention and self-management intervention should take these findings into account in any iterations and should consider embedding the intervention within behaviour change theories. It is suggested that any future intervention should take the form of an educational/behavioural change/enhance self-efficacy and autonomy intervention rather than a diagnostic tool, with the aim of preventing RRI and helping runners to self-manage RRI, subsequently reducing RRI rates or time out of running.

9.10 Future research

The future development of the proposed intervention should continue to follow the MRC framework for the development and evaluation of complex interventions (Skivington et al. 2021). It was out of the scope of the main aims of this thesis to assess useability of the proposed intervention with existing tools. This central aim of this thesis was to explore the development of the proposed intervention, but in the future useability of the intervention could be established using tools such as Normalisation Process Theory (Murray et al 2010) or the NASSS framework (evidence based framework for the **n**on-adoption and **a**bandonment of technologies by individuals and the challenges to **s**cale-up, **s**pread **s**ustainability of interventions) (Greenhalgh and Abimbola, 2019).

The proposed intervention requires iterative development and testing to ensure that it is accessible and useful to the recreational running population. Iterations will need to be tested to make sure it accommodates the needs to the target population (Blandford et al. 2018). This could be achieved via quantitative surveys regarding the iterations or qualitative focus groups.

The development of the intervention also requires software development. Collaboration with colleagues from Computer Science would facilitate the design, coding and testing of the digital intervention (Blandford et al*.,* 2018). Investment would potentially be required in this stage so that it can be ensured that delivery systems work for all end-users of the intervention, including runners, practitioners and other stakeholders such as Run Leaders (Blandford et al*.,* 2018).

Once the proposed intervention is developed, it should go on to be piloted and evaluated for acceptability and feasibility, to ensure that the intervention is delivered as it is intended. The content should be piloted with running experts via a Delphi design to decide what should be included and what should be omitted, as well as an optimal user interface. Following piloting, the intervention would need to be evaluated further via experimental design with recreational runners, in the form of an RCT to assess clinical and cost effectiveness (Blanford et al. 2018).

9.11 Conclusion

The main aim of this thesis was to develop a digital RRI prevention and self-management intervention. Running has is a popular activity which is growing in popularity and has been shown by the research to be beneficial in the management of chronic disease and in reducing mortality (Pedisic et al., 2019). Unfortunately RRI remains a problem for many runners. To help people to keep running and maintain the health benefits gained from running, it is important to develop interventions which can help recreational runners to prevent and self-manage RRIs.

Current interventions for RRI prevention and management are varied and include exercises, training programmes and attempts to mitigate for risk factors such as biomechanics, all of which have mixed results in the literature (Bredeweg et al. 2010; Earl and Hoch 2010; Fields et al. 2010). Following a review of the literature it was identified that there was a gap for systematically developed evidence based digital RRI prevention and self-management interventions. Therefore, the development of the proposed intervention followed a developmental framework. The adopted framework for this study was the MRC framework for the development and evaluation of complex interventions (Skivington *et al.,* 2021).

This thesis has demonstrated that there is a gap for a digital RRI prevention and self-management intervention for recreational runners in Wales. Current digital interventions are developed based on clinical evidence or expert opinion with very little involvement from all stakeholders involved in recreational running and focus very strongly on prevention with no interventions currently available for self-management. Recreational runners in Wales have been found to be experiencing a high occurrence of RRI and utilise a number of ways to prevent and manage RRI but are not currently using any digital approaches designed for the prevention and management of RRI. Content that runners want to see within the intervention included exercises, training and recovery, and the ability for diagnosis within the intervention. Stakeholders also favoured exercise and training content within the intervention but did not endorse the idea of a diagnostic function within the intervention, which demonstrates some conflicting views between the participating groups. Attention should be paid to the potential risks of the intervention raised by stakeholders in this thesis, so that end-users of any developed intervention are able to use the intervention safely and without harm. It is argued that this study is novel in its approach as there are currently no studies which have investigated what running stakeholders want to see in interventions for the prevention and self-management of RRI among recreational runners and therefore provides new insights on what should be included in any future intervention.

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Appendix 1: Original Ethical approval

School of Healthcare Sciences
Head of School and Dean Professor David Whittaker

Ysgol Gwyddorau Gofal Iechyd
Pennaeth yr Ysgol a Deon Yr Athrawes David Whittaker

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

04 February 2020

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Kath Walker
Cardiff University
School of Healthcare Sciences

Dear Kath

Run Healthy, Run Strong: The Development Of A Running Related Injury Prevention and Self-Management Programme

I am writing to inform you that the Chair of the Research Ethics Committee has, following consultation, **approved** your revised research proposal. The Committee will ratify this decision at its meeting on 11 February 2020.

Please note that if there are any major amendments to the project you will be required to submit a revised proposal form. You are advised to contact me if this situation arises. In addition, in line with the University requirements, the project will be monitored on an annual basis by the Committee and an annual monitoring form will be despatched to you in approximately 11 months' time. If the project is completed before this time you should contact me to obtain a form for completion.

Please do not hesitate to contact me if you have any questions.

Yours sincerely

[redacted]

Mrs Liz Harmer Griebel
Research Administration Manager

c.c. Liba Sheeran, Nicola Phillips

Appendix 2: Amendments approval letter

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

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

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5 MAY 2020

KATH WALKER
CARDIFF UNIVERSITY
SCHOOL OF HEALTHCARE SCIENCES

Dear Kath

Research project title: Run Healthy, Run Strong: The Development Of A Running Related Injury Prevention and Self-Management Programme

SREC reference: REC701

The School of Healthcare Research Ethics Committee has reviewed the above application amendments via its proportionate review process.

Ethical Opinion
The Committee gave a favorable 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 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 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.

The Committee must be informed when your research project has ended. This notification should be made to HCAREEthics@cf.ac.uk within three months of research project completion.

Complaints/Appeals

If you are dissatisfied with the decision made by the Committee, please contact Dr Kate Button in the first instance to discuss your complaint. If this discussion does not resolve the issue, you are entitled to refer the matter to the Head of School for further consideration. The Head of School may refer the matter to the University Research Integrity and Ethics Committee (URIEC), where this is appropriate. Please be advised that URIEC will not normally interfere with a decision of the Committee and is concerned only with the general principles of natural justice, reasonableness and fairness of the decision.

Please use the Committee reference number on all future correspondence.

The Committee reminds you that it is your responsibility to conduct your research project to the highest ethical standards and to keep all ethical issues arising from your research project under regular review.

You are expected to comply with Cardiff University's policies, procedures and guidance at all times, including, but not limited to, its Policy on the Ethical Conduct of Research involving Human Participants, Human Material or Human Data and our Research Integrity and Governance Code of Practice.

Yours sincerely,

[redacted]

Senior Lecturer
Director of Research Governance

Cc Liba Sheeran, Nicola Phillips

Appendix 3: Research Risk Assessment and Management

Identified Risks	Likelihood	Potential Impact/Outcome	Risk Management
Identify the risk/hazards present	High/Medium/Low	Who might be harmed and how?	Evaluate the risks and decide on the precautions
Lone working	Low	Researcher at potential risk of physical/psychological harm.	Researcher (KW) will follow all guidelines for lone working and will have a research assistant present at
Data collection within a group.	Low	Disagreement between participants.	Researcher to facilitate focus groups and steer them to avoid conflict.
Data collection taking place in an unfamiliar place.	Medium	Researcher at risk of harm.	Researcher (KW) to familiarise herself with locations ahead of focus groups and interviews. Researcher (KW) will have an assistant to assist in familiarising participants with directions and the environment.
Use of audio recording equipment.	Low	Possibility of electrical mishap.	Ensure researcher (KW) trained to sue audio recording equipment.
Arrangement of seating.	Low	Physical injury to researcher (KW)	Ensure Cardiff University manual handling policies followed at all times.

COSHH assessment not required.

Appendix 4: CINAHL (via EBSCO) database search strategy

Concept 1: 'Running related injury'

Search	Keywords	Number of articles
S1	Running injuries	983
S2	Running-related injuries	176
S3	Running-related musculoskeletal injury	12
S4	Running-related pain	14
S5	Running-related complaint	0
S6	Running-related lower extremity injury	5
S7	Lower extremity running injuries	37
S8	Running restriction	25
S9	Athletic injur*	16,157
S10	Patella femoral pain syndrome	4
S11	Patellofemoral pain syndrome	1,532
S12	Iliotibial band friction syndrome	206
S13	Achilles tendinopathy	1,048
S14	Plantar fasciitis	1,423
S15	Patellar tendinopathy	452
S16	Hamstring injur*	857
S17	Overuse injury	2,414
S18	Overuse injur*	1,271
S19	Medial tibial stress syndrome	279
S20	Shin splints	200
S21	Gluteus medius injur*	14
S22	Stress fracture*	2,407
S23	Ankle inversion injur*	108
S24	Calf strain	48
S25	Muscle strain	1,692
S26	Muscle injur*	4,461
S27	Lower limb injur*	868
S28	Lower extremity injur*	2,359
S29	Sports injuries	14,526
S30	Sports injury	14,526
S1-30	OR search	32,902

Concept 2: Injury prevention

Search	Keywords	Number of articles
S1	Injury prevention	24,986
S2	Running injury prevention	151
S3	Sports injury prevention	430
S4	Strength and conditioning	1,986

S5	Stretching	6,928
S6	Training load	1,425
S7	Orthotics	5,232
S8	Running shoes	363
S9	Running trainers	14
S10	Warm-up	1,763
S11	Exercise	161,799
S12	Advice	26,803
S13	Load management	139
S14	Gait retraining	185
S15	Education	611,528
	OR search	802,434

Concept 3: Injury self-management

Search	Keywords	Number of articles
S1	Self-management	14,874
S2	Strength exercises	2,777
S3	Stretching	6,928
S4	Rehabilitation	163,403
S5	Injury rehabilitation	16,580
S6	Behaviour change	16,928
S7	Attitude change	7,545
S8	Load management	139
S9	Training loads	1,425
S10	Education	611,528
S11	Gait retraining	185
S12	Exercise	161,799
S1-S12	OR search	904,505

Concept 4: 'Digital'

Search	Keywords	Number of articles
S1	Online	60,303
S2	EHealth	13,374
S3	MHealth	12,844
S4	Mobile application	7,320
S5	Application	128,673
S6	App	7,277
S7	Web-based	13,241
S8	Remote	14,870
S9	Video-based	1,923
S10	Digital	34,848
S11	Platform	18,485
OR S1-S11		253,897

Appendix 5: AMED database search strategy

Concept 1: ‘Running related injury’

Search	Keywords	Number of articles
S1	Running injuries	3294
S2	Running-related injuries	1749
S3	Running-related musculoskeletal injuries	420
S4	Running-related pain	20
S5	Running-related complaint	21
S6	Running-related lower extremity injury	1984
S7	Lower extremity running injuries	1147
S8	Running restriction	3045
S9	Athletic injur*	4310
S10	Patella femoral pain syndrome	319
S11	Patellofemoral pain syndrome	414
S12	Iliotibial band friction syndrome	46
S13	Achilles tendinopathy	864
S14	Plantar fasciitis	371
S15	Patellar tendinopathy	547
S16	Hamstring injur*	95
S17	Overuse injury	87
S18	SPINAL INJURY	289
S19	Medial tibial stress syndrome	38
S20	Shin splints	25
S21	Gluteus medius injur*	38
S22	Stress fracture*	207
S23	Ankle inversion injury	1540
S24	Calf strain	421
S25	Muscle strain	57
S26	Muscle injury	131
S27	Lower limb injuries	2413
S28	Lower extremity injuries	2464
S29	Sports injuries	189
S30	Sports injury	115
S1-30	OR search	6235

Concept 2: Injury prevention

Search	Keywords	Number of articles
S1	Injury prevention	425
S2	Running injury prevention	1553
S3	Sports injury prevention	890
S4	Strength and conditioning	2191
S5	Stretching	1189
S6	Training load	4583

S7	Orthotics	302
S8	Running shoes	1857
S9	Running trainers	1534
S10	Warm-up	484
S11	Exercise	10537
S12	Advice	1168
S13	Load management	3
S14	Gait retraining	3727
S15	Education	15241
	OR search	47358

Concept 3: Injury self-management

Search	Keywords	Number of articles
S1	Self-management	697
S2	Strength exercises	3236
S3	Stretching	1189
S4	Rehabilitation	11634
S5	Injury rehabilitation	10383
S6	Behaviour change	3134
S7	Attitude change	3122
S8	Load management	3
S9	Training load	4583
S10	Education	15241
S11	Gait retraining	3727
S12	Exercise	10537
S1-S12	OR search	99652

Concept 4: 'Digital'

Search	Keywords	Number of articles
S1	Online	1187
S2	EHealth	17
S3	MHealth	24
S4	Mobile application	502
S5	Application	6857
S6	App	116
S7	Web-based	370
S8	Remote	461
S9	Video-based	93
S10	Digital	1030
S11	Platform	1253
OR S1-S11		11059

AND search with all concepts = 71 articles

Appendix 6: Medline (via OVID) Search Strategy

Concept 1: 'Running related injury'

Search	Keywords	Number of articles
S1	Running injuries	6395
S2	Running-related injuries	5605
S3	Running-related musculoskeletal injury	182
S4	Running-related pain	68
S5	Running-related complaint	307
S6	Running-related lower extremity injury	10729
S7	Lower extremity running injuries	9438
S8	Running restriction	6820
S9	Athletic injuries	10046
S10	Patella femoral pain syndrome	6417
S11	Patellofemoral pain syndrome	1,163
S12	Iliotibial band friction syndrome	78
S13	Achilles tendinopathy	6,136
S14	Plantar fasciitis	1,178
S15	Patellar tendinopathy	6,610
S16	Hamstring injuries	3986
S17	Overuse injury	607
S18	Overuse injuries	
S19	Medial tibial stress syndrome	186
S20	Shin splints	153
S21	Gluteus medius injury	7,023
S22	Stress fracture	4,105
S23	Ankle inversion injury	7,393
S24	Calf strain	6,656
S25	Muscle strain	570
S26	Muscle injuries	3525
S27	Lower limb injuries	5431
S28	Lower extremity injuries	1265
S29	Sports injury	1025
S30	Sports injuries	1847
S1-S28	OR search	46,149

Concept 2: Injury prevention

Concept 2: Injury prevention

Search	Keywords	Number of articles
S1	Injury prevention	6794
S2	Running injury prevention	7811
S3	Sports injury prevention	8476
S4	Strength and conditioning	5898
S5	Stretching	3770

S6	Training load	4905
S7	Orthotics	1166
S8	Running shoes	7888
S9	Running trainers	8936
S10	Warm-up	2677
S11	Exercise	11331
S12	Advice	7296
S13	Load management	71
S14	Gait retraining	9547
S15	Education	10689
	OR search	

Concept 3: Injury self-management

Search	Keywords	Number of articles
S1	Self-management	
S2	Strength exercises	
S3	Stretching	
S4	Rehabilitation	
S5	Injury rehabilitation	
S6	Behaviour change	
S7	Attitude change	
S8	Load management	
S9	Training loads	
S10	Education	
S11	Gait retraining	
S12	Exercise	
S1-S12	OR search	

Concept 4: ‘Digital’

Search	Keywords	Number of articles
S1	Online	60,298
S2	EHealth	13,371
S3	MHealth	12,841
S4	Mobile application	7,317
S5	Application	128,661
S6	App	7,276
S7	Web-based	13,240
S8	Remote	14,868
S9	Video-based	1,923
S10	Digital	34,841
S11	Platform	18,482
OR S1-S11		149,874

AND search with all concepts = 164 articles

Appendix 7: EMBASE via OVID search strategy

Search	Keywords	Number of articles
S1	Running injuries	973
S2	Running-related injuries	172
S3	Running-related musculoskeletal injury	12
S4	Running-related pain	15
S5	Running-related complaint	0
S6	Running-related lower extremity injury	5
S7	Lower extremity running injuries	37
S8	Running restriction	25
S9	Athletic injur*	17, 140
S10	Patella femoral pain syndrome	4
S11	Patellofemoral pain syndrome	1,539
S12	Iliotibial band friction syndrome	207
S13	Achilles tendinopathy	1,054
S14	Plantar fasciitis	1,434
S15	Patellar tendinopathy	452
S16	Hamstring injur*	864
S17	Overuse injury	2,552
S18	Medial tibial stress syndrome	280
S19	Shin splints	212
S20	Gluteus medius injur*	14
S21	Spinal injur*	23, 757
S22	Stress fracture*	2,485
S23	Ankle inversion injur*	116
S24	Calf strain	49
S25	Muscle strain	1,713
S26	Muscle injur*	4,558
S27	Lower limb injur*	881
S28	Lower extremity injur*	2,394
S1-S28	OR search	55,400

Concept 2: Injury prevention

Search	Keywords	Number of articles
S1	Injury prevention	24,983
S2	Strength and conditioning	1,195
S3	Stretch*	10,677
S4	Training load	1,425
S5	Orthotics	5,232
S6	Running shoes	363
S7	Running trainers	14
S8	Warm-up	1,763

S9	Exercise*	163,319
S10	Advice	26,800
S11	Load management	139
S12	Gait retraining	185
S13	Education	611,456
S1-S13	OR search	805,345

Concept 3: Injury self-management

Search	Keywords	Number of articles
S1	Self-management	14,874
S2	Strength exercise*	2,804
S3	Stretch*	10,677
S4	Rehabilitation	163,387
S5	Injury rehabilitation	16,581
S6	Behaviour change	16,926
S7	Attitude change	7,542
S8	Load management	139
S9	Training loads	1,425
S10	Education	611,456
S11	Gait retraining	185
S12	Exercise*	163,319
S1-S12	OR search	209,148

Concept 4: 'Digital'

Search	Keywords	Number of articles
S1	Online	60,298
S2	EHealth	13,371
S3	MHealth	12,841
S4	Mobile application	7,317
S5	Application	128,661
S6	App	7,276
S7	Web-based	13,240
S8	Remote	14,868
S9	Video-based	1,923
S10	Digital	34,841
S11	Platform	18,482
OR S1-S11		149,874

Appendix 8: Pubmed Search strategy

Concept 1: 'Running related injury'

Search	Keywords	Number of articles
S1	Running injuries	28740
S2	Running-related injuries	427
S3	Running-related musculoskeletal injury	286
S4	Running-related pain	347
S5	Running-related complaint	49
S6	Running-related lower extremity injury	360
S7	Lower extremity running injuries	5742
S8	Running restriction	43053
S9	Athletic injur*	4523
S10	Patella femoral pain syndrome	1919
S11	Patellofemoral pain syndrome	2382
S12	Iliotibial band friction syndrome	870
S13	Achilles tendinopathy	2754
S14	Plantar fasciitis	1828
S15	Patellar tendinopathy	2186
S16	Hamstring injuries	942
S17	Overuse injury	23243
S18	Spinal injuries	151436
S19	Medial tibial stress syndrome	2233
S20	Shin splints	2573
S21	Gluteus medius injury	2
S22	Stress fracture	4983
S23	Ankle inversion injury	2977
S24	Calf strain	72844
S25	Muscle strain	143373
S26	Muscle injuries	306946
S27	Lower limb injuries	52766
S28	Lower extremity injuries	29092
S29	Sports injury	38155
S30	Sports injuries	52901
S1-S28	OR search	643851

Concept 2: Injury prevention

Search	Keywords	Number of articles
S1	Injury prevention	255574
S2	Running injury prevention	19214
S3	Sports injury prevention	21285
S4	Strength and conditioning	38859
S5	Stretching	99581
S6	Training load	133274

S7	Orthotics	4866
S8	Running shoes	5736
S9	Running trainers	3715
S10	Warm-up	141437
S11	Exercise	427139
S12	Advice	421716
S13	Load management	147922
S14	Gait retraining	1785
S15	Education	1,029,753
	OR search	1,958,439

Concept 3: Injury self-management

Search	Keywords	Number of articles
S1	Self-management	439820
S2	Strength exercises	126600
S3	Stretching	99581
S4	Rehabilitation	237798
S5	Injury rehabilitation	86874
S6	Behaviour change	279910
S7	Attitude change	115051
S8	Load management	147922
S9	Training loads	133274
S10	Education	1029753
S11	Gait retraining	1785
S12	Exercise	427139
S1-S12	OR search	1864918

Concept 4: ‘Digital’

Search	Keywords	Number of articles
S1	Online	873879
S2	EHealth	24226
S3	MHealth	22740
S4	Mobile application	144011
S5	Application	1476288
S6	App	67918
S7	Web-based	107651
S8	Remote	193220
S9	Video-based	6451
S10	Digital	434731
S11	Platform	459355
OR S1-S11		2,412,255

131584 before criteria applied. Criteria applied = 5837. Further screening = 58 articles identified

Appendix 9: Email sent out to runners via Run Wales to promote survey

Run Healthy, Run Strong project
Researchers from Cardiff University need help from the runners of Wales to try to solve the running injury puzzle. The project called Run Healthy, Run Strong aims to build a picture of the running population of Wales, their injuries and what runners find helps to manage and prevent running injuries. If you'd like to help the link to the survey is (hyper link inserted).
Upon completion of the survey participants will receive a FREE infographic of the 6 best glute strength exercises for runners.
For more information you can contact Lead Researcher (and runner) Kathleen Walker at [redacted]

Appendix 10: Participant Information Sheet for recreational runners survey

Run Healthy, Run Strong: The Development of A Running Injury Prevention Self-Management Platform for Recreational Runners

We would like to invite you to take part in our Cardiff University research study. Before you decide you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully. You will have an opportunity to ask questions if you read anything that is not clear, or you would like further information.

Summary

Over the last two decades there has been an increase in the running population. Running is a relatively low cost activity and easily accessible, providing health, social and emotional benefits to participants. However with an increase in the numbers of running there has been an increase in the rates of running injury, leading to many runners having to stop and even leave the sport altogether.

