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Osteoarthritis and Cartilage

Research priorities for physical activity and exercise management of people with knee and hip osteoarthritis: A multi-stage international priority-setting study from the OARSI Rehabilitation Discussion Group

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SUMMARY

Objective: To identify research priorities for physical activity and exercise management of knee and hip osteoarthritis (OA).
Design: We used a multi-stage process involving an international multi-disciplinary panel of 276 experts (150 consumers, 69 clinicians spanning 5 disciplines, 54 researchers, and 3 funder/consumer organisation

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representatives) from 26 countries. The process included: 1) compiling a list of unanswered research questions from existing research; 2) assembling the panel and generating additional questions from members via an online survey; 3) consolidating research questions (eg. removing duplicates); 4) scoring questions for priority by the panel on an 11-point numeric rating scale (0='not a priority at all; 10='highest priority') via another online survey; and 5) ranking the top 20 priority questions by the panel via an online discrete choice experiment (1000Minds).

Results: A list of 61 research questions was compiled from the literature and the panel generated an additional 346 questions. Following consolidation, 178 questions remained and were scored by 150 of the original panelists (54%), with mean priority scores from 5.0 to 8.4. 153 (55%) panelists completed the discrete choice experiment. The top three research priorities were: 1) investigating the impact of physical activity and exercise on delaying/avoiding joint replacement, 2) developing effective interventions to promote long-term exercise adherence, and 3) stratifying people to the most appropriate form of exercise support.

Conclusion: We identified research priorities about physical activity and exercise management of knee and hip OA. These will guide the international research agenda with the aim of improving outcomes for people with OA.

Introduction

Osteoarthritis (OA) is a highly prevalent musculoskeletal condition, commonly affecting the knee and hip joints, and is a leading cause of chronic pain and disability worldwide [1]. Clinical guidelines from the Osteoarthritis Research Society International (OARSI) [2] and other organisations [3–5] consistently recommend physical activity and exercise as first-line management for all individuals with OA. Physical activity is defined as any bodily movement produced by skeletal muscles that requires energy expenditure, while exercise is a type of physical activity that is planned, structured, repetitive and purposeful [6]. The recommendations supporting physical activity and exercise are due to their reported benefits on pain, function and quality-of-life [7] and their excellent safety profile [8]. Physical activity and exercise are also beneficial for general health and the treatment of other co-morbidities such as diabetes, depression and heart disease [9,10] which are common in people with OA and with a greater number linked to worsening health [11].

Despite these recommendations, benefits of physical activity and exercise on pain and function in people with OA are only small-to-moderate in magnitude, with effects waning over time [12,13] and differing across joint sites [14,15]. There are many barriers to participation in physical activity and exercise [16] and long-term adherence can be poor [17,18], which may explain the diminishing benefits. Recently, published evidence has raised uncertainty about the role of physical activity and exercise for OA, including whether the benefits on pain and physical function are, at a group level, clinically meaningful [20], and whether contextual effects such as therapist attention are the predominant mechanism of action [19–21]. Additionally, there is a lack of understanding about the optimal exercise dosage, how to promote long-term adherence, and which subgroups respond most favourably to physical activity and exercise. Thus, many unanswered questions remain. Addressing priority knowledge gaps with findings from appropriately designed research studies could improve clinical practice and, ultimately, patient outcomes.

Health research priority setting assists researchers, funders and policymakers ensuring that research efforts align with patient preference, are targeted, and research funding investment effectively utilised, to achieve the greatest potential health impact. [22]. Prior research priority-setting initiatives in OA, have not focused on physical activity and exercise [23,24] with the exception of one [25]. In 2018, the European League Against Rheumatism (EULAR) (now called the European Alliance of Associations for Rheumatology) developed a broad physical activity research agenda for inflammatory arthritis and OA combined [25] . Although findings from these studies provide some guidance, no recent global OA research priority setting study has exclusively explored physical activity and exercise management in OA to provide more detailed research recommendations. Under the auspices of the Osteoarthritis Research Society International (OARSI) Rehabilitation Discussion Group, we therefore aimed to identify research priorities for physical activity and exercise management of people with knee and hip OA.