Some runners turn to the internet to get information on how to avoid injury and self manage the most common running related injuries. There is a lot of information out there but most online resources lack evidence and are not always relevant to one's own injury or circumstances.

As well as collecting and reviewing the available evidence for running related injury prevention we also want to establish runners' experiences and opinions regarding injury prevention. We have developed this survey to collect information from runners about their running experiences, injury experiences and what runners have felt is most beneficial in preventing and self managing running related injuries. With this data we then hope to develop RUN HEALTHY, RUN STRONG, a running injury prevention self-management platform.

What is the purpose of the study?

The study aims to develop the content of a running related injury prevention and self-management tool that can be used by recreational runners.

Why have I been invited to participate?

You have been invited to participate in this study because you are a person above 18 years of age, you are a recreational runner and a member of Run Wales Community Running Group or WA affiliated running club.

Do I have to take part?

It is up to you to decide whether to take part. We will describe the steps of the study in this information sheet. If you agree to take part in the study, we will ask you to sign a consent form. You are free to withdraw from the study at any time without giving a reason.

What will happen to me if I take part?

You will be given a link to the survey. The survey will take you through various domains: your running experiences, your injury experiences, what you have felt to be most beneficial when preventing or self-managing injury and what content you would like to see in a running injury prevention tool.

At the end of the survey there will be an option to take a further part in this study via a focus group. You are not obligated to take any further part in this study but if you do wish to take part in a focus group related to this study then you will be asked to consent to be contacted by the researcher (KW) via your email address.

If you agree we will also invite you to take part in a focus group to gather more

detailed information about your running experiences and views on running injury prevention.

The focus groups will be held in the School of Healthcare Sciences, Eastgate House, Newport Road, Cardiff. Refreshments will be available during the focus groups. You can choose not to participate in the focus groups or interviews if you don't want to.

What will I have to do?

We will ask you to sign an electronic consent form and you should be aware of the following before you participate:

- After signing informed constent you will be able to click on the link to the survey.
- Once you have clicked on the link you will be taken to the survey. The survey will ask you about you, your running experiences, any experience of running injury, how you try to prevent running injuries, what you have felt to be beneficial to you in preventing or self-managing running injury and what content you feel would be most useful in a running related injury prevention and self-management programme. This will take you 10-15 minutes to complete.
- If you consent to be contacted further, you will be invited to take part in a focus group (60 minutes maximum) that will be made up of between 5-8 other runners.

What are the possible disadvantages and risks of taking part?

There is no disadvantage or a risk in taking part other than time burden completing the survey (which takes about 10-15 minutes). Information will be stored confidentially and will only be shared anonymously with project supervisors.

What are the possible benefits of taking part?

We cannot promise that this study will help you to prevent running related injury but the information we obtain from the study will help the development and design of a running related injury prevention and self-management programme.

What if there is a problem?

If you have any concerns about any part of the study, you should ask the researcher and she will do their best to answer your questions and deal with your concerns. If you are still unhappy and wish to make a formal complaint, you should contact:

Dr Kate Button

Director of Research Governance

School of Healthcare Sciences

[redacted]

Will my taking part in this study be kept confidential?

All information which is collected about you will be kept strictly confidential. The researcher will maintain your privacy and confidentiality and the survey is completely anonymous. The procedures for handling, processing, storage and destruction of data will follow the Data Protection Act 2018. All the data will be anonymous and given a code, known only to the researcher. The data will be stored in an encrypted and password protected computer known only by the researcher. This data will only be used for this study and future studies will not have access to it unless further agreement from you is requested and consent obtained. Data identifiable to you will be stored securely at Cardiff University and accessed only by the principal researcher. In addition, the data will be kept for a minimum of fifteen years and disposed of securely according to the recommendations of the Data Protection Act 2018.

Anonymised data arising from the study will be shared with the Healthcare Sciences Department at Cardiff University, Run Wales and Welsh Athletics.

How will my data be managed?

Cardiff University is the sponsor for this study based in the United Kingdom. We will be using information from you in order to undertake this study and will act as the data controller for this study. This means that we are responsible for looking after your information and using it properly. Cardiff University will keep identifiable information about you for 15 years after the study has finished.

Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible.

You can find out more about how we use your information at: https://www.cardiff.ac.uk/public-information/policies-and-procedures/data-protection or by contacting the University's Data Protection Officer: inforequest@cardiff.ac.uk

What will happen to the results of the research study?

The researcher may publish the study in academic journals and present the results at conferences. In addition, the main findings will be disseminated to all participants via an online link which will be sent to your email. The findings will also be made available to the funder (KESS2, Run Wales and Welsh Athletics). Only anonymised results will be published, you will not be identified in any report or publication. .

Who is organising and funding the research?

This research is jointly funded by Cardiff University, KESS2 fund, Bangor University, Run Wales and Welsh Athletics.

Who has reviewed the study?

The study has been reviewed by the Cardiff University School of Healthcare Sciences Research Ethics Committee and Health and Care Research Wales. Cardiff University is the Sponsor for the study, in accordance with the UK Policy Framework for Health and Social Care Research.

Further information and contact details

Principal Researcher: Kathleen Walker

Telephone:

Email:

Thank you for reading the information sheet above.

Now please select one of the following options:

Option	Text	Outcome
1	*I read the information sheet and want to participate*	Link to go to e-consent
2	*I don't want to participate*	Thank you very much for your interest. We would be very interested to hear the reasons for your choosing to opt out. Please click statements that apply: - I don't have time - I am not currently running - I don't have access to internet Other

Appendix 11: E-Consent Form for survey

Title of Study: Run Healthy, Run Strong: The Development of A Running Injury Prevention Self-Management Platform for Recreational Runners

Name of Researcher: Kathleen Walker

To participate in this project you need to confirm your agreement with each of the statements below. Please tick each box.

1. I confirm that I have read and understand the information sheet (date 04/09/2019, version 1) for the above study and have had opportunity to ask questions. (*required).
2. I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, and without my medical care or legal rights being affected but any data collected up to the point of my withdrawal will be kept. (*required)
3. I understand that my details will be linked to a unique identifier to ensure confidentiality. (*required)
4. I confirm that data from the study can be used in the final report and other academic publications and may be presented at conference, I understand that these will be used anonymously. (*required)
5. You may contact me regarding taking part in a focus group. (optional)
6. I agree for you to share my anonymised data with external collaborators in the UK and abroad, including commercial companies. (optional)
7. You may contact me in the future to ask if I would be interested in participating in future Cardiff University research. (optional)
8. I agree to take part in the above study. (*required)

Participant's name
Date of Birth
Email address
Date of consent

By pressing the submit button I agree to take part in this study

'Submit'

Appendix 12: Survey questions

1. How old are you?
2. What is your gender?
    a. Female
    b. Male
3. What is you height? Cm
4. What is your weight? Kgs
5. Which region of Wales do you live in?
    a. Blaenau Gwent
    b. Bridgend
    c. Cardiff
    d. Carmarthenshire
    e. Caerphilly
    f. Ceredigion
    g. Conwy
    h. Denbighshire
    i. Flintshire
    j. Gwynedd
    k. Isle of Anglesey
    l. Merthyr Tydfil
    m. Monmouthshire
    n. Neath Port Talbot
    o. Newport
    p. Pembrokeshire
    q. Powys
    r. Rhondda Cynon Taf
    s. Swansea
    t. Torfaen
    u. Vale of Glamorgan
    v. Wrexham
6. How long have you been running?
    a. Less than 3 months
    b. 3 months to 2 years
    c. Over 3 years
7. What are your main reasons for running? Tick up to three that apply.
    a. Health reasons e.g. to be fitter
    b. To meet people
    c. For mental well-being
    d. To compete in races
    e. Weight loss
    f. Other
8. If you selected other please specify.
9. What is the average distance in miles that you run each week?
    a. 0-5 miles
    b. 6- 10 miles
    c. 10-30 miles
    d. 30 miles +

10. Who do you run with? Tick the two most frequent.
    a. With a running club
    b. With a community running group
    c. Run alone
    d. With friends
    e. Other
11. If you selected other please specify.
12. Do you take part in mass participation events or races?
    a. Yes
    b. No
13. If you answered yes, in the last 12 months how many mass participation events have you taken part in?
14. What distance mass participation events/races do you typically take part in?
    a. 5km
    b. 10km
    c. Half marathon
    d. Marathon
    e. Ultra marathon
15. Do you do any activities besides running? Tick all that apply.
    a. Cycling
    b. Swimming
    c. Weight training
    d. Exercise classes e.g. circuits, crossfit, spinning
    e. Yoga/pilates
    f. Other
    g. I don't do any activities outside of running
16. If you selected other please specify.
17. Who motivates you to run? Tick up to 3 that apply.
    a. I motivate myself
    b. Friends
    c. Running leader/coach
    d. Experts e.g. coaches, physiotherapists
    e. Role models e.g. sports people, athletes, professional runners
    f. Celebrities
    g. Social media influencers
    h. Other
18. If you selected other, please specify
19. Do you monitor your running training?
20. If you answered yes, how do you monitor your running training?Tick up to three that apply.
    a. Paper diary
    b. Running watch
    c. Smartphone application
    d. Web platform
    e. Other
21. If you selected other, please specify.
22. Where do you source your training programmes from? Tick up to 3 that apply
    a. Online
    b. Running magazine

c. Book
d. Running coach/club/leader
e. I devise the training plan myself
f. I don't follow a programme, I run by how I feel.
g. Other

23. If you selected other, please specify.
24. If you ticked online/running magazine/book, are you able to provide more details?
25. Do you use a GPS watch and/or smartphone app to monitor your running activity?
26. If you use an app which app do you use?
    a. Strava
    b. Map my run
    c. Run keeper
    d. Nike run club
    e. NHS couch to 5k
    f. Other
27. If you selected other please specify.
28. If you use a watch which watch do you use?
    a. Garmin
    b. Suunto
    c. Fitbit
    d. Apple watch
    e. Other
29. If you selected other please specify.
30. What do you look for in a smartphone app/ GPS watch? Tick all that apply.
    a. Training programme resource
    b. Function to monitor training volume e.g. distances and distances run per week
    c. Function to monitor intensity e.g. speed, pace, intervals
    d. Function to monitor rest periods
    e. Heart rate monitor
    f. Connectivity to other runners for support
    g. To see other runners to compete with
    h. Function to keep track of the wear of running shoes
    i. Motivation function e.g giving awards, feedback on weekly/monthly mileage etc
    j. Other
31. If you selected other please specify.
32. If your smartphone app/GPS watch provides you with advice on training volumes/recovery periods/pacing of runs, do you take this advice on board?
    a. Yes
    b. No
33. If you do not take the advice given by your smartphone app/GPS watch what are the reasons for this?
34. If you follow a training programme do you ever do more than the training programme recommends?
    a. Yes
    b. No
35. If you answered yes, why is this? Tick all that apply
    a. I feel good so I feel I can run further/faster than the programme recommends
    b. I want to compete with friends/followers

c. I feel that sometimes more is better
d. Other

36. If you selected other, please specify
37. What else do you use your smartphone app/GPS watch to monitor? Tick all that apply
    a. Sleep
    b. Weight management
    c. Calorie counting
    d. Hydration
    e. Nutrition
    f. Step count
    g. Other sports activities e.g. gym, cycling
    h. Menstrual cycle
    i. Stress levels
    j. Other
38. If you selected other please specify
39. Many smartphone apps/GPS watches use gamification features to motivate users. What gamification features motivate your training? Tick up to 3 that apply
    a. Number of runners following me
    b. Number of likes/kudos on my activities
    c. Competing with the times of other runners
    d. Competing with runners over a set route
    e. Improving my place on a leader board
    f. I am not motivated by any of the above
40. Have you ever sustained a running-related injury?
    a. Yes
    b. No
41. How many times have you been injured due to running?
    a. 1-3
    b. 3-7
    c. >7
42. What was your most recent running-related injury?
    a. Foot injury (e.g. plantar fasciitis)
    b. Achilles tendon injury (e.g tendonitis, tear)
    c. Shin splints
    d. Stress fracture
    e. Hamstring injury (e.g. strain, tear)
    f. Quadriceps injury (e.g. strain, tear)
    g. Calf injury (e.g. strain, tear)
    h. Ankle ligament sprain
    i. Knee ligament sprain
    j. Patellofemoral knee pain
    k. Iliotibial band pain syndrome
    l. Hip pain
    m. Low back pain
    n. Neck, shoulder pain
    o. Buttock pain/glute strain
    p. Other
43. If you selected other, please specify.

44. How much time off running did you need following your most recent injury?
    a. None, I continued to run through the injury
    b. 1-2 weeks
    c. 2-4 weeks
    d. 4-6 weeks
    e. 6 + weeks
45. How did you manage your most recent injury? Tick all that apply.
    a. Rest
    b. GP visit
    c. Visited a physiotherapist/sports therapist
    d. Had a sports massage
    e. Self-management
    f. Followed advice from running peers
46. If you self-managed your most recent running injury how did you do this?
    a. Stretching
    b. Strength exercises
    c. Foam rolling
    d. Ice treatment
    e. Heat treatment
    f. Modified running training
    g. Cross-trained i.e cycling, swimming etc
    h. Other
47. If you selected other, please specify.
48. Have you ever been forced to take time off work because of your running injury?
    a. Yes
    b. No
49. If yes, are you able to provide details of how long and why?
50. Have you ever been forced to stop your daily functional tasks because of your running injury?
    a. Yes
    b. No
51. If you answered yes, please could you provide more details?
52. What have you found to be the most beneficial in managing your running injury? Tick the three most important.
    a. Advice from healthcare professionals (e.g. Physiotherapists, GP, Pharmacist)
    b. Advice from running coach/running leader/running club
    c. Orthotics Massage Advice from running peers
    d. Gait assessment
    e. Finding the right shoes
    f. Exercise programmes
    g. Online advice
    h. Other
53. If you selected other please specify.
54. If you have used online resources when injured, what have you found to be the most useful? Tick all the apply
    a. NHS website
    b. Information video format e.g. You Tube
    c. Physiotherapy/Sports Therapy web sites

    d. Online running magazine
    e. Other
55. If you selected other please specify
56. Have you ever found your chosen smartphone app/GPS watch useful when managing an injury?
    a. Yes
    b. No
57. If you found your chosen device/app useful for injury management how did you find it beneficial? Tick all that apply
    a. Modifying types of runs
    b. Monitoring training volume i.e. distance
    c. Monitoring intensity of runs i.e. speed
    d. Monitoring/advising rest periods
    e. Provided specific injury management advice
    f. Other
58. If you selected other, please specify
59. Would you be interested in a smartphone app that could help you prevent or manage a running injury?
    a. Yes
    b. No
60. What features would you want to see in an injury prevention app? Tick up to 3
    a. An 'Injury Free' running toolbox (e.g. to advise on running mileage)
    b. Resilient Runner toolbox (e.g to advise on exercises for better running)
    c. Self-diagnostic tool (e.g find out what type of injury I may have)
    d. Self-screen tool (e.g. decide when to seek help from a professional)
    e. 'After injury' guide (e.g guide on recovery/rest periods)
    f. Return to Running Toolbox (e.g. advice on starting to run again after injury)
    g. 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)
    h. Other 3
61. If you selected other please specify
62. Who would you want this information from?
    a. Health professionals e.g. Physiotherapists, Sports Therapists, Doctors, Podiatrists
    b. Fellow runners
    c. Well known runners
    d. Running coaches/leaders
    e. Other
63. If you selected other please specify
64. How important is it to you that the information in a running injury prevention/management app is based on current research evidence?
    a. Very important
    b. Important
    c. Not important
    d. Not sure
65. Would it be helpful within an injury prevention/management app to have a feature that allows you to enter your symptoms and advise you whether you need to see a health professional?
    a. Very helpful
    b. Helpful

c. Not helpful
d. Not sure

66. Would you want to see exercise programmes for the prevention/management of specific running injuries within the app?
    a. Yes
    b. No
67. Are there any other types of information that you would want to see in an injury prevention/management app?
    a. Nutritional information
    b. Hydration information
    c. Information on managing stress
    d. Sleep advice
    e. Other
68. If you selected other please specify.

Appendix 13: SPSS output

Monitor training by gender – cross tabs and chi-square test

Crosstab

			Gender		
			Female	Male	Total
Monitor training?	Yes	Count	141a	84a	225
		row % of Monitor training?	62.7%	37.3%	100.0%
		col % of Gender	95.9%	98.8%	97.0%
	No	Count	6a	1a	7
		row % of Monitor training?	85.7%	14.3%	100.0%
		col % of Gender	4.1%	1.2%	3.0%
Total		Count	147	85	232
		row % of Monitor training?	63.4%	36.6%	100.0%
		col % of Gender	100.0%	100.0%	100.0%

col prop test on Gender at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance	Exact Significance (2-sided)	Exact Significance (1-sided)
Pearson Chi-Square	1.553[a]	1	.213		
Continuity Correction[b]	.719	1	.396		
Likelihood Ratio	1.789	1	.181		
Fisher's Exact Test				.427	.203
Linear-by-Linear Association	1.547	1	.214		
N of Valid Cases	232				

a. 2 cells (50.0%) expf < 5. Min exp = 2.56...

b. Computed only for a 2x2 table

Monitor training cross tabs and chi-square test – by age category

Crosstab

			Age category						Total
			18-24	25-34	35-44	45-54	55-64	65 and over	
Monitor training?	Yes	Count	3a	24a	78a	77a	36a	6a	224
		row % of Monitor training?	1.3%	10.7%	34.8%	34.4%	16.1%	2.7%	100.0%
		col % of Age category	100.0%	96.0%	98.7%	96.3%	97.3%	85.7%	97.0%
	No	Count	0a	1a	1a	3a	1a	1a	7
		row % of Monitor training?	0.0%	14.3%	14.3%	42.9%	14.3%	14.3%	100.0%
		col % of Age category	0.0%	4.0%	1.3%	3.8%	2.7%	14.3%	3.0%
Total		Count	3	25	79	80	37	7	231
		row % of Monitor training?	1.3%	10.8%	34.2%	34.6%	16.0%	3.0%	100.0%
		col % of Age category	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

col prop test on Age category at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	4.183[a]	5	.523
Likelihood Ratio	3.091	5	.686
Linear-by-Linear Association	.989	1	.320
N of Valid Cases	231		

a. 7 cells (58.3%) expf < 5. Min exp = .09...

Monitor training by experience – cross tabs and chi-square test

Monitor training? * Running Experience Crosstabulation

			Running Experience			
			Less than 3 months	3 months - 2 years	More than 2 years	Total
Monitor training?	Yes	Count	1a	47b	177b	225
		col % of Running Experience	50.0%	100.0%	96.7%	97.0%
	No	Count	1a	0b	6b	7
		col % of Running Experience	50.0%	0.0%	3.3%	3.0%
Total		Count	2	47	183	232
		col % of Running Experience	100.0%	100.0%	100.0%	100.0%

col prop test on Running Experience at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	16.592[a]	2	<.001
Likelihood Ratio	7.212	2	.027
Linear-by-Linear Association	.165	1	.684
N of Valid Cases	232		

a. 3 cells (50.0%) expf < 5. Min exp = .06...

Monitor training by average miles per week – cross tabs and chi-square test

Crosstab

			Average miles per week				
			0-5	6-10	10-30	30+	Total
Monitor training?	Yes	Count	16a	70a	111a	28a	225
		row % of Monitor training?	7.1%	31.1%	49.3%	12.4%	100.0%
		col % of Average miles per week	88.9%	97.2%	97.4%	100.0%	97.0%
	No	Count	2a	2a	3a	0a	7
		row % of Monitor training?	28.6%	28.6%	42.9%	0.0%	100.0%
		col % of Average miles per week	11.1%	2.8%	2.6%	0.0%	3.0%
Total		Count	18	72	114	28	232
		row % of Monitor training?	7.8%	31.0%	49.1%	12.1%	100.0%
		col % of Average miles per week	100.0%	100.0%	100.0%	100.0%	100.0%

col prop test on Average miles per week at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	4.973[a]	3	.174
Likelihood Ratio	4.216	3	.239
Linear-by-Linear Association	3.030	1	.082
N of Valid Cases	232		

a. 4 cells (50.0%) expf < 5. Min exp = .54...

How runners monitor training by running experience

two-dim-tab

			Running Experience			
			Less than 3 months	3 months - 2 years	More than 2 years	Total
Monitor_training[a]	Monitor by Paper training diary	Count	0	6	20	26
		pct-within	0.0%	12.8%	11.2%	
	Monitor by Running watch	Count	1	35	151	187
		pct-within	100.0%	74.5%	84.8%	
	Monitor by- Smartphone app	Count	1	40	115	156
		pct-within	100.0%	85.1%	64.6%	
	Monitor by - Web platform	Count	0	4	37	41
		pct-within	0.0%	8.5%	20.8%	
	Monitor - Other	Count	0	1	3	4
		pct-within	0.0%	2.1%	1.7%	
Total		Count	1	47	178	226

On respondents

a. Dichgroup tab

Monitor training by gender

two-dim-tab

			Gender		
			Female	Male	Total
Monitor_training[a]	Monitor by Paper training diary	Count	20	6	26
		pct-within	14.1%	7.1%	
	Monitor by Running watch	Count	114	73	187
		pct-within	80.3%	86.9%	
	Monitor by- Smartphone app	Count	100	56	156
		pct-within	70.4%	66.7%	
	Monitor by - Web platform	Count	14	27	41
		pct-within	9.9%	32.1%	
	Monitor - Other	Count	2	2	4
		pct-within	1.4%	2.4%	
Total		Count	142	84	226

On respondents

a. Dichgroup tab

Monitor training by average miles per week

two-dim-tab

			Average miles per week				Total
			0-5	6-10	10-30	30+	
Monitor_training[a]	Monitor by Paper training diary	Count	2	6	13	5	26
		pct-within	12.5%	8.5%	11.7%	17.9%	
	Monitor by Running watch	Count	9	55	98	25	187
		pct-within	56.3%	77.5%	88.3%	89.3%	
	Monitor by- Smartphone app	Count	13	53	75	15	156
		pct-within	81.3%	74.6%	67.6%	53.6%	
	Monitor by - Web platform	Count	0	6	22	13	41
		pct-within	0.0%	8.5%	19.8%	46.4%	
	Monitor - Other	Count	0	2	2	0	4
		pct-within	0.0%	2.8%	1.8%	0.0%	
Total		Count	16	71	111	28	226

On respondents

a. Dichgroup tab

Number of apps by experience

Apps_selected * Running Experience Crosstabulation

			Running Experience			
			Less than 3 months	3 months - 2 years	More than 2 years	Total
Apps_selected	.00	Count	1a	0b	18a, b	19
		col % of Running Experience	50.0%	0.0%	9.8%	8.2%
	1.00	Count	0a	33a	116a	149
		col % of Running Experience	0.0%	70.2%	63.4%	64.2%
	2.00	Count	1a	11a	43a	55
		col % of Running Experience	50.0%	23.4%	23.5%	23.7%
	3.00	Count	0a	1a	6a	7
		col % of Running Experience	0.0%	2.1%	3.3%	3.0%
	4.00	Count	0a, b	2b	0a	2
		col % of Running Experience	0.0%	4.3%	0.0%	0.9%
Total		Count	2	47	183	232
		col % of Running Experience	100.0%	100.0%	100.0%	100.0%

col prop test on Running Experience at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	18.977[a]	8	.015
Likelihood Ratio	20.187	8	.010
Linear-by-Linear Association	2.217	1	.136
N of Valid Cases	232		

a. 9 cells (60.0%) expf < 5. Min exp = .02...

Number of apps used

Apps_selected * Gender 1 = female 2 = male Crosstabulation

			Gender 1 = female 2 = male		
			female	male	Total
Apps_selected	.00	Count	13a	5a	18
		row % of Apps_selected	72.2%	27.8%	100.0%
		col % of Gender 1 = female 2 = male	8.8%	6.0%	7.8%
	1.00	Count	99a	50a	149
		row % of Apps_selected	66.4%	33.6%	100.0%
		col % of Gender 1 = female 2 = male	67.3%	59.5%	64.5%
	2.00	Count	30a	25a	55
		row % of Apps_selected	54.5%	45.5%	100.0%
		col % of Gender 1 = female 2 = male	20.4%	29.8%	23.8%
	3.00	Count	4a	3a	7
		row % of Apps_selected	57.1%	42.9%	100.0%
		col % of Gender 1 = female 2 = male	2.7%	3.6%	3.0%
	4.00	Count	1a	1a	2
		row % of Apps_selected	50.0%	50.0%	100.0%
		col % of Gender 1 = female 2 = male	0.7%	1.2%	0.9%
Total		Count	147	84	231
		row % of Apps_selected	63.6%	36.4%	100.0%
		col % of Gender 1 = female 2 = male	100.0%	100.0%	100.0%

col prop test on Gender 1 = female 2 = male at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	3.333[a]	4	.504
Likelihood Ratio	3.298	4	.509
Linear-by-Linear Association	2.806	1	.094
N of Valid Cases	231		

a. 4 cells (40.0%) expf < 5. Min exp = .73...

Number of apps used by age category

Apps_selected * Age category Crosstabulation

			Age category						
			18-24	25-34	35-44	45-54	55-64	65 and over	Total
Apps_selected	.00	Count	$0_{a, b, c}$	$1_{b, c}$	2_{c}	11_{b}	$2_{b, c}$	3_{a}	19
		row % of Apps_selected	0.0%	5.3%	10.5%	57.9%	10.5%	15.8%	100.0%
		col % of Age category	0.0%	4.0%	2.5%	13.8%	5.4%	42.9%	8.2%
	1.00	Count	$1_{a, b}$	$15_{a, b}$	$52_{a, b}$	57_{b}	$22_{a, b}$	2_{a}	149
		row % of Apps_selected	0.7%	10.1%	34.9%	38.3%	14.8%	1.3%	100.0%
		col % of Age category	33.3%	60.0%	65.8%	71.3%	59.5%	28.6%	64.5%
	2.00	Count	2_{a}	8_{a}	22_{a}	9_{b}	12_{a}	$1_{a, b}$	54
		row % of Apps_selected	3.7%	14.8%	40.7%	16.7%	22.2%	1.9%	100.0%
		col % of Age category	66.7%	32.0%	27.8%	11.3%	32.4%	14.3%	23.4%
	3.00	Count	0_{a}	0_{a}	3_{a}	2_{a}	1_{a}	1_{a}	7
		row % of Apps_selected	0.0%	0.0%	42.9%	28.6%	14.3%	14.3%	100.0%
		col % of Age category	0.0%	0.0%	3.8%	2.5%	2.7%	14.3%	3.0%
	4.00	Count	0_{a}	1_{a}	0_{a}	1_{a}	0_{a}	0_{a}	2
		row % of Apps_selected	0.0%	50.0%	0.0%	50.0%	0.0%	0.0%	100.0%
		col % of Age category	0.0%	4.0%	0.0%	1.3%	0.0%	0.0%	0.9%
Total		Count	3	25	79	80	37	7	231
		row % of Apps_selected	1.3%	10.8%	34.2%	34.6%	16.0%	3.0%	100.0%
		col % of Age category	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

col prop test on Age category at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	38.633[a]	20	.007
Likelihood Ratio	34.373	20	.024
Linear-by-Linear Association	3.391	1	.066
N of Valid Cases	231		

a. 20 cells (66.7%) expf < 5. Min exp = .03...

Number of apps used and average miles per week

Apps_selected * Average miles per week Crosstabulation

			Average miles per week 0-5	6-10	10-30	30+	Total
Apps_selected	.00	Count	3a	3a	10a	3a	19
		row % of Apps_selected	15.8%	15.8%	52.6%	15.8%	100.0%
		col % of Average miles per week	16.7%	4.2%	8.8%	10.7%	8.2%
	1.00	Count	11a	50a	70a	18a	149
		row % of Apps_selected	7.4%	33.6%	47.0%	12.1%	100.0%
		col % of Average miles per week	61.1%	69.4%	61.4%	64.3%	64.2%
	2.00	Count	4a	16a	29a	6a	55
		row % of Apps_selected	7.3%	29.1%	52.7%	10.9%	100.0%
		col % of Average miles per week	22.2%	22.2%	25.4%	21.4%	23.7%
	3.00	Count	0a	2a	5a	0a	7
		row % of Apps_selected	0.0%	28.6%	71.4%	0.0%	100.0%
		col % of Average miles per week	0.0%	2.8%	4.4%	0.0%	3.0%
	4.00	Count	0a, b	1a, b	0b	1a	2
		row % of Apps_selected	0.0%	50.0%	0.0%	50.0%	100.0%
		col % of Average miles per week	0.0%	1.4%	0.0%	3.6%	0.9%
Total		Count	18	72	114	28	232
		row % of Apps_selected	7.8%	31.0%	49.1%	12.1%	100.0%
		col % of Average miles per week	100.0%	100.0%	100.0%	100.0%	100.0%

col prop test on Average miles per week at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	9.894[a]	12	.625
Likelihood Ratio	11.159	12	.515
Linear-by-Linear Association	.165	1	.685
N of Valid Cases	232		

a. 11 cells (55.0%) expf < 5. Min exp = .16...

Use of smartphone app by gender

app * gender Crosstabulation

			gender		
			female	male	Total
app	yes	Count	70a	84b	154
		row % of app	45.5%	54.5%	100.0%
		col % of gender	49.3%	100.0%	68.1%
		% of Total	31.0%	37.2%	68.1%
	no	Count	72a	0b	72
		row % of app	100.0%	0.0%	100.0%
		col % of gender	50.7%	0.0%	31.9%
		% of Total	31.9%	0.0%	31.9%
Total		Count	142	84	226
		row % of app	62.8%	37.2%	100.0%
		col % of gender	100.0%	100.0%	100.0%
		% of Total	62.8%	37.2%	100.0%

col prop test on gender at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance	Exact Significance (2-sided)	Exact Significance (1-sided)
Pearson Chi-Square	62.504[a]	1	<.001		
Continuity Correction[b]	60.191	1	<.001		
Likelihood Ratio	86.035	1	<.001		
Fisher's Exact Test				<.001	<.001
Linear-by-Linear Association	62.228	1	<.001		
N of Valid Cases	226				

a. 0 cells (0.0%) expf < 5. Min exp = 26.76...

b. Computed only for a 2x2 table

Use of smartphone app by age category

app * age category Crosstabulation

			age category						Total
			18-24	25-34	35-44	45-54	55-64	65 and over	
app	yes	Count	2a	25b	14c	70a, b	36b	6a, b	153
		row % of app	1.3%	16.3%	9.2%	45.8%	23.5%	3.9%	100.0%
		col % of age category	66.7%	100.0%	17.9%	90.9%	100.0%	100.0%	68.0%
		% of Total	0.9%	11.1%	6.2%	31.1%	16.0%	2.7%	68.0%
	no	Count	1a	0b	64c	7a, b	0b	0a, b	72
		row % of app	1.4%	0.0%	88.9%	9.7%	0.0%	0.0%	100.0%
		col % of age category	33.3%	0.0%	82.1%	9.1%	0.0%	0.0%	32.0%
		% of Total	0.4%	0.0%	28.4%	3.1%	0.0%	0.0%	32.0%
Total		Count	3	25	78	77	36	6	225
		row % of app	1.3%	11.1%	34.7%	34.2%	16.0%	2.7%	100.0%
		col % of age category	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	1.3%	11.1%	34.7%	34.2%	16.0%	2.7%	100.0%

col prop test on age category at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	139.901[a]	5	<.001
Likelihood Ratio	157.942	5	<.001
Linear-by-Linear Association	29.542	1	<.001
N of Valid Cases	225		

a. 4 cells (33.3%) expf < 5. Min exp = .96...

Smartphone app use by running experience

app * running experience Crosstabulation

			running experience			
			less than 3 months	3 months to 2 years	more than 2 years	Total
app	yes	Count	1a, b	40b	113a	154
		row % of app	0.6%	26.0%	73.4%	100.0%
		col % of running experience	50.0%	85.1%	63.8%	68.1%
		% of Total	0.4%	17.7%	50.0%	68.1%
	no	Count	1a, b	7b	64a	72
		row % of app	1.4%	9.7%	88.9%	100.0%
		col % of running experience	50.0%	14.9%	36.2%	31.9%
		% of Total	0.4%	3.1%	28.3%	31.9%
Total		Count	2	47	177	226
		row % of app	0.9%	20.8%	78.3%	100.0%
		col % of running experience	100.0%	100.0%	100.0%	100.0%
		% of Total	0.9%	20.8%	78.3%	100.0%

col prop test on running experience at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	8.042[a]	2	.018
Likelihood Ratio	8.897	2	.012
Linear-by-Linear Association	5.539	1	.019
N of Valid Cases	226		

a. 2 cells (33.3%) expf < 5. Min exp = .64...

Smartphone app use by average miles per week

app * Average distance per week Crosstabulation

			Average distance per week				
			0-5	6-10	10-30	30 +	Total
app	yes	Count	15a, b	26c	85b	28a	154
		row % of app	9.7%	16.9%	55.2%	18.2%	100.0%
		col % of Average distance per week	93.8%	36.6%	76.6%	100.0%	68.1%
		% of Total	6.6%	11.5%	37.6%	12.4%	68.1%
	no	Count	1a, b	45c	26b	0a	72
		row % of app	1.4%	62.5%	36.1%	0.0%	100.0%
		col % of Average distance per week	6.3%	63.4%	23.4%	0.0%	31.9%
		% of Total	0.4%	19.9%	11.5%	0.0%	31.9%
Total		Count	16	71	111	28	226
		row % of app	7.1%	31.4%	49.1%	12.4%	100.0%
		col % of Average distance per week	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	7.1%	31.4%	49.1%	12.4%	100.0%

col prop test on Average distance per week at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	54.059[a]	3	<.001
Likelihood Ratio	61.255	3	<.001
Linear-by-Linear Association	17.728	1	<.001
N of Valid Cases	226		

a. 0 cells (0.0%) expf < 5. Min exp = 5.10...

Online resources that runners find useful – by gender

two-dim-tab

			Gender		
			Female	Male	Total
online_resources[a]	Online resources most useful - NHS website	Count	34	19	53
		pct-within	40.0%	35.2%	
	Online resources most useful - Information video format e.g. You Tube	Count	24	28	52
		pct-within	28.2%	51.9%	
	Online resources most useful? - Physiotherapy/Sports Therapy web sites	Count	36	36	72
		pct-within	42.4%	66.7%	
	Online resources most useful? Online running magazine	Count	34	18	52
		pct-within	40.0%	33.3%	
	Online resources most useful? - Other	Count	2	3	5
		pct-within	2.4%	5.6%	
Total		Count	85	54	139

On respondents

a. Dichgroup tab

Online resources thar runners find useful – by running experience

two-dim-tab

			Running Experience: 3 months - 2 years	Running Experience: More than 2 years	Total
online_resources[a]	Online resources most useful - NHS website	Count	12	41	53
		pct-within	40.0%	37.6%	
	Online resources most useful - Information video format e.g. You Tube	Count	11	41	52
		pct-within	36.7%	37.6%	
	Online resources most useful? - Physiotherapy/Sports Therapy web sites	Count	12	60	72
		pct-within	40.0%	55.0%	
	Online resources most useful? Online running magazine	Count	11	41	52
		pct-within	36.7%	37.6%	
	Online resources most useful? - Other	Count	1	4	5
		pct-within	3.3%	3.7%	
Total		Count	30	109	139

On respondents

a. Dichgroup tab

<u>Online resources that runners find useful – by average miles per week</u>

two-dim-tab

			Average miles per week 0-5	6-10	10-30	30+	Total
online_resources[a]	Online resources most useful - NHS website	Count	3	14	32	4	53
		pct-within	42.9%	31.8%	42.7%	30.8%	
	Online resources most useful - Information video format e.g. You Tube	Count	3	20	25	4	52
		pct-within	42.9%	45.5%	33.3%	30.8%	
	Online resources most useful? - Physiotherapy/Sports Therapy web sites	Count	3	21	42	6	72
		pct-within	42.9%	47.7%	56.0%	46.2%	
	Online resources most useful? Online running magazine	Count	2	10	35	5	52
		pct-within	28.6%	22.7%	46.7%	38.5%	
	Online resources most useful? - Other	Count	0	0	4	1	5
		pct-within	0.0%	0.0%	5.3%	7.7%	
Total		Count	7	44	75	13	139

On respondents

a. Dichgroup tab

Finding NHS sites useful - gender

Crosstab

			gender		
			female	male	Total
NHS sites	yes	Count	53a	0b	53
		row % of NHS sites	100.0%	0.0%	100.0%
		col % of gender	37.9%	0.0%	23.7%
	no	Count	87a	84b	171
		row % of NHS sites	50.9%	49.1%	100.0%
		col % of gender	62.1%	100.0%	76.3%
Total		Count	140	84	224
		row % of NHS sites	62.5%	37.5%	100.0%
		col % of gender	100.0%	100.0%	100.0%

col prop test on gender at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance	Exact Significance (2-sided)	Exact Significance (1-sided)
Pearson Chi-Square	41.656[a]	1	<.001		
Continuity Correction[b]	39.587	1	<.001		
Likelihood Ratio	59.377	1	<.001		
Fisher's Exact Test				<.001	<.001
Linear-by-Linear Association	41.470	1	<.001		
N of Valid Cases	224				

a. 0 cells (0.0%) expf < 5. Min exp = 19.88...

b. Computed only for a 2x2 table

Finding NHS sites useful by age category

Crosstab

			age category						Total
			18-24	25-34	35-44	45-54	55-64	65 and over	
NHS sites	yes	Count	1a	11a	41a	0b	0b	0a, b	53
		row % of NHS sites	1.9%	20.8%	77.4%	0.0%	0.0%	0.0%	100.0%
		col % of age category	100.0%	44.0%	52.6%	0.0%	0.0%	0.0%	23.8%
	no	Count	0a	14a	37a	77b	36b	6a, b	170
		row % of NHS sites	0.0%	8.2%	21.8%	45.3%	21.2%	3.5%	100.0%
		col % of age category	0.0%	56.0%	47.4%	100.0%	100.0%	100.0%	76.2%
Total		Count	1	25	78	77	36	6	223
		row % of NHS sites	0.4%	11.2%	35.0%	34.5%	16.1%	2.7%	100.0%
		col % of age category	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

col prop test on age category at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	81.657[a]	5	<.001
Likelihood Ratio	102.354	5	<.001
Linear-by-Linear Association	54.441	1	<.001
N of Valid Cases	223		

a. 4 cells (33.3%) expf < 5. Min exp = .24...

Finding info videos useful

Crosstab

			Average distance per week				
			0-5	6-10	10-30	30 +	Total
info_videos	yes	Count	11a	38a	3b	0b	52
		row % of info_videos	21.2%	73.1%	5.8%	0.0%	100.0%
		col % of Average distance per week	78.6%	53.5%	2.7%	0.0%	23.2%
	no	Count	3a	33a	108b	28b	172
		row % of info_videos	1.7%	19.2%	62.8%	16.3%	100.0%
		col % of Average distance per week	21.4%	46.5%	97.3%	100.0%	76.8%
Total		Count	14	71	111	28	224
		row % of info_videos	6.3%	31.7%	49.6%	12.5%	100.0%
		col % of Average distance per week	100.0%	100.0%	100.0%	100.0%	100.0%

col prop test on Average distance per week at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	95.317[a]	3	<.001
Likelihood Ratio	102.544	3	<.001
Linear-by-Linear Association	79.828	1	<.001
N of Valid Cases	224		

a. 1 cells (12.5%) expf < 5. Min exp = 3.25...

Finding info videos useful - gender

info_videos * gender Crosstabulation

			gender		
			female	male	Total
info_videos	yes	Count	24a	28b	52
		row % of info_videos	46.2%	53.8%	100.0%
		col % of gender	16.9%	33.3%	23.0%
	no	Count	118a	56b	174
		row % of info_videos	67.8%	32.2%	100.0%
		col % of gender	83.1%	66.7%	77.0%
Total		Count	142	84	226
		row % of info_videos	62.8%	37.2%	100.0%
		col % of gender	100.0%	100.0%	100.0%

col prop test on gender at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance	Exact Significance (2-sided)	Exact Significance (1-sided)
Pearson Chi-Square	8.045[a]	1	.005		
Continuity Correction[b]	7.144	1	.008		
Likelihood Ratio	7.840	1	.005		
Fisher's Exact Test				.006	.004
Linear-by-Linear Association	8.009	1	.005		
N of Valid Cases	226				

a. 0 cells (0.0%) expf < 5. Min exp = 19.33...

b. Computed only for a 2x2 table

Finding info videos useful – age category

Crosstab

			age category						Total
			18-24	25-34	35-44	45-54	55-64	65 and over	
info_videos	yes	Count	1a	10a	41a	0b	0b	0a, b	52
		row % of info_videos	1.9%	19.2%	78.8%	0.0%	0.0%	0.0%	100.0%
		col % of age category	100.0%	40.0%	52.6%	0.0%	0.0%	0.0%	23.3%
	no	Count	0a	15a	37a	77b	36b	6a, b	171
		row % of info_videos	0.0%	8.8%	21.6%	45.0%	21.1%	3.5%	100.0%
		col % of age category	0.0%	60.0%	47.4%	100.0%	100.0%	100.0%	76.7%
Total		Count	1	25	78	77	36	6	223
		row % of info_videos	0.4%	11.2%	35.0%	34.5%	16.1%	2.7%	100.0%
		col % of age category	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

col prop test on age category at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	80.677[a]	5	<.001
Likelihood Ratio	100.644	5	<.001
Linear-by-Linear Association	51.351	1	<.001
N of Valid Cases	223		

a. 4 cells (33.3%) expf < 5. Min exp = .23...

Finding physio websites useful by distance per week

Crosstab

			Average distance per week				
			0-5	6-10	10-30	30 +	Total
physio websites	yes	Count	12a	38a	22b	0b	72
		row % of physio websites	16.7%	52.8%	30.6%	0.0%	100.0%
		col % of Average distance per week	85.7%	53.5%	19.8%	0.0%	32.1%
	no	Count	2a	33a	89b	28b	152
		row % of physio websites	1.3%	21.7%	58.6%	18.4%	100.0%
		col % of Average distance per week	14.3%	46.5%	80.2%	100.0%	67.9%
Total		Count	14	71	111	28	224
		row % of physio websites	6.3%	31.7%	49.6%	12.5%	100.0%
		col % of Average distance per week	100.0%	100.0%	100.0%	100.0%	100.0%

col prop test on Average distance per week at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	54.290[a]	3	<.001
Likelihood Ratio	61.228	3	<.001
Linear-by-Linear Association	52.878	1	<.001
N of Valid Cases	224		

a. 1 cells (12.5%) expf < 5. Min exp = 4.50...