Method

Study design

From May to October 2024, we used a multi-stage, international, multi-disciplinary process guided by the nine themes of good practice health research priority setting outlined by Viergever et al. [22] This involved five stages adapted from methodology based on the Child Health and Nutrition Research Initiative method of priority setting [26] and used by Paskins et al. [26,27] These five stages included: 1) compiling a list of unanswered research questions from existing research; 2) assembling an expert panel and generating additional research questions from members via an online survey; 3) consolidating research questions (eg. removing those out of scope, combining duplicates; 4) scoring research questions based on their priority level by the panel via an online survey; and 5) ranking the top 20 research questions based on priority by the panel via an online preference-based ranking experiment to develop a final set of research priorities. The process was overseen by an international Steering Group, comprising of 14 OA physical activity and exercise researchers from the OARSI Rehabilitation Group Committee spanning 5 countries (Australia, United States of America, United Kingdom, Denmark and Belgium) and two fields (physiotherapy, health science). All members of the Steering Group had prior experience/expertise in OA research priority setting and consensus methodology (e.g. [24,28,29]). Ethical approval was obtained from the University of Melbourne and participants provided electronic written consent. Reporting aligns with the PRIority SEtting of health research (REPRISE) guideline [30]. No formal evaluation of our prioritisation process is currently planned.

Scope

The scope of this work covered research questions in humans encompassing a range of research fields relevant to physical activity and exercise management of knee and hip OA, such as clinical research, applied health services and implementation science (Table 1). It did not cover prevention of incident OA, risk of OA following joint injury, or post-operative physical activity and exercise rehabilitation (eg. following joint replacement surgery).

Scope
Unanswered research questions in humans relating to physical activity and/or exercise management of people with knee and hip OA. *Exercise* is defined as - all forms of physical activity that involve dedicated time to expending energy. Exercise is planned, structured, repetitive, and purposeful physical activities. *Physical activity* is defined as - all other types of physical activity (bodily movement produced by skeletal muscles that requires energy expenditure) that do not fall within the exercise definition (e.g., incidental, unstructured physical activities like daily step counting, time spent in daily activities like walking). **Long-term goal** To improve the impact of research studies in physical activity/exercise management of people with knee and hip OA by addressing unanswered research questions in the field. Specifically, the goals are to: – Enhance outcomes from physical activity/exercise management in people with knee and hip OA – Improve the quality of life and wellbeing of those with knee and hip OA – Reduce personal, social, and economic burden of knee and hip OA **Expert international multi-disciplinary panel** • People with knee and hip OA: Have been told by a health professional that they have knee or hip OA and they have undertaken physical activity and exercise to help manage their OA. • Researchers: First or last author on at least two papers on human physical activity and exercise research in OA in the past 5 years. • Healthcare and exercise providers: Currently registered/licensed to practice as a healthcare provider or exercise provider in their home country and have managed at least one patient with OA per week over the past six months with physical activity or exercise. • Representatives of organisations that influence the delivery of OA care and/or funding of OA research e.g., policy makers, industry representatives, OA grant funders, health care administrators/managers: Have decision-making capacity regarding aspects of physical activity and exercise care that are implemented in a clinical setting or health system, or provision of funding for OA research.

Table 1 Osteoarthritis and Cartilage

Summary of the context, purpose and remit of the physical activity/exercise and knee and hip OA research priority setting process.

The criterion for deciding what constituted a priority was adapted from that of Paskins et al. [27] The criterion was: "How much of a priority is answering this research question in the field of knee/hip osteoarthritis, considering both the extent of the knowledge gap and the potential health, social and/or economic impact of the research after it has been adopted, adapted for use, or used to inform further research?".

Stage 1: Compiling a list of unanswered research questions from existing research

Members of the Steering Group reviewed key literature for previous OA research priorities and extracted those that were within scope (as defined above) to develop a draft list of questions. To do this, we reviewed the seven OA research priority papers identified by Bourne et al [23] (up to November 2017) and updated their search to identify any subsequent OA priority-setting studies. This involved searching MEDLINE and EMBASE from December 2017 to November 2023 and the James Lind Alliance (https://www.jla.nihr.ac.uk), Cochrane Priority Setting Methods Group (https://methods.cochrane.org/prioritysetting), and Cochrane Musculoskeletal and Back Groups (https://musculoskeletal.cochrane.org/about-us/priority-setting) review priority lists. We also reviewed the research recommendations identified by Woodcock et al [31] which were extracted from clinical practice guidelines focussed on non-surgical management of OA. Research questions that pertained to exercise or physical management of knee and/or hip OA were included, as well as questions that did not specify a joint of interest. Research questions that explicitly related to joints other than the knee or hip were excluded. Similar questions were then combined and/or re-written and duplicates removed by review and discussion amongst three Steering Group members (KLB, RKN, RSH). The resultant list of questions was grouped under arbitrary headings to assist panelists with subsequent reviewing and scoring.