Physio websites by gender

Crosstab

			gender		
			female	male	Total
physio websites	yes	Count	72a	0b	72
		row % of physio websites	100.0%	0.0%	100.0%
		col % of gender	51.4%	0.0%	32.1%
	no	Count	68a	84b	152
		row % of physio websites	44.7%	55.3%	100.0%
		col % of gender	48.6%	100.0%	67.9%
Total		Count	140	84	224
		row % of physio websites	62.5%	37.5%	100.0%
		col % of gender	100.0%	100.0%	100.0%

col prop test on gender at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance	Exact Significance (2-sided)	Exact Significance (1-sided)
Pearson Chi-Square	63.663[a]	1	<.001		
Continuity Correction[b]	61.327	1	<.001		
Likelihood Ratio	87.351	1	<.001		
Fisher's Exact Test				<.001	<.001
Linear-by-Linear Association	63.379	1	<.001		
N of Valid Cases	224				

a. 0 cells (.0%) expf < 5. Min exp = 27.00...

b. Computed only for a 2x2 table

Finding physio websites useful by running experience

Crosstab

			running experience: 3 months to 2 years	running experience: more than 2 years	Total
physio websites	yes	Count	12a	60a	72
		row % of physio websites	16.7%	83.3%	100.0%
		col % of running experience	25.5%	33.9%	32.1%
	no	Count	35a	117a	152
		row % of physio websites	23.0%	77.0%	100.0%
		col % of running experience	74.5%	66.1%	67.9%
Total		Count	47	177	224
		row % of physio websites	21.0%	79.0%	100.0%
		col % of running experience	100.0%	100.0%	100.0%

col prop test on running experience at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance	Exact Significance (2-sided)	Exact Significance (1-sided)
Pearson Chi-Square	1.192[a]	1	.275		
Continuity Correction[b]	.839	1	.360		
Likelihood Ratio	1.229	1	.268		
Fisher's Exact Test				.298	.180
Linear-by-Linear Association	1.187	1	.276		
N of Valid Cases	224				

a. 0 cells (.0%) expf < 5. Min exp = 15.11...

b. Computed only for a 2x2 table

Physio websites by age category

Crosstab

			age category						Total
			18-24	25-34	35-44	45-54	55-64	65 and over	
physio websites	yes	Count	$1_{a, b}$	$11_{a, b}$	57_{b}	3_{c}	0_{c}	$0_{a, c}$	72
		row % of physio websites	1.4%	15.3%	79.2%	4.2%	0.0%	0.0%	100.0%
		col % of age category	100.0%	44.0%	73.1%	3.9%	0.0%	0.0%	32.3%
	no	Count	$0_{a, b}$	$14_{a, b}$	21_{b}	74_{c}	36_{c}	$6_{a, c}$	151
		row % of physio websites	0.0%	9.3%	13.9%	49.0%	23.8%	4.0%	100.0%
		col % of age category	0.0%	56.0%	26.9%	96.1%	100.0%	100.0%	67.7%
Total		Count	1	25	78	77	36	6	223
		row % of physio websites	0.4%	11.2%	35.0%	34.5%	16.1%	2.7%	100.0%
		col % of age category	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

col prop test on age category at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	111.442[a]	5	<.001
Likelihood Ratio	130.022	5	<.001
Linear-by-Linear Association	64.207	1	<.001
N of Valid Cases	223		

a. 4 cells (33.3%) expf < 5. Min exp = .32...

Interested in an app – by age

Interested in a smartphone app that could help prevent/ manage RRI? * Age category Crosstabulation

			Age category						Total
			18-24	25-34	35-44	45-54	55-64	64 and over	
Interested in a smartphone app that could help prevent/ manage RRI?	Yes	Count	3a	22a	70a	68a	28a	4a	195
		col % of Age category	100.0%	88.0%	88.6%	85.0%	75.7%	57.1%	84.4%
	No	Count	0a	3a	9a	12a	9a	3a	36
		col % of Age category	0.0%	12.0%	11.4%	15.0%	24.3%	42.9%	15.6%
Total		Count	3	25	79	80	37	7	231
		col % of Age category	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

col prop test on Age category at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	7.980[a]	5	.157
Likelihood Ratio	7.286	5	.200
Linear-by-Linear Association	5.840	1	.016
N of Valid Cases	231		

a. 4 cells (33.3%) expf < 5. Min exp = .47...

Interested in an intervention by gender

Interested in a smartphone app that could help prevent/ manage RRI? * Gender Crosstabulation

			Gender		
			Female	Male	Total
Interested in a smartphone app that could help prevent/ manage RRI?	Yes	Count	124a	72a	196
		col % of Gender	84.4%	84.7%	84.5%
	No	Count	23a	13a	36
		col % of Gender	15.6%	15.3%	15.5%
Total		Count	147	85	232
		col % of Gender	100.0%	100.0%	100.0%

col prop test on Gender at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance	Exact Significance (2-sided)	Exact Significance (1-sided)
Pearson Chi-Square	.005[a]	1	.943		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.005	1	.943		
Fisher's Exact Test				1.000	.551
Linear-by-Linear Association	.005	1	.943		
N of Valid Cases	232				

a. 0 cells (.0%) expf < 5. Min exp = 13.19...

b. Computed only for a 2x2 table

Interested in an intervention by experience

Interested in a smartphone app that could help prevent/ manage RRI? * Running Experience Crosstabulation

			Running Experience			
			Less than 3 months	3 months - 2 years	More than 2 years	Total
Interested in a smartphone app that could help prevent/ manage RRI?	Yes	Count	2a, b	45b	149a	196
		col % of Running Experience	100.0%	95.7%	81.4%	84.5%
	No	Count	0a, b	2b	34a	36
		col % of Running Experience	0.0%	4.3%	18.6%	15.5%
Total		Count	2	47	183	232
		col % of Running Experience	100.0%	100.0%	100.0%	100.0%

col prop test on Running Experience at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	7.559[a]	2	.023
Likelihood Ratio	6.443	2	.040
Linear-by-Linear Association	5.616	1	.018
N of Valid Cases	205		

a. 3 cells (50.0%) expf < 5. Min exp = .13...

Interested in an intervention by average miles per week

Interested in a smartphone app that could help prevent/ manage RRI? * Average miles per week Crosstabulation

			Average miles per week				
			0-5	6-10	10-30	30+	Total
Interested in a smartphone app that could help prevent/ manage RRI?	Yes	Count	15a	66a	91a	24a	196
		col % of Average miles per week	83.3%	91.7%	79.8%	85.7%	84.5%
	No	Count	3a	6a	23a	4a	36
		col % of Average miles per week	16.7%	8.3%	20.2%	14.3%	15.5%
Total		Count	18	72	114	28	232
		col % of Average miles per week	100.0%	100.0%	100.0%	100.0%	100.0%

col prop test on Average miles per week at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	4.772[a]	3	.189
Likelihood Ratio	5.117	3	.163
Linear-by-Linear Association	1.025	1	.311
N of Valid Cases	232		

a. 2 cells (25.0%) expf < 5. Min exp = 2.79...

Features that runners want in the intervention – by running experience

two-dim-tab

			Running Experience			
			Less than 3 months	3 months - 2 years	More than 2 years	Total
Features of intervention[a]	Features -'Injury Free' running toolbox (e.g. to advise on running mileage)	Count	1	24	77	102
		pct-within	50.0%	52.2%	50.7%	
	Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	Count	1	30	100	131
		pct-within	50.0%	65.2%	65.8%	
	Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	Count	1	31	85	117
		pct-within	50.0%	67.4%	55.9%	
	Features - self screen tool	Count	0	15	46	61
		pct-within	0.0%	32.6%	30.3%	
	Features- 'After injury' guide (e.g. to guide on recovery/rest periods)	Count	0	23	76	99
		pct-within	0.0%	50.0%	50.0%	
	Features - Return to Running Toolbox (e.g. advice on starting to run again after injury)	Count	0	21	78	99
		pct-within	0.0%	45.7%	51.3%	
	Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	Count	2	26	99	127
		pct-within	100.0%	56.5%	65.1%	
	Features - Other	Count	0	0	3	3
		pct-within	0.0%	0.0%	2.0%	
Total		Count	2	46	152	200

On respondents

a. Dichgroup tab

Features that runners want in the intervention – by gender

two-dim-tab

			Gender		
			Female	Male	Total
Features of intervention[a]	Features -'Injury Free' running toolbox (e.g. to advise on running mileage)	Count	61	41	102
		pct-within	47.7%	56.9%	
	Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	Count	83	48	131
		pct-within	64.8%	66.7%	
	Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	Count	74	43	117
		pct-within	57.8%	59.7%	
	Features - self screen tool	Count	43	18	61
		pct-within	33.6%	25.0%	
	Features- 'After injury' guide (e.g. to guide on recovery/rest periods)	Count	61	38	99
		pct-within	47.7%	52.8%	
	Features - Return to Running Toolbox (e.g. advice on starting to run again after injury)	Count	60	39	99
		pct-within	46.9%	54.2%	
	Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	Count	79	48	127
		pct-within	61.7%	66.7%	
	Features - Other	Count	1	2	3
		pct-within	0.8%	2.8%	
Total		Count	128	72	200

On respondents

a. Dichgroup tab

Features that runners want in the intervention – by average miles per week

two-dim-tab

			Average miles per week				Total
			0-5	6-10	10-30	30+	
Features of intervention[a]	Features -'Injury Free' running toolbox (e.g. to advise on running mileage)	Count	8	35	44	15	102
		pct-within	53.3%	51.5%	47.3%	62.5%	
	Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	Count	8	47	62	14	131
		pct-within	53.3%	69.1%	66.7%	58.3%	
	Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	Count	9	40	58	10	117
		pct-within	60.0%	58.8%	62.4%	41.7%	
	Features - self screen tool	Count	6	19	32	4	61
		pct-within	40.0%	27.9%	34.4%	16.7%	
	Features- 'After injury' guide (e.g. to guide on recovery/rest periods)	Count	4	34	49	12	99
		pct-within	26.7%	50.0%	52.7%	50.0%	
	Features - Return to Running Toolbox (e.g. advice on starting to run again after injury)	Count	6	38	48	7	99
		pct-within	40.0%	55.9%	51.6%	29.2%	
	Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	Count	11	44	58	14	127
		pct-within	73.3%	64.7%	62.4%	58.3%	
	Features - Other	Count	1	0	0	2	3
		pct-within	6.7%	0.0%	0.0%	8.3%	
Total		Count	15	68	93	24	200

On respondents

a. Dichgroup tab

two-dim-tab

			Age category						
			18-24	25-34	35-44	45-54	55-64	64 and over	Total
functions_intervention[a]	Features -'Injury Free' running toolbox (e.g. to advise on running mileage)	Count	2	12	38	36	11	2	101
		pct-within	2.0%	11.9%	37.6%	35.6%	10.9%	2.0%	
	Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	Count	2	15	47	44	20	2	130
		pct-within	1.5%	11.5%	36.2%	33.8%	15.4%	1.5%	
	Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	Count	0	15	44	42	15	1	117
		pct-within	0.0%	12.8%	37.6%	35.9%	12.8%	0.9%	
	Features - self screen tool	Count	2	6	25	21	7	0	61
		pct-within	3.3%	9.8%	41.0%	34.4%	11.5%	0.0%	
	Features- 'After injury' guide (e.g. to guide on recovery/rest periods)	Count	2	11	37	25	21	2	98
		pct-within	2.0%	11.2%	37.8%	25.5%	21.4%	2.0%	
	Features - Return to Running Toolbox (e.g. advice on starting to run again after injury)	Count	3	14	37	27	15	3	99
		pct-within	3.0%	14.1%	37.4%	27.3%	15.2%	3.0%	
	Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	Count	2	17	40	44	20	3	126
		pct-within	1.6%	13.5%	31.7%	34.9%	15.9%	2.4%	
	Features - Other	Count	0	0	1	1	1	0	3
		pct-within	0.0%	0.0%	33.3%	33.3%	33.3%	0.0%	
Total		Count	3	23	71	70	28	4	199

On respondents

a. Dichgroup tab

Chi square and age and resilient runner feature

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.682[a]	5	.749
Likelihood Ratio	2.706	5	.745
Linear-by-Linear Association	1.503	1	.220
N of Valid Cases	231		

a. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 1.32.

Features - Resilient Runner toolbox (e.g. to advise on exercises for better running) * Age category Crosstabulation

			Age category						
			18-24	25-34	35-44	45-54	55-64	65 and over	Total
Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	Yes	Count	2_a	15_a	46_a	44_a	20_a	2_a	129
		% within Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	1.6%	11.6%	35.7%	34.1%	15.5%	1.6%	100.0%
		% within Age category	66.7%	60.0%	58.2%	55.0%	54.1%	28.6%	55.8%
		% of Total	0.9%	6.5%	19.9%	19.0%	8.7%	0.9%	55.8%
	No	Count	1_a	10_a	33_a	36_a	17_a	5_a	102
		% within Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	1.0%	9.8%	32.4%	35.3%	16.7%	4.9%	100.0%
		% within Age category	33.3%	40.0%	41.8%	45.0%	45.9%	71.4%	44.2%
		% of Total	0.4%	4.3%	14.3%	15.6%	7.4%	2.2%	44.2%
Total		Count	3	25	79	80	37	7	231
		% within Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	1.3%	10.8%	34.2%	34.6%	16.0%	3.0%	100.0%
		% within Age category	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	1.3%	10.8%	34.2%	34.6%	16.0%	3.0%	100.0%

Each subscript letter denotes a subset of Age category categories whose column proportions do not differ significantly from each other at the .05 level.

Chi square age and self diagnostic tool

Features- Self-diagnostic tool (e.g. to find out what type of injury I may have) * Age category Crosstabulation

			Age category						
			18-24	25-34	35-44	45-54	55-64	65 and over	Total
Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	Yes	Count	0a, b	15c	44b, c	42a, b, c	15a, b, c	1a	117
		% within Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	0.0%	12.8%	37.6%	35.9%	12.8%	0.9%	100.0%
		% within Age category	0.0%	60.0%	56.4%	52.5%	40.5%	14.3%	50.9%
		% of Total	0.0%	6.5%	19.1%	18.3%	6.5%	0.4%	50.9%
	No	Count	3a, b	10c	34b, c	38a, b, c	22a, b, c	6a	113
		% within Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	2.7%	8.8%	30.1%	33.6%	19.5%	5.3%	100.0%
		% within Age category	100.0%	40.0%	43.6%	47.5%	59.5%	85.7%	49.1%
		% of Total	1.3%	4.3%	14.8%	16.5%	9.6%	2.6%	49.1%
Total		Count	3	25	78	80	37	7	230
		% within Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	1.3%	10.9%	33.9%	34.8%	16.1%	3.0%	100.0%
		% within Age category	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	1.3%	10.9%	33.9%	34.8%	16.1%	3.0%	100.0%

Each subscript letter denotes a subset of Age category categories whose column proportions do not differ significantly from each other at the .05 level.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.311[a]	5	.067
Likelihood Ratio	11.877	5	.037
Linear-by-Linear Association	2.942	1	.086
N of Valid Cases	230		

a. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 1.47.

Chi square for age and injury prevention

Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury) * Age category Crosstabulation

			Age category						
			18-24	25-34	35-44	45-54	55-64	65 and over	Total
Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	Yes	Count	2a	17a	40a	44a	20a	3a	126
		% within Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	1.6%	13.5%	31.7%	34.9%	15.9%	2.4%	100.0%
		% within Age category	66.7%	68.0%	50.6%	55.0%	54.1%	50.0%	54.8%
		% of Total	0.9%	7.4%	17.4%	19.1%	8.7%	1.3%	54.8%
	No	Count	1a	8a	39a	36a	17a	3a	104
		% within Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	1.0%	7.7%	37.5%	34.6%	16.3%	2.9%	100.0%
		% within Age category	33.3%	32.0%	49.4%	45.0%	45.9%	50.0%	45.2%
		% of Total	0.4%	3.5%	17.0%	15.7%	7.4%	1.3%	45.2%
Total		Count	3	25	79	80	37	6	230
		% within Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	1.3%	10.9%	34.3%	34.8%	16.1%	2.6%	100.0%
		% within Age category	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	1.3%	10.9%	34.3%	34.8%	16.1%	2.6%	100.0%

Each subscript letter denotes a subset of Age category categories whose column proportions do not differ significantly from each other at the .05 level.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.548[a]	5	.769
Likelihood Ratio	2.604	5	.761
Linear-by-Linear Association	.475	1	.491
N of Valid Cases	230		

a. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 1.36.

Chi square for running experience and resilient runner content

Features - Resilient Runner toolbox (e.g. to advise on exercises for better running) * Running Experience Crosstabulation

			Running Experience			
			Less than 3 months	3 months - 2 years	More than 2 years	Total
Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	Yes	Count	1a	29a	100a	130
		% within Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	0.8%	22.3%	76.9%	100.0%
		% within Running Experience	50.0%	61.7%	54.6%	56.0%
		% of Total	0.4%	12.5%	43.1%	56.0%
	No	Count	1a	18a	83a	102
		% within Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	1.0%	17.6%	81.4%	100.0%
		% within Running Experience	50.0%	38.3%	45.4%	44.0%
		% of Total	0.4%	7.8%	35.8%	44.0%
Total		Count	2	47	183	232
		% within Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	0.9%	20.3%	78.9%	100.0%
		% within Running Experience	100.0%	100.0%	100.0%	100.0%
		% of Total	0.9%	20.3%	78.9%	100.0%

Each subscript letter denotes a subset of Running Experience categories whose column proportions do not differ significantly from each other at the .05 level.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.786[a]	2	.675
Likelihood Ratio	.792	2	.673
Linear-by-Linear Association	.542	1	.462
N of Valid Cases	232		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is .88.

Chi square for running experience and self-diagnostic tool

Features- Self-diagnostic tool (e.g. to find out what type of injury I may have) * Running Experience Crosstabulation

			Running Experience			
			Less than 3 months	3 months - 2 years	More than 2 years	Total
Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	Yes	Count	1a, b	31b	85a	117
		% within Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	0.9%	26.5%	72.6%	100.0%
		% within Running Experience	50.0%	66.0%	46.7%	50.6%
		% of Total	0.4%	13.4%	36.8%	50.6%
	No	Count	1a, b	16b	97a	114
		% within Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	0.9%	14.0%	85.1%	100.0%
		% within Running Experience	50.0%	34.0%	53.3%	49.4%
		% of Total	0.4%	6.9%	42.0%	49.4%
Total		Count	2	47	182	231
		% within Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	0.9%	20.3%	78.8%	100.0%
		% within Running Experience	100.0%	100.0%	100.0%	100.0%
		% of Total	0.9%	20.3%	78.8%	100.0%

Each subscript letter denotes a subset of Running Experience categories whose column proportions do not differ significantly from each other at the .05 level.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.540[a]	2	.063
Likelihood Ratio	5.625	2	.060
Linear-by-Linear Association	4.680	1	.031
N of Valid Cases	231		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is .99.

Chi square for running experience and injury prevention content

Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury) * Running Experience Crosstabulation

			Running Experience			
			Less than 3 months	3 months - 2 years	More than 2 years	Total
Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	Yes	Count	2a	26a	99a	127
		% within Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	1.6%	20.5%	78.0%	100.0%
		% within Running Experience	100.0%	55.3%	54.4%	55.0%
		% of Total	0.9%	11.3%	42.9%	55.0%
	No	Count	0a	21a	83a	104
		% within Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	0.0%	20.2%	79.8%	100.0%
		% within Running Experience	0.0%	44.7%	45.6%	45.0%
		% of Total	0.0%	9.1%	35.9%	45.0%
Total		Count	2	47	182	231
		% within Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	0.9%	20.3%	78.8%	100.0%
		% within Running Experience	100.0%	100.0%	100.0%	100.0%
		% of Total	0.9%	20.3%	78.8%	100.0%

Each subscript letter denotes a subset of Running Experience categories whose column proportions do not differ significantly from each other at the .05 level.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.665[a]	2	.435
Likelihood Ratio	2.420	2	.298
Linear-by-Linear Association	.354	1	.552
N of Valid Cases	231		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is .90.

Chi square for average miles per week and resilient runner content

Average miles per week * Features - Resilient Runner toolbox (e.g. to advise on exercises for better running) Crosstabulation

			Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)		
			Yes	No	Total
Average miles per week	0-5	Count	8a	10a	18
		% within Average miles per week	44.4%	55.6%	100.0%
		% within Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	6.2%	9.8%	7.8%
		% of Total	3.4%	4.3%	7.8%
	6-10	Count	47a	25a	72
		% within Average miles per week	65.3%	34.7%	100.0%
		% within Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	36.2%	24.5%	31.0%
		% of Total	20.3%	10.8%	31.0%
	10-30	Count	61a	53a	114
		% within Average miles per week	53.5%	46.5%	100.0%
		% within Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	46.9%	52.0%	49.1%
		% of Total	26.3%	22.8%	49.1%
	30+	Count	14a	14a	28
		% within Average miles per week	50.0%	50.0%	100.0%
		% within Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	10.8%	13.7%	12.1%
		% of Total	6.0%	6.0%	12.1%
Total		Count	130	102	232
		% within Average miles per week	56.0%	44.0%	100.0%
		% within Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	100.0%	100.0%	100.0%
		% of Total	56.0%	44.0%	100.0%

Each subscript letter denotes a subset of Features - Resilient Runner toolbox (e.g. to advise on exercises for better running) categories whose column proportions do not differ significantly from each other at the .05 level.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.188[a]	3	.242
Likelihood Ratio	4.228	3	.238
Linear-by-Linear Association	.487	1	.485
N of Valid Cases	232		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.91.

Chi square for average miles per week and a self-diagnostic tool

Average miles per week * Features- Self-diagnostic tool (e.g. to find out what type of injury I may have) Crosstabulation

			Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)		
			Yes	No	Total
Average miles per week	0-5	Count	9a	9a	18
		% within Average miles per week	50.0%	50.0%	100.0%
		% within Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	7.7%	7.9%	7.8%
		% of Total	3.9%	3.9%	7.8%
	6-10	Count	40a	31a	71
		% within Average miles per week	56.3%	43.7%	100.0%
		% within Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	34.2%	27.2%	30.7%
		% of Total	17.3%	13.4%	30.7%
	10-30	Count	58a	56a	114
		% within Average miles per week	50.9%	49.1%	100.0%
		% within Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	49.6%	49.1%	49.4%
		% of Total	25.1%	24.2%	49.4%
	30+	Count	10a	18a	28
		% within Average miles per week	35.7%	64.3%	100.0%
		% within Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	8.5%	15.8%	12.1%
		% of Total	4.3%	7.8%	12.1%
Total		Count	117	114	231
		% within Average miles per week	50.6%	49.4%	100.0%
		% within Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	100.0%	100.0%	100.0%
		% of Total	50.6%	49.4%	100.0%

Each subscript letter denotes a subset of Features- Self-diagnostic tool (e.g. to find out what type of injury I may have) categories whose column proportions do not differ significantly from each other at the .05 level.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.423[a]	3	.331
Likelihood Ratio	3.458	3	.326
Linear-by-Linear Association	1.765	1	.184
N of Valid Cases	231		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.88.

Chi square for average miles per week and injury prevention content

Average miles per week * Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury) Crosstabulation

			Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)		
			Yes	No	Total
Average miles per week	0-5	Count	11_a	7_a	18
		% within Average miles per week	61.1%	38.9%	100.0%
		% within Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	8.7%	6.7%	7.8%
		% of Total	4.8%	3.0%	7.8%
	6-10	Count	44_a	28_a	72
		% within Average miles per week	61.1%	38.9%	100.0%
		% within Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	34.6%	26.9%	31.2%
		% of Total	19.0%	12.1%	31.2%
	10-30	Count	58_a	55_a	113
		% within Average miles per week	51.3%	48.7%	100.0%
		% within Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	45.7%	52.9%	48.9%
		% of Total	25.1%	23.8%	48.9%
	30+	Count	14_a	14_a	28
		% within Average miles per week	50.0%	50.0%	100.0%
		% within Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	11.0%	13.5%	12.1%
		% of Total	6.1%	6.1%	12.1%
Total		Count	127	104	231
		% within Average miles per week	55.0%	45.0%	100.0%
		% within Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	100.0%	100.0%	100.0%
		% of Total	55.0%	45.0%	100.0%

Each subscript letter denotes a subset of Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury) categories whose column proportions do not differ significantly from each other at the .05 level.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.256[a]	3	.521
Likelihood Ratio	2.268	3	.519
Linear-by-Linear Association	1.792	1	.181
N of Valid Cases	231		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.10.

Chi square for gender and injury prevention content

Gender 0 = female 1 = male * Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury) Crosstabulation

			Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury) Yes	No	Total
Gender 0 = female 1 = male	male	Count	47a	35a	82
		% within Gender 0 = female 1 = male	57.3%	42.7%	100.0%
		% within Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	37.0%	33.7%	35.5%
		% of Total	20.3%	15.2%	35.5%
	female	Count	80a	69a	149
		% within Gender 0 = female 1 = male	53.7%	46.3%	100.0%
		% within Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	63.0%	66.3%	64.5%
		% of Total	34.6%	29.9%	64.5%
Total		Count	127	104	231
		% within Gender 0 = female 1 = male	55.0%	45.0%	100.0%
		% within Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury)	100.0%	100.0%	100.0%
		% of Total	55.0%	45.0%	100.0%

Each subscript letter denotes a subset of Features - 'Injury Prevention' (e.g. to advise on the best way to try and avoid/prevent injury) categories whose column proportions do not differ significantly from each other at the .05 level.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.281[a]	1	.596		
Continuity Correction[b]	.154	1	.695		
Likelihood Ratio	.281	1	.596		
Fisher's Exact Test				.679	.348
Linear-by-Linear Association	.280	1	.597		
N of Valid Cases	231				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 36.92.

b. Computed only for a 2x2 table

Chi square for gender and resilient runner content

Gender 0 = female 1 = male * Features - Resilient Runner toolbox (e.g. to advise on exercises for better running) Crosstabulation

			Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)		Total
			Yes	No	
Gender 0 = female 1 = male	male	Count	47a	36a	83
		% within Gender 0 = female 1 = male	56.6%	43.4%	100.0%
		% within Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	36.2%	35.3%	35.8%
		% of Total	20.3%	15.5%	35.8%
	female	Count	83a	66a	149
		% within Gender 0 = female 1 = male	55.7%	44.3%	100.0%
		% within Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	63.8%	64.7%	64.2%
		% of Total	35.8%	28.4%	64.2%
Total		Count	130	102	232
		% within Gender 0 = female 1 = male	56.0%	44.0%	100.0%
		% within Features - Resilient Runner toolbox (e.g. to advise on exercises for better running)	100.0%	100.0%	100.0%
		% of Total	56.0%	44.0%	100.0%

Each subscript letter denotes a subset of Features - Resilient Runner toolbox (e.g. to advise on exercises for better running) categories whose column proportions do not differ significantly from each other at the .05 level.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.018[a]	1	.892		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.018	1	.892		
Fisher's Exact Test				1.000	.502
Linear-by-Linear Association	.018	1	.892		
N of Valid Cases	232				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 36.49.

b. Computed only for a 2x2 table

Chi square for gender and self-diagnostic tool

Gender 0 = female 1 = male * Features- Self-diagnostic tool (e.g. to find out what type of injury I may have) Crosstabulation

			Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)		
			Yes	No	Total
Gender 0 = female 1 = male	male	Count	42a	41a	83
		% within Gender 0 = female 1 = male	50.6%	49.4%	100.0%
		% within Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	35.9%	36.0%	35.9%
		% of Total	18.2%	17.7%	35.9%
	female	Count	75a	73a	148
		% within Gender 0 = female 1 = male	50.7%	49.3%	100.0%
		% within Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	64.1%	64.0%	64.1%
		% of Total	32.5%	31.6%	64.1%
Total		Count	117	114	231
		% within Gender 0 = female 1 = male	50.6%	49.4%	100.0%
		% within Features- Self-diagnostic tool (e.g. to find out what type of injury I may have)	100.0%	100.0%	100.0%
		% of Total	50.6%	49.4%	100.0%

Each subscript letter denotes a subset of Features- Self-diagnostic tool (e.g. to find out what type of injury I may have) categories whose column proportions do not differ significantly from each other at the .05 level.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.000[a]	1	.991		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.000	1	.991		
Fisher's Exact Test				1.000	.550
Linear-by-Linear Association	.000	1	.991		
N of Valid Cases	231				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 40.96.

b. Computed only for a 2x2 table

Running related injury and association with running experience

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	16.136[a]	2	<.001
Likelihood Ratio	10.740	2	.005
Linear-by-Linear Association	8.286	1	.004
N of Valid Cases	232		

a. 2 cells (33.3%) expf < 5. Min exp = .26...

Running-related injury? y/n * Running Experience Crosstabulation

			Running Experience			
			Less than 3 months	3 months - 2 years	More than 2 years	Total
Running-related injury? y/n	Yes	Count	0a	38b	164b	202
		row % of Running-related injury? y/n	0.0%	18.8%	81.2%	100.0%
	No	Count	2a	9b	19b	30
		row % of Running-related injury? y/n	6.7%	30.0%	63.3%	100.0%
Total		Count	2	47	183	232
		row % of Running-related injury? y/n	0.9%	20.3%	78.9%	100.0%

col prop test on Running Experience at .05...

Running related injury and relationship with monitoring training

Running-related injury? y/n * Monitor training 0= no 1 = yes Crosstabulation

			Monitor training 0= no 1 = yes		
			0	1	Total
Running-related injury? y/n	Yes	Count	3a	199b	202
		row % of Running-related injury? y/n	1.5%	98.5%	100.0%
	No	Count	4a	26b	30
		row % of Running-related injury? y/n	13.3%	86.7%	100.0%
Total		Count	7	225	232
		row % of Running-related injury? y/n	3.0%	97.0%	100.0%

col prop test on Monitor training 0= no 1 = yes at .05...

Chi-Square Tests

	Value	df	Asymptotic Significance	Exact Significance (2-sided)	Exact Significance (1-sided)
Pearson Chi-Square	12.531[a]	1	<.001		
Continuity Correction[b]	8.809	1	.003		
Likelihood Ratio	8.025	1	.005		
Fisher's Exact Test				.006	.006
N of Valid Cases	232				

a. 1 cells (25.0%) expf < 5. Min exp = .91...

b. Computed only for a 2x2 table

Appendix 14: Participant information sheet for focus groups with recreational runners

Participant Information Sheet: Qualitative 'Think Aloud' Focus Groups.

Run Healthy, Run Strong: The Development of A Running Injury Prevention Self-Management Platform for Recreational Runners

We would like to invite you to take part in our Cardiff University research study. Before you decide you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully. You will have an opportunity to ask questions if you read anything that is not clear, or you would like further information.

Summary

Over the last two decades there has been an increase in the running population. Running is a relatively low cost activity and easily accessible, providing health, social and emotional benefits to participants. However with an increase in the numbers of running there has been an increase in the rates of running injury, leading to many runners having to stop and even leave the sport altogether.

Some injured runners turn to the internet to get information on how to avoid injury and self manage the most common running related injuries. There is a lot of information out there but most online resources lack any form of evidence and are not always relevant to one's own running related injury.

As well as collecting and reviewing the available evidence for running related injury prevention we also want to establish runners' experiences and opinions regarding injury prevention. With this data we then hope to develop the content for RUN HEALTHY, RUN STRONG, a running injury prevention self-management platform.

What is the purpose of the study?

The study aims to develop the content of RUN HEALTHY, RUN STRONG, a running related injury prevention and self-management tool that can be used by recreational runners.

Why have I been invited to participate?

You participate in running and have previously completed the Run Healthy, Run Strong survey. You indicated that you would be happy for the researcher to contact you with a view to taking part in the next part of the study, a focus group of runners.

Do I have to take part?

It is up to you to decide whether to take part. We will describe the steps of the study in this information sheet. If you agree to take part in the focus group, we will ask you to sign a consent form. You are free to withdraw from the study at any time without giving a reason.

What will happen to me if I take part?

You will be invited to attend one focus group (maximum time 60 minutes) taking place in School of Healthcare Sciences, Cardiff University. The focus group involve between 5-8 people and will be conducted by the prinicipal investigator (Kathleen Walker) together with a research assistant. During the focus group we will explore your views on running:

- why you run, the physical, emotional and social benefits of running.
- Your injury experiences, what you do when you're injured and how it makes you feel.
- Your thoughts on running injury prevention and self-management strategies.
- Modes of delivery of running related injury prevention that you have experienced.
- Explore your views on what you would want to see in a running related injury prevention and self-management programme and the best way for this to be delivered.

The focus group will be audio-recorded and a research assistant will also be taking notes.

Refreshments will be available during the focus groups.

What will I have to do?

We will ask you to sign an electronic consent form and you should be aware of the following before you participate:

- After signing informed electronic constent you will receive an invite to attend the focus group with date, time and instructions how to get there.
- The focus group will take place School of Healthcare sciences, Cardiff Univeristy.
- It will take about 60 minutes and involve maximum 5-8 people.
- It will be conducted by the prinicipal investigator (Kathleen Walker) together with a research assistant.
- The focus group will be audio-recorded and the research assistant will also be taking notes.

What is being tested?

We will explore your experiences of running and running related injury while also exploring your views on the content you would find most beneficial from a running related injury prevention and self-management programme. This information will have the potential to be used in the development of a running related injury tool which will benefit runners who actively want to prevent injury.

What are the possible disadvantages and risks of taking part?

There is no anticipated disadvantage or a risk in taking part other than time burden. Information will be stored confidentially and will only be shared anonymously with the research supervisors.

What are the possible benefits of taking part?

We cannot promise that this study will help you to prevent running related injury but the information we obtain from the study will help the development and design of a running related injury prevention and self-management programme

What if there is a problem?

If you have any concerns about any part of the study, you should ask the researcher and she will do their best to answer your questions and deal with your concerns. If you are still unhappy and wish to make a formal complaint, you should contact:

Dr Kate Button

Director of Research Governance

School of Healthcare Sciences

Will my taking part in this study be kept confidential?

All information which is collected about you will be kept strictly confidential. The researcher will maintain your privacy and confidentiality using a unique 8-digit code not accessible to anyone except the researcher. The procedures for handling, processing, storage and destruction of data will follow the Data Protection Act 2018. All the data will be anonymous and given a code, known only to the researcher. The data will be stored in an encrypted and password protected computer known only by the researcher. This data will only be used for this study and future studies will not have access to it unless further agreement from you is requested and consent obtained. Data identifiable to you will be stored securely at Cardiff University and accessed only by the principal researcher. In addition, the data will be kept for a minimum of fifteen years and disposed of securely according to the recommendations of the Data Protection Act 2018.

Anonymised data arising from the study will be shared with Cardiff University, Run Wales and Welsh Athletics to help develop services for runners and those experiencing running injury but it will not be possible for information to be traced back to individuals.

How will my data be managed?

Cardiff University, KESS2 and Run Wales/Welsh Athletics are the sponsors for this study based in the United Kingdom. We will be using information from you in order to undertake this study and will act as the data controller for this study. This means that we are responsible for looking after your information and using it properly. Cardiff University will keep identifiable information about you for 15 years after the study has finished.

Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible.

You can find out more about how we use your information at: https://www.cardiff.ac.uk/public-information/policies-and-procedures/data-protection or by contacting the University's Data Protection Officer: inforequest@cardiff.ac.uk

What will happen to the results of the research study?

The researcher may publish the study in academic journals and present the results at conferences. In addition, the main findings will be disseminated to all participants via an online link which will be sent to your email. The findings will also be made available to KESS2 and Run Wales/Welsh Athletics. Only anonymised results will be published, you will not be identified in any report or publication. .

Who is organising and funding the research?

This research is funded by Cardiff University, KESS2 Fund and Run Wales/Welsh Athletics.

Who has reviewed the study?

The study has been reviewed by the Cardiff University School of Healthcare Sciences Research Ethics Committee and Health and Care Research Wales.

Further information and contact details

Principal Researcher: Kathleen Walker

Telephone:

Email:

Appendix 15: Consent form for focus groups with recreational runners

Electronic Consent Form

Title of the study:

Run Healthy, Run Strong: The Development of A Running Injury Prevention Self-Management Platform for Recreational Runners

Name of Researcher: Kathleen Walker

To participate in this project you need to confirm your agreement with each of the statements below. Please tick each box.

9. I confirm that I have read and understand the information sheet (date 13/10/2019, version 1 QUAL Focus Groups) for the above study and have had opportunity to ask questions. (*required).

10. I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, and without my medical care or legal rights being affected but any data collected up to the point of my withdrawal will be kept. (*required)

11. I understand that my details will be linked to a unique identifier to ensure confidentiality. (*required)

12. I confirm that data from the study can be used in the final report and other academic publications and may be presented at conference, I understand that these will be used anonymously. (*required)

13. I agree to be audio-recorded during the focus group (*required)

14. I give consent for the use of verbatim anonymised quotes in publications and conference presentations. (*required)

15. I agree for you to share my anonymised data with external collaborators in the UK and abroad, including commercial companies. (optional)

16. I agree to take part in the above study. (*required)

Participant's name
Date of Birth
Email address
Date of consent

By pressing the submit button I agree to take part in this study

'Submit'

Appendix 16: Example of transcript of a focus group with recreational runners

FOCUS GROUP 1 INTERVIEWER: KATHLEEN WALKER

PARTICIPANTS: T, A AND I

KW: Okay we're being recorded. I really hope it does work because I'll be gutted if it plays back and there's nothing at the end when I'm transcribing. Um, Chatham house rules, I don't know if you're familiar with them, everything stays within the meeting, if you have recognized someone, probably don't bring it up within the meeting or what we discuss outside of the focus group. Anything confidential um or anything you afterwards you think ooh I want that struck out of the transcription then let me know. Because otherwise it will be transcribed verbatim but if there's anything you thought afterwards I'd rather that wasn't in there but again we're not talking about anything particularly sensitive. Let me just, I made a note of other bits. Um, and everyone's happy for recording? And if you want to switch off cameras then that's fine. Just as long as I've got the audio which is brilliant. Um, and that's it really, so five past, I don't think anyone else is joining us so lets crack on.

KW: Um so T when you joined you mentioned that you'd been injured. Anyone else been injured?

A: Yeah, yeah a few times in the last couple of years.

I: Yes, a few times.

KW: Yeah A few times? Right, and how do you, this is out to everyone, how do you decide what is a niggle and what is an injury? How do you make that distinction?

T: if it hurts *laughs* but if you can sort of get along with it, um, not bothering you then, um persevere. That is not the right attitude but…

KW but that's how, you, you kind of approach it at the moment, okay, any other approaches to deciding between a niggle and injury?

A: whether I can run on it or not I guess. So I'll go out for a little run or, and if it still hurts I'll probably come back or I'd at least maybe or definitely stretch it post workout, and then if it is still is niggling then I know that it's more than that, potentially, despite you know after recovery.

KW: Okay, so like a testing approach kind of?

A: yeah a testing approach.

KW: so you're trying to work out to work out if it is too painful or not? Okay, Ian?

I: Yeah I think if I was out and it was causing me to hobble a bit or sort of um run and unnaturally, um particularly if it was extreme then I'd, I'd think of that as an injury rather than uh a niggle. Um if it was something that was you know, a slight little twinge but I could run sort of through it, and it might fade then I'd sort of treat that more as a niggle I guess.

KW: yeah so similar approaches from everyone, there's kind of, that testing approach, is it too much…

I: yes

KW, yeah? Okay, so um, then if you say right I am injured what do you tend to do initially?.......Anyone? Jump in.

A: Normally rest, I'd rest depending on what it is. Ice, so like if it's a joint and potentially as well I've always been quite pro-active in the past about going to see a physio or a sports physio, um there's somebody that I've been to quite a few times in the past so I'd go there.

T: Yeah, I would say rest it. I haven't been down the road really of going to um, a physio, maybe about three times in all of the years really that I..I don't know why, perhaps that's something that I should think about more, um..

KW: Do you prefer the try to self-manage approach?

T: Yes and I think, well there's lots of information out there but I think it can get confusing as well, there's too much information and if you don't really know, um, sort of what you're looking for particularly it is confusing I think.

KW: Yeah. I, what do you do when you're injured?

I: Um, Yeah, I think, I'm not very good at sort of applying ice or anything like that, I sort of, or I tend to, maybe, stretch, stretch out the injury um, you know rest, perhaps for a few days um but then I, if it wasn't going away and I wasn't sort of managing to stretch it out then um I have tended to go to um, there's um a physio um locally that I've been to a few times and that's been really helpful to get me through previous injuries, um. So um, yeah, that would be my um sort of approach to it.

KW: And when you are injured how does that effect you? How do you, you know, not just physically but how does it affect you generally?

T: I think it's frustrating and um can get you down if you let it I think. Um cos you just enjoy that space, you know that space and time of running even though sometimes it's hard to get through the door. But um, but it definitely does make me feel frustrated then that I can't do it.

KW: Okay, right moving on to running injury prevention: do any of you do anything actively to prevent yourself getting injured? And that can be anything, diet, your training, training volume, your training programme, any form of recovery that you use, any exercises or stretches. Do any of you do anything at the moment?

A: Lots of stretches.

KW: Lots of stretches?

A: So and that's probably been the reason why I have had those injuries in the past would be down to a lack of stretching.

KW: Okay.

A: In my case. Yes, so yeah, lots of stretches sometimes I stretch more than I run.

KW: Oh really? How often are you stretching then?

A: Well before and after a run typically and then typically also the morning after or the day after.

KW: So you've got a routine going of stretches?

A: Yeah but that's only come from going to see the physio because prior to that it would just be the odd you know calf stretch, and a lack of awareness previously.

KW: Anyone do anything proactive, preventative wise?

T: I don't, I don't think I do enough stretches, I mean listening to you A, then I probably need to do more stretches um,

KW: I, do you do anything?

I: yes yeah it's interesting to hear A say about the stretching because I've always been reasonably good at that, I've been running since I was 16 so it's a really long time now, um yeah I've always been pretty good at that but it's amazed me just how much stretching I now need to do compared to sort of previously to uh, to try and prevent injuries and sort of um maybe um shake off little niggles and and things like that. Um and uh, and uh yeah I've got into the habit of perhaps looking things up and trying to find sort of various exercises, of maybe using foam rollers and um things like that to try and er and um help with things um, even change shoes because I think could well be, shoes could well be the cause of the injury possibly and um other things like I, I'll use rests, um you know maybe frequency of training. At the moment I'm, so not running every single day, I'm sort of running um, well trying to run every other day, um but I rarely will go back to back so that's another sort of technique I guess to try and um to try and avoid…

KW: So it sounds like you've got all bases covered, looking at all angles.

I; I try to.

KW: T it was interesting what you said about there being a lot of information out there about running injury prevention, and that actually brings me on to the next question is, where do you all tend to go if you're looking for information about running injury prevention or running injuries?

T: well my running club do a lot of sort of, put a lot of good stuff out there and pointers where to go. Um so maybe I would look at that but I know I'm not disciplined enough to in that respect. I think my problem is that I want an instant fix and I need to be more patient and um but I think I would start with them probably.

KW: Yeah, is there anything anyone's found useful out there or anywhere you tend to be drawn to?

I: I tended to use Runners' World a little bit in the past but it's often quite difficult to pin things down, they've got, it's such an ocean of information on that site, um, I mean I'm not really, the Run Wales site I've started using um more recently since I've been a Run Leader, um I think there's, um they're sort of gathering, seem to be gathering any information into a, um a particular area for sort of training and injury information but I haven't really explored that part that much yet.