Stage 2: Assembling an expert panel and generating additional research questions

We assembled an international, multi-disciplinary panel of experts (see Table 1) to participate in Stages 2, 4 and 5. No reimbursement was provided for participation. Potential panelists with sufficient English and computer and internet access were included if they self-identified as a consumer, researcher, health care and exercise provider, or representative of organisations that influence the delivery of OA care and/or funding of OA research (see Table 1).

A range of potential panelists with different backgrounds from different countries were targeted and electronic snowball sampling used. Sampling techniques consisted of: Steering Group members emailing invitations to their networks; email advertisements being sent to the membership lists of OARSI and its Rehabilitation Discussion Group and 'Joint Effort' Initiative; advertisements on social media (e.g., Facebook, Twitter); and potential panelists being encouraged to send the invitation to colleagues and/or patients/consumers who they thought might be eligible and interested in participating. Steering Group members meeting the inclusion criteria were included on the panel.

Survey 1 was administered electronically via REDCap™ (Research Electronic Data Capture) hosted at the University of Melbourne [32,33] and developed and pilot tested by the Steering Group. The first questions screened for eligibility, and those who were eligible and provided informed consent became expert panel members. Each panelist was presented with the list of research questions from Stage 1 organised under headings, as well as a description of the criterion used to evaluate to what extent they deemed the question a research priority. This stage was aimed at giving panelists the opportunity to provide additional research questions if they felt that any important questions had not been captured in the list (Appendix 1).

Survey questions also gathered demographic information about the panelists (Table 2). While the survey was open (5.5 weeks) we intermittently reviewed responder characteristics and adjusted recruitment strategies aiming to achieve diversity in gender, country of residence, panel member type, and health professions.

Stage 3: Consolidating research questions

This was conducted by the Steering Group and involved several steps:

1. Online survey data were anonymised and cleaned (demographic information removed). Two independent researchers (JJP, SS) reviewed the anonymised additional questions provided by the panel and removed ambiguous questions, duplicates and those that were out of scope. They also separated text entries that described multiple questions into individual questions. This process was reviewed by one Steering Group member (KLB).
2. The resulting list of questions was amalgamated with those generated from the literature review in Stage 1. Similar questions were again combined and/or re-written and duplicates removed using the same process as above.
3. Resultant questions were reworded if necessary to ensure they were answerable by the scoring scale to be used in Stage 4. This was an iterative process involving teams of 2 Steering Group members allocated to subsets of questions (RSH, MAH, BJL, LMT,