KW: Okay A, is there…

A: yeah Runner's World as well if, but that would just be from a Google search and then recognizing it because I've used it before and I do agree with I there is quite a lot on there and sometimes it can be a bit too in my impression a bit too article like as in you just want that kind of instant fix, you want to kind of have something that says this is what you should do or this is a diagram of how to stretch that or something you know, something simple as opposed to scroll down through all the adverts.

KW: yeah I know what you mean I do that with recipes, okay article, article, article, where's the ingredients, where's the bullet points about what I need? Yeah… so what have you found good about, so then what's good about online injury information, is there anything that's good about it that you've found?

BIG PAUSE AS PARTICIPANTS THINKING!

A: Free.

KW: Free? Yeah okay

I: Yeah, yeah.

T: I just think, like you say there's too much information really and that you could get lost amongst all the information and not find what you want.

KW: Okay, that's really interesting. Okay, so that's the less helpful elements of it then. That its not, is it overwhelming then?

A: yeah

I: yes I would say so. If you're looking at calf injuries for example then you get a sort of an ocean of information and quiet often it will be different on each um site you find and you think of well which one, which one is possible going to be the best or which one is going to work? A lack of consistency I suppose. That's um one of the problems.

KW: Okay um so, do you guys feel that you've been successful in preventing running injuries? Do you feel that the strategies you take, I mean I know T you were saying that you're not sure that you do that well enough at the moment but does anyone else feel that they're pretty good at preventing running injuries with their approaches?

A: Since getting injured a few times yes but not before. I think I still thought I was my invincible 20 year old self you know at that point whereas…

KW: I know what you mean there, In my head I'm still an 18 year old 800m runner. No no no.

I: sounds familiar.

LAUGHTER

KW: So is there anything you would choose to avoid, if you were given, some, a list of things to help you prevent injury is there anything that you would actively avoid and think no I'm not going there, it doesn't help, it doesn't work, you wouldn't pay attention to it. Is there anything you'd disregard?

T: I can't think of anything particularly.

I: I think one of them might be um the sort of analysis you get in some sports shoes, running shoes shops.

KW: Oh right? Like gait analysis?

I: Yeah, gait analysis, yeah I probably would, maybe it's my natural skepticism, it's gonna be steering you towards a particular type of shoe or something like that, um but um yeah, I'm never quite sure whether the machine has just been rolled in and somebody has gone on a couple of hours course that teach them how to use it and err but maybe I'm being unfair but LAUGHS

KW: It's interesting though that you say that because that often comes up as one of the things that runners are quite keen on, and I know on my local village group the first things that people suggest is go get you gait analysed so that's actually really interesting that you say that. A anything that you've found doesn't work, doesn't help?

A: I couldn't think of anything until with regards with what I just said I'm just thinking about potentially if something's tied in with a company maybe? You might think it might be a bit skewed one way or the other..

KW: Yeah?

A: To do this to prevent it you must buy these running shoes for example. That or, yeah I'm trying o think of other examples. But yeah, or supplements for example, something like that or you know, protein things all the things, like some of the things they give out in goodie bags at the end of races.

KW: Yeah I'm always a bit, really?? Okay so moving on to when you are injured: and I think we've all been injured here. What are the initial things that you all do? I think you mentioned ice but what do you do to self-manage? So you're injured. First thing, I think you mentioned was icing the joint you said A?

A: Yeah. Rest up, ice it. Hope it goes away.

KW: And you mentioned a visit to a physio?

A: Um hmm if it doesn't go away, go find a physio yeah.

KW: Go find a physio..

A: Yeah, get it properly seen to. Get an assessment from a physio.

KW: Anything else that if you're self-managing that you tend to do? And again it could be anything. Diet, training programmes stuff, anything that you think is your first instinct to do? Or have we covered it?

I: Yeah I think um training programme might be one of them but that would probably be when I was coming back from injury maybe to avoid um you know maybe making the same mistakes again or sort of putting the same sort of pressure on myself but that's later on, that's not the first thing. The first thing would be yeah, ice and then go to a physio if it's not improving.

KW: Yeah? T, anything that you..?

T: Yeah I just thought of something else, I also try and look back at what my running pattern was to see if I can find what triggered it. Um, I do think about that sometimes because um, I know what triggered my last injury, so um it was sort of try and be aware of that then as you start to get back into things.

KW: yeah? Okay. Again if you're self-managing an injury is it the same resources that you go to again or is there anything else you've found when self-managing an injury?

T: no I can't think of anything.

KW: No? So Runners' World, physio, those kind of things. Um, so it sounds like the first things you do, just recapping what you said: rest is one of the initial things you all mentioned as well, ice, and again I've split this up but it's probably going to be very similar again, because I'm trying to separate prevention from self-management because they are two different things but at the same time they are similar but do you ever, when you are self-managing, I mean T you mentioned running friends, running clubs, are running peers ever any help when you're managing injury? Or do you only go for, kind of official information?

T: Uh no, well I think when chatting to people as well you get a lot of information but also what works for somebody obviously necessarily doesn't work for yourself. So you know you have to be a bit cautious in that way as well I think. Whereas if you went to a professional they'd give you better advice or more appropriate advice.

KW: Again I'm going to have to change these questions around I think as I'm learning as I'm going along here … um so when you are managing an injury again is the online information helpful? Or is still that it's too much, it's that ocean of information, it's contradictory as you said I? Is it similar to the prevention stuff?

I: Yeah, I think so, certainly in my experience. Yeah it's just too much, too many conflicts then between information and too much searching through before you sort of find anything um straightforward, it always ends up putting doubt in my mind and I always end up thinking uh yeah I want to go and chat to a physio and get some proper advice.

KW: Yeah? Okay. Right so this project, we are steaming through this actually so thank you. With this project we are hoping to develop an online sort of intervention thing, so if I was presenting an app to you and I was sort of wanting your input what would you want to see. This is really what I'm getting at now, this is sort of the more important side of the focus group, um what would be the content that you would consider to be most useful if I was presenting or if I was telling you that I was making a running related injury prevention and self-management programme or app?

A: Something that's really simple. Straight forward to access, has got, me personally I would feel like if it's got lots of diagrams or how to, or videos, just thinking about that recipe analogy that you used earlier, something prescriptive like that but also that you know is reinforced or backed up with some kind of scientific, you know, um

KW: Evidence?

A: Yeah evidence or this is being used, yeah, or endorsement by physios or something like that.

KW: Yeah, yeah, okay.

A: Simple I think for me. Simple and easy to access.

T: Yeah I agree with that and something that you can drill down to the information that you want or you need relatively straight forwardly without having to go through um ,lots of other information.

KW: So like you say, quite simple, straight forward, almost bullet point type information?

T: yeah if it was, um when you say bullet point, perhaps like a list of things and you could just click on something and it would take you specifically to something that you're looking for and you don't have to wade through other information to get there.

KW: I anything content wise that you would want?

I: yes I think straightforward, something that is you know presents itself in quite a straight forward, I mean I don't know why this is so, just a random thought thats come up, maybe something that starts off with a diagram um, off I don't know, runner's legs or something like that where you can click on a certain area say right this is where my problem is uh and click then through to you know a possible um well diagnosis perhaps is too strong a word but sort of yeah okay this is the spot, this is what it's like, it could easily be in this area…um…

KW: Like a symptom checker?

I: yeah, yeah, yeah, yes, that's right.

KW: so what you're saying like a leg with the locations highlighted where it's likely to be?

I yes, yeah something like that.

A: I was thinking of a picture thing as well where you push..oh sorry..

KW: No, no it's good that you're all kind of…um so what about advice on monitoring training? So things lie your volume, recovery, advice on trainers, would that be something that would be helpful from this type of thing?

I: yep I would say so.

KW: Do you all monitor your training now? Like T you said you'd look back at your running diary, is that something that would be helpful?

T: yes I think so yeah, um I'm not so sure about the er, did you say running shoes?

KW: yeah.

T: I'm not so sure about that um but definitely for um as I monitor my, you know as I look back that would be good but I'm not sure about having a recommendation or types of shoes, I'm not sure about that.

KW: Okay, um and what about things like exercise programmes, you know preventative exercises, stretches, core stability, is that something that you'd want to see from an app?

T: Yeah I think so.

A: Yeah

KW: Where do you find that information at the moment, where do you go? Cos there's loads out there isn't there.

I: Yeah

KW: There's you tube, there's Runners' World, there's so much out there so it's like how do you pick?

I: Again I've found that I've had most confidence when I've gone to a physio and the physio has said right okay I think you're or it looks like your um calf muscle problem or whatever is down to a weakness elsewhere and you get um a set of exercises, strength exercises or stretching exercises to um to try and counter that imbalance so um yeah if you could get that information from an app as well that would be really useful. For me anyway.

KW: And again would it help that it was physio lead?

I: Yes

KW: Or a strength and conditioning coach?

I and A: Yeah

KW: This is going back again but is it general injury information that you want or would you want specific injury information? It almost sounds like you could almost do with the two like you said but general information or more specific injury information? What would be more helpful or what would you want content wise? So you know, to treat hip pain, leg pain, back pain or would you want something more like this is for prevention or treatment of plantar fasciitis, this is for patella femoral knee pain or would you rather just hip pain, knee pain what's….?

A: Hmm it's hard, I often struggle with the really technical names to remember them.

KW: Okay. No that's really good to hear actually..

A: But then at the same time point just thinking of knee pain or back pain is really vague because it could be anything, so it's tricky I don't really have an answer. I definitely would struggle with yeah, the full names side of things unless I already knew that I had it.

I: I suppose if a group of exercises um helped one of the general areas like your core or your back although I suppose that's linked, um then that would, that could be useful. Um but I suppose if you had, if you knew like A said, if you knew you had a specific injury in a specific area then it would be really good to know specific exercises that might help those particular issues. If that makes sense.

KW: No that makes sense. T? What are your feelings?

T: Could it be that you had sort of both side by side? You could have the general information and then you could go further if you needed to.

KW: That's really useful to know actually. So when you're looking at, imagining this amazing app that we're looking forward to what would be more appealing to you format wise? So is it a smartphone kind of thing, website, you tube channel? What do you find more user friendly, more appealing when you're looking at things like this? Do you want it in your hand, on your phone so you can take it wherever you go or what's easier, what works best for you?

T: Yeah, I think something mobile that you can take with you. And you can look at at as and when.

KW: Okay, anyone else. Or both?

A: for me mobile based, not necessarily an app to download, maybe something that you can access through browser on your phone? But that's just my personal preference because sometimes downloading apps can be really cluttering cos you know high in effort and actually if there were links to an existing website that would be really preferable.

I: Definitely phone based for me in terms of preference.

KW: Would you, if you had been injured would you want to see information about returning to running? Would you want to see return to running programmes would that be of interest if you have been injured?

I: yeah it would.

T: yeah I think so.

KW; yeah so kind of thinking about, kind of similar to couch to 5k but more of an introducing load if you know what I mean?

I: yeah.

A: That would be good.

KW: Okay.

I: in fact I've been looking for one recently on, because I sort of had, well I had a brief illness and I was coming back to running after that illness and um I was really struggling because I'd always done, I'd always run to programmes in the past so I was immediately looking for a programme and it was sort of I guess an older guy's return to 10k running type thing that I was looking for but I never really found them I must admit so I'm playing it by ear at the moment um so following a variety of things including the normal club runs so um so interestingly that's something that I've looked for, not necessarily totally linked to injury but partly linked to injury prevention I suppose.

KW: Yeah, That coming back…

I: Yeah particularly for someone who is my age who's done a lot of running over the years sort of is aware that I've got probably got sort of a bit of wear and tear here and there.

KW: So even though you're not a novice by any means but that starting from not quite the beginning but from a baseline level of haven't been able to do a lot? That kind of thing would be useful?

I: Yeah definitely.

KW: With a view to not getting you injured as you're starting back?

I: yeah that's right yeah.

A: maybe something on setbacks as well so say you are returning to it and then it flares up again whatever it is um how then to react to that. Do you actually just go back to square one again? Or is this likely to happen? Or yeah something like that.

KW: yeah because it's true, injury isn't always a straight line is it, there's often bumps in the road so that's actually really interesting that you said that because you don't often, when you think I'm doing this rehab and I'm gonna get back in but it doesn't always work like that I suppose does it? No, that's interesting. So information wise what do you think of talking head type of, do you want to listen to someone talk about an injury or would you rather it was again, just written information?

T: I'd rather it was written down so that I can dip in and out cos if you were listening to a talking head you'd have to wait for them to finish sort of thing if you get my point?

KW: No I understand what you mean. So exercise videos, what about things you can print off? Would that be of any use? Or is it better kept in a technical…

I: To an extent, but I mean it could be in a format that's easy to look at on your phone when you're sort of stretching in the gym or um, well you tend to have your phone with you or even if you're in the lounge sort of stretching before running and or just as rehab or something, yeah if it was clear and on the smartphone screen then that's probably yeah the most useful.

KW: Okay, any other thoughts? Anything else that is springing to mind, that you thought this would be really useful if this was out there for injury prevention or self management? Putting you all on the spot…

LAUGHTER

A: Maybe you could link to I don't know, something like to the nearest physio or your nearest…?

KW: Yeah? Okay.

A: Something like that cos you don't often know where to go sometimes.

KW: That's true because you know like you say you google and lots of things come up and you're not sure, yeah, no, so that helps as well because one of the things that we've talked about is having some, we've talked about the symptom checker, would it be useful to have something that would tell you, you need to go and see a physio right now? You shouldn't do this on your own.

T: Yeah.

A: So like a traffic light system? Yeah, yeah.

KW: Traffic light system? Actually, that's..stealing all your ideas A! Yeah, that you could put in your symptoms and maybe it would flag up that you needed to see a qualified person?

I: Um I'm just thinking like NHS um apps work in that sort of way, if you know, if you're checking, rather than sort of going to hospital or the doctor out of hours or whatever you, there are, I think it's actually on the website form isn't it but its you know its marked form usuable and you go through the symptoms and then they say yeah exactly that, you need to go to hospital straight away or just ring um whatever NHS direct or something like that so um yeah that could be useful.

KW: Because it is always hard to know you know even me as a qualified person, it is hard to know when you need to go and see someone isn't it.

A: It is.

I: yeah

KW: So that's really helpful. Anything else you want to ask about the project or has occurred to you or anything at all, because I think we've covered loads and so I think that's really helpful, thank you.

I: Something that just occurred to me from what was said a few minutes ago about directing you to physios um I actually went to a physio recently that I specifically knew was a runner as opposed to a physio who you know was really good, had run but wasn't specifically a runner and I did find that really really helpful and really useful um whether that's helpful for this I'm not sure?

KW: No, I suppose it's like all professions some people have their special interests like my son plays rugby so I'm not a great rugby physio but I might send him to…no that's interesting, I suppose if you feel they've got that insight into running?

I: Yes yeah, yep yeah.

KW: Maybe a bit more empathy? I don't know, for injured runners possibly? Now that's interesting, so maybe like a directory of local physios I suppose? And who is a runner and who is not??

I: LAUGHS yep, yeah

KW: So you can pick who…?

A: Traffic light them

KW: Well I think we've covered everything and in 45 minutes, that's amazing. Thank you so much for spending this time with me this evening, I did have a panic that nobody was going to come, but no you've all been fantastic, I might stop recording now if everyone's…I'll pause that.

END

Appendix 17: Participant information sheet for focus groups with health practitioners

CARDIFF UNIVERSITY PRIFYSGOL CAERDYDD

Participant Information Sheet

Qualitative evaluation using focus groups

Run Healthy, Run Strong: The Development of A Running Injury Prevention Self-Management Platform for Recreational Runners

We would like to invite you to take part in our Cardiff University research study. Before you decide you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully. You will have an opportunity to ask questions if you read anything that is not clear, or you would like further information.

Summary

Over the last two decades there has been an increase in the running population. Running is a relatively low cost activity and easily accessible, providing health, social and emotional benefits to participants. However with an increase in the numbers of running there has been an increase in the rates of running injury, leading to many runners having to stop and even leave the sport altogether.

Some injured runners turn to the internet to get information on how to avoid injury and self manage the most common running related injuries. There is a lot of information out there but most online resources lack any form of evidence and are not always relevant to one's own running related injury.

As well as collecting and reviewing the available evidence for running related injury prevention we also want to establish runners' experiences and opinions regarding injury prevention. With this data we then hope to develop the content for RUN HEALTHY, RUN STRONG, a running injury prevention self-management platform.

What is the purpose of the study?

The study aims to develop the content of RUN HEALTHY, RUN STRONG, a running related injury prevention and self-management tool that can be used by recreational runners.

Why have I been invited to participate?

You have been invited to take part as a clinician or physician who treats and helps prevent running related injuries in recreational runners or as a strength and conditioning coach/endurance running coach who has a role in helping recreational runners in preventing running related injuries.

Do I have to take part?

It is up to you to decide whether to take part. We will describe the steps of the study in this information sheet. If you agree to take part in the focus group, we will ask you to sign a consent form. You are free to withdraw from the study at any time without giving a reason.

What will happen to me if I take part?

You will be invited to attend one focus group (maximum 60 minutes) taking place in School of Healthcare Sciences, Cardiff University. The focus group involve between 5-8 people and will be conducted by the prinicipal investigator (Kathleen Walker) together with a research assistant. During the focus group we will explore your views on running related injury prevention and self-management: The discussion will cover:

- Your experiences of treating runners, what you believe contributes to RRIs, the treatment approaches you utilise when treating a runner with RRI and your approach to preventing RRIs.
- Your use of online programmes/software and whether you utilize any online programmes when preventing and treating RRIs and if you recommend any online programmes to runners aiming to prevent RRI.
- Your views on the potential content for an online programme, the content you would like to see included in an RRI prevention programme and your views on the format that you feel would be most feasible for an RRI prevention and self-management programme.

The focus group will be audio-recorded and a research assistant will also be taking notes.

Refreshments will be available during the focus groups.

What will I have to do?

We will ask you to sign an electronic consent form and you should be aware of the following before you participate. After signing informed electronic constent you will receive an invite to attend the focus group with date, time and instructions how to get there.

What is being tested?

We will explore your views and experiences of running and running related injury while also exploring your views on the content you would find most beneficial from a running related injury prevention and self-management programme. This information will have the potential to be used in the development of a running related injury tool which will benefit runners who actively want to prevent injury.

What are the possible disadvantages and risks of taking part?

There is no anticipated disadvantage or a risk in taking part other than time burden. Information will be stored confidentially and will only be shared anonymously with the research supervisors.

What are the possible benefits of taking part?

The information we obtain from the study will help the development and design of a running related injury prevention and self-management programme.

What if there is a problem?

If you have any concerns about any part of the study, you should ask the researcher and she will do their best to answer your questions and deal with your concerns. If you are still unhappy and wish to make a formal complaint, you should contact:

Dr Kate Button

Director of Research Governance

School of Healthcare Sciences

Will my taking part in this study be kept confidential?

All information which is collected about you will be kept strictly confidential. The researcher will maintain your privacy and confidentiality using a unique 8-digit code not accessible to anyone except the researcher. The procedures for handling, processing, storage and destruction of data will follow the Data Protection Act 2018. All the data will be anonymous and given a code, known only to the researcher. The data will be stored in an encrypted and password protected computer known only by the researcher. This data will only be used for this study and future studies will not have access to it unless further agreement from you is requested and consent obtained. Data identifiable to you will be stored securely at Cardiff University and accessed only by the principal researcher. In addition, the data will be kept for a minimum of fifteen years and disposed of securely according to the recommendations of the Data Protection Act 2018.

Anonymised data arising from the study will be shared with Cardiff University, Run Wales and Welsh Athletics to help develop services for runners and those experiencing running injury but it will not be possible for information to be traced back to individuals.

How will my data be managed?

Cardiff University, KESS2 and Run Wales/Welsh Athletics are the sponsors for this study based in the United Kingdom. We will be using information from you in order to undertake this study and will act as the data controller for this study. This means that we are responsible for looking after your information and using it properly. Cardiff University will keep identifiable information about you for 15 years after the study has finished.

Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible.

You can find out more about how we use your information at: https://www.cardiff.ac.uk/public-information/policies-and-procedures/data-protection or by contacting the University's Data Protection Officer: inforequest@cardiff.ac.uk

What will happen to the results of the research study?

The researcher may publish the study in academic journals and present the results at conferences. In addition, the main findings will be disseminated to all participants via an online link which will be sent to your email. The findings will also be made available to KESS2 and Run Wales/Welsh Athletics. Only anonymised results will be published, you will not be identified in any report or publication. .

Who is organising and funding the research?

This research is funded by Cardiff University, KESS2 Fund and Run Wales/Welsh Athletics.

Who has reviewed the study?

The study has been reviewed by the Cardiff University School of Healthcare Sciences Research Ethics Committee and Health and Care Research Wales.

Further information and contact details

Principal Researcher: Kathleen Walker

Telephone:

Email:

Appendix 18: E-consent form for focus groups with health practitioners

Electronic Consent Form

Title of the study:

Run Healthy, Run Strong: The Development of A Running Injury Prevention Self-Management Platform for Recreational Runners

Name of Researcher: Kathleen Walker

To participate in this project you need to confirm your agreement with each of the statements below. Please tick each box.

17. I confirm that I have read and understand the information sheet (date 13/10/2019, version 1 QUAL Focus Groups) for the above study and have had opportunity to ask questions. (*required).

18. I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, and without my medical care or legal rights being affected but any data collected up to the point of my withdrawal will be kept. (*required)

19. I understand that my details will be linked to a unique identifier to ensure confidentiality. (*required)

20. I confirm that data from the study can be used in the final report and other academic publications and may be presented at conference, I understand that these will be used anonymously. (*required)

21. I agree to be audio-recorded during the focus group (*required)

22. I give consent for the use of verbatim anonymised quotes in publications and conference presentations. (*required)

23. I agree for you to share my anonymised data with external collaborators in the UK and abroad, including commercial companies. (optional)

24. I agree to take part in the above study. (*required)

Participant's name
Date of Birth
Email address
Date of consent

By pressing the submit button I agree to take part in this study

'Submit'

Appendix 19: Example of transcript from focus groups with health practitioners

KW: Did everyone have a chance to read through the participation sheet and all the stuff I sent through?

J: Yeah

KW: Brilliant, so basically we're trying to develop the content for what could be an app or a website in conjunction with Run Wales, um running participation has boomed and obviously with that we've seen huge increases in running injuries and from a public health perspective it would be really good if we could keep these people running for all the health benefits they get, um so any way we can do that, people don't always have access to NHS (National Health Service) or private appointments or can't get to for any reason, like a pandemic, can't get to see a physio um maybe something like a digital app for runners in Wales would be a good idea. So I've conducted a survey with um runners, um we did focus groups with runners to find out what they wanted from a digital intervention and then that's come, and then we've come round then to clinicians because you're kind of an important piece of the puzzle really because we want to know what clinicians think would be feasible and reasonable in a digital intervention. So um are you all treating runners at the moment? Are you seeing runners in clinics?

V: I've been redeployed to the community so I'm definitely not seeing runners at the moment, they're all about seventy, eighty plus um but yeah before in musculoskeletal but not at the moment.

OVER TALKING

V: Sorry J….

J: We're not really doing much hands on stuff at the moment, all on the phone or computer, on video um and the same really with triathlon I haven't got back into doing anything really hands on. We've built like, the protocols for hands on but we haven't thankfully needed to yet but.

KW: JM?

JM: I'm mainly based in FCP (first contact practitioner) now so um we're treating people remotely, video or telephone or bringing people in if they need, if the clinical need err is there so we can see people face to face in primary care um not so much ongoing treatment at the moment no.

KW: Yeah um…

J: When I was working in A&E (accident and emergency) I saw a lot of stress fractures come in, more than usual.

KW: Oh really? In the first lockdown?

J: Yeah there was a lot more stress fractures happening than normal, definitely in A&E, I'm not there now but I was there for the first six months um

KW: That's actually really interesting isn't it, the loading that people were doing in the first lockdown.

V: I definitely had a few patients with tendinopathy, people that had started running and just gone out for runs and, a lot of people had done Couch to 5k so they had been okay but yeah people who had just started doing 5ks and 10ks, there were quite a few aches and pains from that, it was all over the phone it has been quite hard to try and treat them.

J: You had a bine stress injury V.

V: Yeah, me and J assessed one recently face to face which is nice, quite an interesting one.

KW: Um so with regards preventative strategies what are your go to things that you're advising runners to do?

V: I think the biggest one for me is probably just gradually, if they want to increase their mileage and intensity just doing it gradually um I did the Running Rehab course last year, that was with Tom Goom the Running Physio, he was saying try and just keep it to around 10% increase of your overall mileage each week er and was saying like that's the biggest cause of running injuries usually that people try and up it too quickly and too soon so I'd say that's probably my main advice is to try and prevent injuries happening.

KW: Any other thoughts?

JM: Yeah I would agree with that, I think you know like you've just discussed with lockdown we've got a large population of runners that are physically not ready to run particularly um so their bodies are maybe, haven't experienced loading for a long time um so getting them prepared to run is really important I think that's a step people often skip but that pacing, (508) unfortunately I think that 10% rule at very early stage is sometimes really difficult to implement isn't it because you know 10% of very little is very little. People tend to jump those, jump those steps.

J: Um…from my perspective if I, do you want me to talk about it from I guess more of a hmm well I guess probably what I would be doing would be talking I guess about capacity so you know, well I kind of um struggling to know where to start…

V: There's quite a lot isn't there.

J: Yeah like in terms of yeah where do you want to start with it?

KW: Thinking of the novices.

J: With the novices?

KW: Yeah

J: Um…

V: Maybe footwear another one, like making sure that they've got running trainers, I have seen quite a few people recently just with like fashion trainers on or like completely flat shoes out on a run so yeah I think making sure people know that they do need decent shoes. I don't think you need to be too particular about type of footwear but as long as it's just like meant for running.

KW: Yeah..

V: If you're a complete novice you might not even realise.

JM: I wonder in a way do people fully understand what running uh entails you know? So do they know like if I go out there I'm actually going to put X amount of body weight through my joints and tendons so you know, I noticed um I did, I lived in New Zealand for a short time and power walking was really, really popular there, and we seem to skip the power walking part and go straight to running um sometimes I think there could be more of an emphasis around actually conditioning your cardiovascular system and your strength system to deal with the impact of running.

KW: Yeah..

JM: So you know and that pacing is absolutely vital um cos you've got lots of people coming back to running having not loaded their tendons for, tendons and muscles for and bones you know, like you a say bone stress, for years and then they're taking up the Couch to 5k and I know with my um focus groups we did with runners for my MSc that the nature of competitiveness um the nature of sort of wearable tech where you're seeing your friends doing extra sessions so they have to do an extra session so there's lots of concepts around that that need unpicking as well really.

GROUP: Yeah..

J: I'm guessing things like, I would divide them into internal and external factors, so external factors being like your trainers, the type of surface that you run on um, how hard you go, how fast you go, how long you go um what you do in terms of breaks like in between so is it like that you know you're starting with walk/run, you know how you gradually incrementally increase that, um and then things like your movement..

JM: Sorry I've lost you.

J: Hmm?

JM: Sorry I lost everyone.

J: Oh.. and then things like movement control so what, what muscles are important in terms of control of your body when you're running and how you would train those um like nutrition..

KW: Yeah…

J: Like thinking from a tissue healing point of view and from a bone injury prevention point of view not from trying to be a nutritionist but like what like factors do we need to consider when we're trying to prevent injuries that are effected by nutrition, and then um what was the other one I was thinking of? Umm..

JM: Rest and sleep…

J: And tendons…..yeah sleep….and then tendon health really.

KW: Yeah…and then thinking about the runners we see, our recreational population what do you think the barriers are to getting the, the difficulties and challenges we've maybe got to getting that through to them? I mean JM you mentioned about the um competing with other people which is quite interesting.

JM: There's some interesting concepts they brought about that competitive nature and when injured some of the language they used, and I'm not sure if L shared my dissertation with you but you're more than welcome to have a look, I can send it over, but um some of the language people used when they were injured to compare themselves to what, that they wanted to stab all the other runners out there or you know they hate seeing other runners running because they can't run so I think it comes down to some of that um that side of things is when they're injured you know what do people run for? So emotionally you know what, what not just fitness, mentally a lot of these runners found that was the only space they could exist happily in, they needed that support so that's one really important thing. I think um you were saying some of the barriers there, some of the barriers I think maybe down to not wanting to think about injury at all and whether injury prevention is such a kind of foreign concept for some people that they might need to think of it as a performance enhancer? Because people will buy anything that enhances performance but they won't buy anything that you know possibly, you know it's a harder sell injury prevention than performance you know. But if you can train more often and you can develop more often then that's going to improve your performance.

KW: Yeah

J: Time's a barrier isn't it. So like if you want them to do a bit of a warm up or you want them to do something to help with the injury prevention side of things then you know if they're busy that's a barrier....a lot of people look at running as an exercise that helps them to lose weight as well, so like when they're injured they're obsessed with the fact that they've got to carry on doing that because that's the thing that burns the calories rather than like any strength or conditioning work which actually is the thing that enables them to carry on doing the cardiovascular work you know but that's quite a hard thing….

V: Especially at the moment with gyms shut they can't get on the cross trainer or the bike like they might not have ANY equipment at home to cross train so running is, if they're trying to do it to keep fit and lose weight for a lot of people it's the only option they really have at the moment.

KW: Yeah

V: And then there's so many challenges on Strava as well like running a hundred kilometers in a month and people enter these and like it's good that they want to get fit and set themselves a goal but in terms of trying to pace your training plan and gradually build up, it can be awful for that.

JM: I remember some of the comments saying you know if I don't run with my watch I'm not running, um it doesn't count if it's not on Strava, all these sorts of comments you know. Um there's no. Yeah there's not that many people out there for kind of the love of running and just getting out to move across the landscape sort of thing, it's a all very competitive and timed and focus driven and target driven um rather than listening to um what your body says on a particular day, it's I ran this fast last time, so therefore I must be able to run it faster today because I'm two weeks down the line which you know we know isn't true it's just on how you feel really and that comes with experience I think, so the lack of, the thing we came across was we kind of framed it as an Injury Prevention Paradox really is that we had a lot of runners who were very experienced and they felt that running was really important to them um and they'd all been injured, yet none of them had invested any time or knowledge into injury prevention, so there's some, there's something missing between, you've got all the factors that really, that should be number one priority you know, I don't want to get injured again and I feel running is really important to me but I've not invested in that thing so there is like you say, there's time cos people just want to get out and run, I've got half hour so I'll get out and run as hard as I can um, there's facilities, there's knowledge, I don't think people have got uh seemingly that the, because there's not clear consistent message from anywhere on what's, what is good injury prevention, there's lots of historical, you know some clubs are very stretchy based, some clubs will do things, they listen to their friends and so there's no one, joined up thinking that everybody is uh one single message that we're all trying to put across um…

KW: Moving onto online stuff, um are any of you pointing people towards any apps or web sites or do you utilise any software in your treatment of runners at the moment?

V: Not really that much recently cos to be honest in the NHS we don't get a huge amount of like high level runners, um but I do suggest couch to 5k a lot and that's for brand new runners or if, I mean, my sister was a really goo runners and she had a horrible injury and even for her she used couch to 5k to get back on track and it worked really well for her so I do suggest that quite a lot, um sometimes I'll like write out a plan for them but actually couch to 5k, people enjoy it they''ve got someone in their ear telling them what to do, they can choose a different…

KW: Yeah Michael Johnson talking to you..

V: Yeah that's who she had she loves him LAUGHS and um there is the Running Physio website which is quite good but I feel like it's more for health care professionals rathe than patients themselves but there's some nice infographics on there, I've sent out a couple of those before.

KW: Anyone use anything else for their recreational jobbing runners, weekend warriors?

JM: I use the Running Physio like you say, I point patients in that direction cos I think it's a good evidence based resource and what's, there's another one um…it's got a really good video library of strengthening exercises umm….. ……. Bearded fellow um..

KW: Mike James?

JM: Run Live .com

KW: Oh yes

J: Adam Meakins is it?

JM: Yes RunLive.com is it?

J: What did you say it was? What was it? Adam…?

JM: I can't quite remember it?

V: Oh no yeah I know the guy you're talking about but I can't quite remember his name… Run Live J,

JM: Run Live that's it yes.

V: He's quite controversial isn't he, I can't remember his name.

JM: Yeah, he's got good like home, home umm videos for lower limb strengthening stuff you know that patients can, if they're looking for a good um routine to do…

V: I think he does a podcast as well.

JM: Yeah he's got a podcast yeah, I can't remember his name.

KW: Now okay I was told about this by L, this is new to me, are you aware of the CSP (CHARTERED SOCIETY OF PHYSIOTHERAPY) app finder?

V: No

JM: Nope

J: No

KW: That's fine, that was, L suggested I bring it up but if you haven't heard of it it's fine, I had to look it up today, um on the CSP website there's an app finder and it directs you to things like couch to 5k, some NHS MSK (musculoskeletal) apps but, we can move on from that, if nobody's heard of it we can skip that. Um so moving on to what my project is, um as I said I interviewed the runners about the kinds of things that they would like to see in the Ideal Running Prevention App and self-management app so I'm going to try and share, I've done like a, NVivo helped me do like a hierarchy of themes so I'm going to share like a screen and I'm hoping it works…SHARES SCREEN …(.KW muttering to herself trying to share screen)…can you see that? Has that come up?

JM: Yeah

KW: So this was um the um injury prevention and self-management advice section, so they've actually ended up being quite a big section on loading, they wanted, there was a fair hot spot on warm up and cool down advice, the smaller sections in the loading relate to return to running after injury and recovery, exercises with a tiny bit about stretching, um dietary advice which also included hydration um some people wanted some tailored information towards age and maybe some specific conditions and um

SNEEZE

V: Sorry

KW: Bless you

JM: Bless you

KW:…and a bit about equipment um some people wanted to know about foam rollers and um other bits and bobs and then I'm going to try and find the other, I couldn't see it then ….uhhh…I did have another one but that's not the one I wanted ….so they were also asking about diagnosis um…whether the app, when to be highlighted that they should go and see someone face to face or like a symptom checker, like a, someone described it as like a traffic light system where you put in your symptoms in and it would tell you yes you can use the app, carry on using the app or no you should, red light, you should go and see someone…so what are your thoughts firstly on those topics for a resource, for a digital resource? Are they the kinds of things you'd expect to see in something like this?

J: Can you put the first one up again?

JM: I think the traffic light idea is really good.

KW: Yeah I'll put it up again.

J: I guess for the injury/symptom checker would you need like an algorithm, I don't know..

KW: Yeah…

J: I think it's a good idea.

V: I think it would be, before you get onto the traffic light system, if there was like a body chart, so they could click on where their pain is and then you could go through to the different, like common running injuries in that area and then onto the traffic light system, just to maybe like, help them self-diagnose a little bit umm and then yeah work out if they need to see someone or if they can self-manage.

KW: Yeah…okay…um what about the screen that's up now, does that seem fair enough?

V: Are the bigger boxes like what people seem to want more?

KW: Yeah so ….the app…the programme produced this for me…yeah loading was a big thing for them, especially return…

V: And warm up advice I'm surprised that's there…

KW: Yeah, that kept coming up over and over um exercises they were very much saying um we know we should do some strength exercises but we get given them, we don't do them, we probably should do them um which led onto them asking about um notifications and feedback loops within an app um so sort of adherence issues…

V: Maybe like for prevention if you had a circuit on there that wouldn't take them too long but its got like the best evidence based exercises for glute strengthening and quad strengthening and stuff sort of they could just literally follow that, like a half an hour video or something…

KW: Yep.

JM: Yeah.

V: And more specific ones for specific injuries, obviously that would be quite demanding to put that all on there.

KW: No I don't think that would be…any other thoughts?

JM: Yeah exercises that could be done anywhere, you know at home with whatever you've got so you know rather than involving particular equipment might be, most of these runners, especially we know that novice runners are probably the target audience cos they're the ones getting injured most often um yeah you know so give them exercises that they can do uhh rather than having to visit a gym maybe if we're thinking of time being the issue…or specialist equipment.

KW: Yeah….anything that you think they've missed out that you think should be included?

V: There's not really, apart from a little bit about return to running there's not really anything about their training programme and what it should look like and how to get faster or cover more mileage but I think it's like we were saying a lot of runners aren't really aware and they just run, they don't really think about how much they're doing.

J: Would that be classed under loading then?

V: Oh yeah…

KW: It was um what some of them were saying, they were concerned because they've got their Strava and the likes they thought it was too similar to that then but Strava I didn't think Strava gave training programmes, I don't know if the paid version does, I'm not on the paid version so, I'm not sure.

V: You actually monitor like how much you're doing so you can look back at your runs a week.

KW: Yeah…so you could see if you were doing too much or you were like potentially cos an overuse injury the issue has happened weeks before symptoms appear sometimes don't they….I'm going to see if, there was another one but I can't find it..

JM: A bit of myth busting might be worthwhile to have in there.

KW: Yeah.

JM: You know sort of common myths of er around you know which we could dispel in terms of available evidence.

V: Yeah

KW: Yeah…um format wise what would you think, I mean firstly I mean it was very, I think that was the screen that I'm trying to find and it's not coming up, it was very fifty fifty between app and PC, it wasn't kind of err a, a big sway either way but do you have any opinions on how it should be, that information should be presented to patients, how your runners would rather it?

J: What was your average like age group, or your mean age group and your range?

KW: It was mid-forties, which kind of reflected the survey as well and seems to reflect other research to do with um recreational runners, the runners tend to be in their early to mid-forties, a little bit towards um the overweight side um and average running from the survey was probably 20-25 miles a week.

J: I guess if you're developing an app there's going to be contemporary, those people that are forty five will soon be fifty but there will be other people in their forties and forty five and they're more likely to use an app and as everyone moves up through the generations like, like your, perhaps a web based thing will become outdated perhaps?

TWO PARTICIPANTS TALING AT THE SAME TIME

JM: Go on…

V: Oh sorry,I just was saying an app would probably be a bit easier to use and you know they can just check it whenever on their phone rather than having to get onto a computer.

J: Remembering a web page or like….I've got like thousands of webpages open on my iPhone and every now and then I delete them all like and then can't remember what that web page was.

JM: You can't find them

KW: Yeah I do that with my laptop I've got them all, the tabs at the…

J: I literally don't know how to bookmark things LAUGHS it's like save them all

LAUGHTER

JM: But I think you definitely, you're definitely right the world is going app based, you're going to have an app for everything um and if you're, if time is a barrier then if you're sitting on the bus or you're sitting waiting at the GP's , you're sitting in work, at dinnertime you can check an app, while you're not likely to load a web page.

KW: Yeah

J: Something that might be useful is if it links to Strava or something and you know like how um is it My Fitness Pal links to Strava I think so like you can, it'll upload your exercise to My Fitness Pal, if you could have something that uploaded 'Loading' I guess into that app, that could be helpful.

KW: Yeah

J: I don't know what kind of financial implications that would have or how complex that sort of thing is, I can't really envisage how you develop and app.

KW: Me neither, its like a post doc thing…

JM: I think when people you know they spend a fortune on all sorts of guff which has no bearing on their running ability and you know it's how we go about selling this sort of thing to runners to make it desirable to them, you know using social marketing techniques, influencers within maybe social media and the running communities, so who are those influencers, are they running coaches, their friends, their, is it, you know Michael Johnson, is it people you know, who do we need to sell this to, because for this to work it needs to go out to the masses doesn't it you know, and people need to be singing the same message.

KW: Yeah, and then sort of presentation style, is it videos? is it lists of exercises? Is it, what do you think people would rather? Listening to a talking head type person? I don't think I can get Michael Johnson but..

LAUGHTER

KW: I'd love to

V: Probably videos for the exercises. Um just cos it's easier for them to watch and follow then um but there maybe in terms of the injuries and advice on self-management. Well it depends doesn't it, like for me I'd rather read it but I think it really depends on the person, some people find it easier to watch someone talk and to listen to them, others prefer to read it.

J: Have you, have you seen um ED's app on ACL's (anterior cruciate ligament) K?

KW: No …

J: Not app sorry, web page, it might be worth asking K about that, so she's done a website for ACL rehab and she's delivered the message in text, in animation and recorded like, so this is more just the information sharing stuff, she's put it in multimedia, so you can read it um, you can watch a video about, a person speaking about it or you can watch an animation.

V: It would be really good to have the options I think.

J: Yeah to be honest the worst one was like the physio just delivered the information. Obviously it's a bit different when you're doing exercises because you probably need a human being for that rather than an animated character..

KW: I suppose we have to consider accessibility as well don't we, you know for everyone, it can't just be for people who can hear it and read it and

J: Ask K about ED's website.

KW: Yeah, thank you for that.

JM: I think like you say you've got to have the, it's got to be shiny like all these websites and bits and bobs you've got out there on social media now isn't it, it's got to be useable, so if you're on Instagram and you just flick across a couple of exercises for different body parts it's got to have that useability and a lot of NHS stuff can often be…

J: I quite like that on Instagram when you, like if you say like looking at like glute rehab or something and then you flick across the exercises, I quite like that when you see that on Instagram 'ahh a few different'.. and it is only a small snippet so you don't have to watch like a whole ten minute video to get all the information.

V: Yeah and that's why we like Tom Goom's infographics and I think there's been some like Clinical Edge ones as well cos it just gives you the main points and its like colourful, it's not just a list of information, there's like text in different places, it's quite, you can just read it in a couple of minutes and actually get quite a lot from it.

J: Yeah

KW: Yeah, so again that…

JM: You were talking about, those animations, the um MACP (Musculoskeletal Association of Chartered Physiotherapists) Cauda Equina one um, the little cartoon one they've got now is fantastic, you know I think it really sells that message and something like that, which is with a bit of music and just presented well, it will often stick longer in the mind than a big paragraph of reading won't it.

KW: Yeah, haven't seen that either, I'll have to…

JM: It's really good, you know when they draw freehand and it's all sort of a comical nature to it but it's a serious topic obviously and just, compared to the cue card it's much more memorable.

V: Yeah, Tame the Beast is quite a good one as well for chronic pain, I've sent that to a to of patients and that's quite popular.

KW: Yeah I think I've seen that one, that's a really good one.

JM: Yeah it's excellent.

Kw: Um re kind of unintended consequences, do you envisage, can you see any issues with providing this kind of content in an app to runners without necessarily having guidance from a physio and safety…?

JM: I think if it's, I think if it's very sort of generic and front facing, as long as you identify red flags in any algorithm. There is obviously anything you know you'd look to discuss um, I know there's some papers out there where they sort of talked about gait retraining for landing on your forefoot and taking more steps and they had a real big increase in Achilles and calf injuries cos people suddenly without doing the other bits of strength training, they just took the message they wanted, so that's one thing you might be careful of 'ooh actually I like that bit, I'll take that' but they've not taken the whole message they've taken a portion of that message so you know if you said look, you know it's a good idea to hit the ground more often and a bit more softly towards the balls of your feet but to do that you need to do X amount weeks of strength training to sort of, and pace it back slowly um like your barefoot runner who goes from running in a big heel to a you know, completely barefoot shoe and doing the same distance straight away, you know they're an injury risk aren't they, so I suppose you've got to think of those type of changes.

KW: Hmm yeah…yeah so there is ways we can counteract that with like you say with the messaging behind it, the 'use this website but, use this app but bare in mind you need to have done this, this and this' kind of…approach.

JM: Yeah, I think it's the same with loading and pacing, big changes, anything you do with running, if you make a big change it'd generally going to lead to, or it could lead to injury couldn't it, so I think as long as you don't keep these, it doesn't sound like you're going to add anything in there which would be that dramatic.

KW: Yeah, anyone else see any issues with the content or safeguarding issues or…no?

V: No I don't think so.

KW: Um….there is one thing that, just to bring this up as I remembered it, there was a 50/50 split again between people wanting just general exercises for general conditioning and specific injury exercises, do you think…because one of the physios in the last focus group said it would be more difficult to prescribe exercises via an app for injury but do you have any thoughts on whether it should be either or, or both, is there a place?

J: For prevention?

KW: It's going to be partly a self-management app as well um is the discussion but again only if it's feasible, only if it works. Some of the runners were saying 'oh yeah we'd like um if I get plantar fasciitis I'd like a list of exercises to do for that or if I get Achilles problems or knee err knee problem I want exercises for that', whereas other runners were saying 'oh no I just want to know I should do these exercises for my hips, to keep my hips really good, I just want to know general strength and conditioning', so I just wondered, big question really is there a place I suppose for specific injury management exercises within the app or are we…?

V: I think the common injuries, like Achilles tendonitis and yeah just kind of general knee pain you could give a few exercises for that but it's hard to get very specific when we can't assess their flexibility and their strength, so as long as it always comes with a little caveat saying you know, if this problem is not improving it's important that you do speak to a physio or see a physio, you know.

KW: Yeah.

V: Yeah I feel like if it was only general exercises for prevention and there was nothing there for specific injuries I sort of feel that there would be something missing.

KW: Yeah, okay, but as long as we've got that safeguarding in there to say..

J: Yeah you need that caveat don't you.

V: Yeah, and then you could have like specific glute exercises, three or four exercises for that and then hamstrings, so if they do want to focus on specific muscles well then they've got that information but yeah it would be quite difficult with injuries without doing that assessment first.

KW: Yeah, brilliant, anyone got any other thoughts about what we're doing or any issues that you think we should consider?

J: It sounds interesting.

V: Yeah I think it would be really good.

KW: If we get that far LAUGHS

JM: It's a big undertaking isn't it.#

KW: Yeah, yeah I've been doing a systematic review as well and that's still going so....yeah.

V: There's definitely a need for it.

JM: Looking at the, looking at the evidence of any apps that are out there, I think someone did a survey of running apps that are out there for injury prevention and none of them had any evidence based stuff on and that's, that's the

KW: I think I remember that one…

JM: I think it needs to be based in evidence and m we could do with dispelling some of the running club myths you know, some of those commonly held beliefs that you know that go round the running clubs and sort of see what's out there, what do people think, what do people, what are they told?

KW: Hmm yeah.

JM: Cos even from uh an athletics point of view, a lot of the people I interviewed said the message they got were different, from different, that people had been on the same course but they were getting different messages from the course.

KW: Yeah…um one thing, I'm going to say, one last thing, um some physios, some runners were asking for a physio directory so, cos they were saying that you know they go round all the physios and they finally find one that understands running and, or is a runner themselves, what do you think? Would that be a good idea or are we kind of…?

J: It's quite difficult isn't it.

KW: Yeah…

V: I think it's difficult because you'll have like physios in certain practices that are more into their running, I don't know, I'm not aware of any running physio practices in Cardiff um so they'll be like individuals but they'll be like dotted around, it would be hard I think to put a list of physios on there.

KW: Yeah, yeah and not all physios, even though they might be into running they don't always work for everyone…..it's a very personal thing as well isn't it.

J: I think probably will you open yourself up to criticism if you're suggesting a physio and then actually that person doesn't get this person better, so you know.

KW: Yeah.

JM: They move, physios notoriously move don't they and they'll work for a bit in one clinic and then go somewhere else and…

V: Yeah..

JM: And I think one of, I remember one of the, again harping back to that focus group we did, a couple of the runners said they feel embarrassed to go to the NHS because it's not a real problem, but if we're looking at the NHS as something that promotes healthy living and we're looking to keep people active we need to say well actually don't be embarrassed about that, you know those are the people we want to see because those, if we keep you running we keep you fit and active, we reduce many of your co-morbidities, so encouraging people to access you know their local FCP um for up front advice cos most of them would be able to give and then that obviously leads them onto how much advice and education a physio INAUDIBLE

KW: Yeah and a physio directory sort of implies that people can automatically afford to pay out and there's this, the people that fund me are sort of working towards improving things generally, like, the research is sort of intended to help the um sort of the more deprived areas of Wales and I suppose if we've got a physio directory that's saying ooh these are your private physios, well in those areas they might not be able to kind of access that, you know the NHS is their like you say JM we should be encouraging people to contact the NHS and their First Contact Practitioner.

J: It's quite difficult, cos then you're defining who is a good physio for running is very subjective, are you going to go round and test that everyone is a good physio, like…?

V: Yeah it's quite biased isn't it.

KW: I did sit in a few of the focus groups going 'hmmm cringe' because you know not everyone private is excellent and like you know vice versa so it was a bit of a weird one.

V: Yeah but I can understand where they're coming from because it does help to speak to someone who gets it and can actually speak to them from experience themselves about running injuries, but yeah it's just hard I think to pinpoint those people and put them on a website.

KW: Yeah, yeah….brilliant. Thank you. That's everything you'll be glad to know, under and hour we've done it! I'll stop recording.

ENDS

Appendix 20: Participant information sheet for interviews with Run Leaders

CARDIFF UNIVERSITY PRIFYSGOL CAERDYDD

Participant Information Sheet: Interviews with Run Leaders

Run Healthy, Run Strong: The Development of A Running Injury Prevention Self-Management Platform for Recreational Runners

We would like to invite you to take part in our Cardiff University research study. Before you decide you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully. You will have an opportunity to ask questions if you read anything that is not clear, or you would like further information.

Summary

Over the last two decades there has been an increase in the running population. Running is a relatively low cost activity and easily accessible, providing health, social and emotional benefits to participants. However with an increase in the numbers of running there has been an increase in the rates of running injury, leading to many runners having to stop and even leave the sport altogether.

Some injured runners turn to the internet to get information on how to avoid injury and self manage the most common running related injuries. There is a lot of information out there but most online resources lack any form of evidence and are not always relevant to one's own running related injury.

As well as collecting and reviewing the available evidence for running related injury prevention we also want to establish runners' experiences and opinions regarding injury prevention. With this data we then hope to develop the content for RUN HEALTHY, RUN STRONG, a running injury prevention self-management platform.

What is the purpose of the study?

The study aims to develop the content of RUN HEALTHY, RUN STRONG, a running related injury prevention and self-management tool that can be used by recreational runners.

Why have I been invited to participate?

You have been invited to take part as a stakeholder who has a direct development role with runners and running clubs registered with Welsh Athletics and Run Wales.

Do I have to take part?

It is up to you to decide whether to take part. We will describe the steps of the study in this information sheet. If you agree to take part in the interview, we will ask you to sign a consent form. You are free to withdraw from the study at any time without giving a reason.

What will happen to me if I take part?

You will be invited to attend an (maximum 1 hour) taking place in School of Healthcare Sciences, Cardiff University. The interview will be conducted by the prinicipal investigator (Kathleen Walker). During the focus group we will explore your views on running related injury prevention and self-management: The discussion will aim to establish the views of stakeholders on the material currently available to end users and what stakeholders feel would be of benefit to their end users. The interview will cover:

- What is currently available to the end user via the Run Wales/ Welsh Athletics web site regarding running related injury prevention advice?
- As a stakeholder what does the interviewee feel would benefit the end user of an online RRI prevention programme?
- How would the interviewee want to see an online prevention programme presented to end users?

What will I have to do?

We will ask you to sign an electronic consent form and you should be aware of the following before you participate:

- After signing informed electronic consent form the researcher (KW) will contact you to arrange a suitable time and date for the interview.
- The focus group will take place School of Healthcare sciences, Cardiff Univeristy.
- It will take approximately 30 minutes.
- It will be conducted by the prinicipal investigator (Kathleen Walker).
- The interview will be audio-recorded and the researcher (KW) will also be taking notes.

What are the possible disadvantages and risks of taking part?

There is no anticipated disadvantage or a risk in taking part other than time burden. Information will be stored confidentially and will only be shared anonymously with the research supervisors.

What are the possible benefits of taking part?

The information we obtain from the study will help the development and design of a running related injury prevention and self-management programme.

What if there is a problem?

If you have any concerns about any part of the study, you should ask the researcher and she will do their best to answer your questions and deal with your concerns. If you are still unhappy and wish to make a formal complaint, you should contact:

Dr Kate Button

Director of Research Governance

School of Healthcare Sciences

Will my taking part in this study be kept confidential?

All information which is collected about you will be kept strictly confidential. The researcher will maintain your privacy and confidentiality using a unique 8-digit code not accessible to anyone except the researcher. The procedures for handling, processing, storage and destruction of data will follow the Data Protection Act 2018. All the data will be anonymous and given a code, known only to the researcher. The data will be stored in an encrypted and password protected computer known only by the researcher. This data will only be used for this study and future studies will not have access to it unless further agreement from you is requested and consent obtained. Data identifiable to you will be stored securely at Cardiff University and accessed only by the principal researcher. In addition, the data will be kept for a minimum of fifteen years and disposed of securely according to the recommendations of the Data Protection Act 2018.

Anonymised data arising from the study will be shared with Cardiff University, Run Wales and Welsh Athletics to help develop services for runners and those experiencing running injury but it will not be possible for information to be traced back to individuals.

How will my data be managed?

Cardiff University, KESS2 and Run Wales/Welsh Athletics are the sponsors for this study based in the United Kingdom. We will be using information from you in order to undertake this study and will act as the data controller for this study. This means that we are responsible for looking after your information and using it properly. Cardiff University will keep identifiable information about you for 15 years after the study has finished.

Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible.

You can find out more about how we use your information at: https://www.cardiff.ac.uk/public-information/policies-and-procedures/data-protection or by contacting the University's Data Protection Officer: inforequest@cardiff.ac.uk

What will happen to the results of the research study?

The researcher may publish the study in academic journals and present the results at conferences. In addition, the main findings will be disseminated to all participants via an online link which will be sent to your email. The findings will also be made available to KESS2 and Run Wales/Welsh Athletics. Only anonymised results will be published, you will not be identified in any report or publication. .

Who is organising and funding the research?

This research is funded by Cardiff University, KESS2 Fund and Run Wales/Welsh Athletics.

Who has reviewed the study?

The study has been reviewed by the Cardiff University School of Healthcare Sciences Research Ethics Committee and Health and Care Research Wales.

Further information and contact details

Principal Researcher: Kathleen Walker

Telephone:

Email:

Appendix 21: E-Consent form for interviews with Run Leaders

Electronic Consent Form

Title of the study:

Run Healthy, Run Strong: The Development of A Running Injury Prevention Self-Management Platform for Recreational Runners

Name of Researcher: Kathleen Walker

To participate in this project you need to confirm your agreement with each of the statements below. Please tick each box.

25. I confirm that I have read and understand the information sheet (date 13/10/2019, version 1 QUAL Interviews) for the above study and have had opportunity to ask questions. (*required).

26. I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, and without my medical care or legal rights being affected but any data collected up to the point of my withdrawal will be kept. (*required)

27. I understand that my details will be linked to a unique identifier to ensure confidentiality. (*required)

28. I confirm that data from the study can be used in the final report and other academic publications and may be presented at conference, I understand that these will be used anonymously. (*required)

29. I agree to be audio-recorded during the focus group (*required)

30. I give consent for the use of verbatim anonymised quotes in publications and conference presentations. (*required)

31. I agree for you to share my anonymised data with external collaborators in the UK and abroad, including commercial companies. (optional)

32. I agree to take part in the above study. (*required)

Participant's name
Date of Birth
Email address
Date of consent

By pressing the submit button I agree to take part in this study

'Submit'

Appendix 22: Recruitment email to Run Champions

Dear Run Activator/Run Champion,

As part of a PhD programme at Cardiff University and in conjunction with Welsh Athletics/Run Wales, I am researching digital interventions for the prevention and self-management of running-related injuries within the recreational running population.

As part of this project I am conducting online one to one interviews with stakeholders from Run Wales to 1) establish the content currently available to runners from Run Wales for injury prevention and self-management and 2) establish stakeholders’ views on how a digital/online injury prevention and self-management programme would be of benefit to runners in Wales and how this content should be presented to runners.

All that would be required of you would be approximately 30-40 minutes of your time to take part in one off online interview.

If you would be interested in taking part in the study I have included a Participant Information Sheet with more details about the research. I have also included a Consent Form. If you have any questions about the research please do not hesitate to contact me at

Appendix 23: Example transcript of interview with Run Leader from Welsh Athletics

KW: Thank you H for doing this interview, you remember our chats before about what I'm doing, I'm creating or trying to develop an intervention to prevent injury so I've done a survey with runners, interviewed runners, interviewed um physios and strength and conditioning coaches about what they think should be in the intervention but then I really need to talk to the people who know the runners best which is where, you know them in a different way, so that's where you come in, the piece of the puzzle. Um so firstly what's your current role in Run Wales?

H: So I'm the Participation Officer at the moment for Run Wales which basically means um driving participation I suppose, the role has changed a little bit from when I started, I was a Run Activator which again was driving participation so again that's basically where we're at.

KW: Okay and in that do you give any advice to Run Leaders about injuries, about where to tell people to go for injury information or what they should do if…

H: We try not to just because of our you know our real lack of knowledge around injury and you know how dangerous it can be when someone's suggesting that it's a problem and you know it's not that a problem and things, we try not to, we always encourage um professional advice um we do signpost um to various bits and pieces um if we think you know, if it's a black and white you know this is what we think it is um but we always follow it up with please, please do see a professional or speak to a professional so…

KW: Um are you ever able, have you ever come across any online information, injury information that you've found useful to direct people to?

H: I find the Runner's World stuff quite useful, um cos they do a lot of, again they sign post on again but you know Google can be very dramatic can't it so um the Runner's World stuff helpful but again I wouldn't signpost people to Runner's World specifically just because it might not be that and you know and we live in such a, not a dangerous society but I wouldn't, I would hate to think I'm sign posting someone in the wrong direction then and causing more harm so….

KW: Yeah um with the Run Wales and Welsh Athletics web sites what's currently available that you know of for recreational runners via those sites..?

H: I don't think there's; anything at the moment, I don't think so, obviously we've had a big reshuffle with what we're doing over lockdown and everyone was furloughed and we've come back to sort of a fresher project and I know we've got plans to work with you and get some, and get the tool kit up and running but I don't think as like a click thing I don't think there's anywhere at the moment. There might be on Welsh Athletics but Run Wales hasn't no.

KW: Yeah because we're talking ore about the recreational runners really.

H: Yeah so there should be something definitely because obviously as well like new runners coming through that you know, it's a recreational you know, what's the phrase? The recreational no it's not recreational, you know what I'm trying to say , it's part of starting to run you get injured unfortunately don't you because you don't really know what you're doing.

KW: Yeah if you're a novice you don't… yeah. Um, so if we were to think of a, the Ideal Injury Prevention intervention, sort of reduce injury risk, prevention and self-management app, what do you think would benefit the recreational runners in something like that, what do you think would help that?

H: I think um all the basic stuff, um you know the taking care and the, like I mean I always, it's probably not the right information but I always in my sort of tool kit I always say you need ibruprofen, ice, time and an expert really so I suppose what that expert could provide really would be, I don't know it's just collating it all and putting it there I think. It might be nice to have some sort of map, a human body map and little bits of information on the side um…

KW: How about things like exercises, I'm just thinking about things that the, cos when we interviewed the runners I mean they, that ballooned when I asked them what they wanted, so they were after things like um lots of different exercises to prevent injury, um advice on warm ups, um nutritional advice, hydration advice um stress management came up, age related advice um so is there anything there that you think would be useful to your runners or….?

H: Yeah definitely um like the stretching and things because like obviously every time I've seen a physio they've given me exercises to try and eliminate the problem or you know prevent the problem and I definitely think some videos of stretches and appropriate stretches not just you know, and the warm ups , I think if we could some warm up videos of why we're warming up in that way because I think that's important, that's key to understanding a lot of it like you know, I'm still really guilty of not warming up properly and you know I'm injured at the moment and the first thing S said to me last night was 'well you don't warm up properly' and I was like probably not but if I knew if warming up in the that specific way was to prevent my calf going or prevent my knees from you know, so I think it's education obviously but yeah the videos definitely.

KW: Yeah, so it sounds like an educational element you think would be….

H: I think…I think educating is probably more key to it than the sort of showing because I think once you, once it clicks it's like, when you start running and you know like, like me, like I know trainers are key to injury prevention for my style of running so I know I've got to have the right trainers just to start off okay and I only know that through being taught, I only know that through my gait analysis being done and people, and the guys on the treadmill explaining to me why I run that way and why I need that specific trainer otherwise I'd be guilty of just getting the cheapest trainers I could, you know or the prettiest trainers or things like that but I think now because I know that that's key so I think if I know that doing this exercise is going to prevent me from hurting later on then yeah it sort of clicks in then doesn't it?

KW: Yeah you've got that understanding then of why it's, it's not just a thing that, oh the physio sold me this or this person just wants to sell me something, if you've got that understanding it makes more sense to you.

H: Yeah.

KW: Yeah

H: And I think you, you attach yourself to it then don't you because the understanding is there so it becomes part of why you run, like I don't like warming up, I hate it, but I know that I should warm up because it does this, now I'm particularly injured going forward I know what I'll have to do to my calves to make that not happen again.

KW: Yeah.

H: Or, you know I just thought it was a tedious process really.

LAUGHTER

KW: Do you think that's possibly the experience for like the novices and the recreational, so not thinking of like sub-elite club runners so our kind of meet at the bus stop type groups, do you think they find the injury prevention stuff tedious?

H: I think so because they're so geared up on just starting to run or just running for you know, like me I'm a social runner so I, I always felt quite self-conscious warming up as well because I thought I looked like an idiot, you know because you're not running fast, you're just going for a jog, I never wanted people to think that I thought I was more serious than I was and I think that's got a lot to do with it as well, where we're still fitting in, in the world of running you know?

KW: Yeah, um so thinking about how we would package something like this do you think it would suit better on an app or a website or a bit of both? Where do you think…?

H: I think a bit of both, I think some, I think some courses might be a good shout as well because when you're new into it you're desperate for information, you're desperate to be doing the right thing and I think if you could do some sort of like maybe online learning which could be done through an app I suppose, where you tick off that you've read that bit and that you understand that bit and oh yeah I get that bit but you could go back to it then as well, so like you know you've got that resource there.

KW: Yeah like modules?

H: Yeah

KW: Yeah

H: You can't take it all in in one go can you? You know, there's physios out there now who've been qualified years and years and they still have to learn new things and that's brilliant and I think, but I think for the basics it would be nice to have that resource then to you know, like it's been years since I looked at calf things because I haven't had problems with my calf but this week now I'll probably be inundated with information about my calf because that's what I'm looking for so….but if I had that in one place it would be great.

KW: Yeah and it sounds like….

H: And it would be a trusted source obviously so…

KW: Yeah so like a phys, a professional evidence based?

H: Yeah..

KW: so scientific but in the right language?

H: Yeah.

KW; It sounds like you'd, you think maybe a bit of like you said, written education but also you can opt to see some videos of these exercises that will help…

H: And I think the opting thing is key as well because I don't want to sit through say someone teaching me about back injuries when I've never had a back injury but come three or four months down the line I might have a back injury so I want it there but I don't want to look at it then you know?

KW: Yeah, yeah cos you don't want it, like you say you don't want to be forced to scroll through a whole load of, you'd just put it away then you wouldn't…

H: Cos yeah you know like when you look at BBC Food recipes I'm just like show me the ingredients, I don't want to read your adverts or the I give my family this dish on a Thursday and it's really easy…

KW: My childhood memory of why I eat beetroot or something.

LAUGHTER

H: Yeah cut to the recipe! So you know things like that I think you know and it is a saturated sort of land now that, luckily the internet is there for us but yeah if I could have a trusted source of bits that I could pick out I think that would be great.

KW: Yeah and is that something you think the runners that you know, the specific population that we're talking about, do you think that that's something that would appeal to them?

H: Definitely, definitely and I think with the nutrition side of things like um, I watched a guy on Twitter yesterday saying that he's been injury free for like three months because he's eating well and like obviously he can't prove that but I think if we could have bits of information you know like a nutrition side that said right your muscles are going to feel better if you eat or drink like this then I think you know, a bit of everything then really.

KW: Yeah, do you see any potential problems or barriers or like we all them the unintended consequences…?

H: Yeah that's the only thing isn't it, you're going to get one who takes everything, who takes their perception of what they've read as gospel and you know it could be something very, very different and that's, that's the only thing and I think, and again we're so fed up of people, of like reading things like 'At your own risk' and you know things become a little bit less trustworthy then but it's unfortunately again where we're at with things that people, that people do misinterpret information like this stuff so, but that would be the only worry that someone's looking at a shin injury when it's probably their other arm or….LAUGHS…so

KW: Any other thoughts or…ideas?

H: No I think that's the only thing that would, otherwise I think it would be really useful, only the misinterpretations of things so, and they can't be helped, it's every day it's everything , you know the guy who had the Winnebago and went to make a cup of tea in the back because like the advert had said something like you can have a cup of tea as you drive but obviously you can't, you have to stop the Winnebago but he won his but he can't claim the lawsuit because the advert wasn't clear enough apparently.

KW: So yeah we need to be, for something like this we need to be very clear,

H: Crystal clear

KW: Crystal clear yeah. Brilliant, that's all my questions, thank you.

H: No probs.

END