	Survey 1 (n=276)	Survey 2 (n=150)	Survey 3 (n=153)
Type of expert, n (%)			
Researcher	54 (20)	41 (27)	38 (25)
Clinician	69 (25)	36 (24)	37 (24)
Consumer	150 (54)	71 (47)	76 (50)
Funders	3 (1)	2 (1)	2 (1)
Gender, n (%)			
Woman or female	181 (66)	90 (60)	92 (60)
Man or male	95 (34)	60 (40)	61 (40)
Health profession, n (%)*			
Physiotherapist	63 (91)	32 (89)	33 (89)
Rheumatologist	2 (3)	2 (6)	2 (5)
Orthopaedic surgeon	2 (3)	1 (3)	1 (3)
Chiropractor	1 (1)	1 (3)	1 (3)
Support worker	1 (1)	0 (0)	0 (0)
Joint/s with osteoarthritis, n (%)#			
Knee	104 (69)	53 (75)	55 (72)
Hip	12 (8)	3 (4)	4 (5)
Both	34 (23)	15 (21)	17 (22)
Country of residence, n (%)			
Australia	112 (40)	75 (50)	79 (52)
South Africa	48 (17)	11 (7)	12 (8)
United Kingdom	35 (13)	17 (11)	16 (10)
United States	22 (8)	14 (9)	12 (8)
Denmark	11 (4)	7 (5)	7 (5)
Canada	9 (3)	5 (3)	7 (5)
Ireland	4 (1)	2 (1)	1 (1)
Belgium	3 (1)	1 (1)	1 (1)
India	3 (1)	0 (0)	0 (0)
Switzerland	3 (1)	2 (1)	1 (1)
Brazil	2 (1)	2 (1)	1 (1)
China	2 (1)	2 (1)	2 (1)
Germany	2 (1)	2 (1)	2 (1)
Malaysia	2 (1)	0 (0)	1 (1)
Nepal	2 (1)	2 (1)	2 (1)
Netherlands	2 (1)	1 (1)	1 (1)
New Zealand	2 (1)	1 (1)	1 (1)
Nigeria	2 (1)	0 (0)	1 (1)
Sweden	2 (1)	1 (1)	0 (0)
Ukraine	2 (1)	1 (1)	1 (1)
Egypt	1 (0)	0 (0)	1 (1)
Hungary	1 (0)	1 (1)	1 (1)
Philippines	1 (0)	1 (1)	1 (1)
Qatar	1 (0)	1(1)	1 (1)
Thailand	1 (0)	0 (0)	0 (0)
United Arab Emirates	1 (0)	1 (1)	1 (1)

* n = 69 clinicians in Survey 1, 36 clinicians in Survey 2 and 37 clinicians in Survey 3

n = 150 consumers in Survey 1, 71 consumers in Survey 2 and 76 consumers in Survey 3

Table 2 Osteoarthritis and Cartilage

Demographic characteristics of expert panel members.

YH, KB, HM, NJC, STS, EW, DKW). This process produced a final list of questions.

4. The final list was presented to two people with lived experience of hip/knee OA who had undertaken physical activity and exercise to help manage their OA. They reviewed each question and provided suggestions to improve readability for a lay audience. For example, questions that contained scientific language (e.g. epigenetics, biomarker etc) that may be unfamiliar to a lay audience were re-written.
5. Given the large number of questions on the final list, the list was randomly divided into three subsets of questions, stratified by headings developed in Stage 1, in order to facilitate Stage 4. Each subset contained an equivalent proportion of questions under the different headings.

Stage 4: Scoring the research questions based on priority

In Survey 2 (online survey in Qualtrics, 2024, Utah, United States of America), panelists were randomly presented (1:1:1 ratio, stratified by researcher, clinician, consumer or representative) with one of the three subsets of questions from Stage 3 using the randomiser function in Qualtrics (total number in each subset ranged from 58 to 60). Randomisation order was unknown to the Steering Group. Panelists were asked to score each of their allocated questions based on the extent to which they believed each was a priority, using the research priority criterion (Appendix 1). Scoring was on an 11-point numeric rating scale (0='not a priority at all'; 10='highest priority'). Each panelist received the questions in their subset in a randomised order. The survey was open for 4 weeks and panelists received up to 3 email reminders to help boost completion rates. Anonymised data were exported from Qualtrics and analysed in Microsoft Excel (version 16.95.4). The mean panelists' score for each question was used to present the questions in order of priority (highest to lowest). Four researchers (KLB, RKN, JJP, SS) independently coded the questions into broad themes. They met to discuss and agree on the final themes and allocation of questions. This was reviewed by another researcher (RSH) who confirmed the theme groupings.

Stage 5: Ranking and developing the final set of research priorities

The third online survey (Survey 3) was a preference-based ranking experiment via 1000Minds decision-making software (www.1000Minds.com). This asks users to choose between alternatives and employs a type of multi-criteria decision analysis to rank the alternatives. This was chosen over other preference methods such as a discrete choice experiment as our ranking was based on a single attribute (priority). In this survey, all panelists were presented with the 20 highest-scored questions from Stage 4 in a series of pairs (alternate scenarios). For each pair presented, panelists were asked "Which of these (two) research questions would you consider to be the higher priority considering both the extent of the knowledge gap and the potential health, social and/or economic impact of the research after it has been adopted, adapted for use, or used to inform further research". The survey was open for 4 weeks and panelists received up to 3 email reminders to help boost completion rates.

This process produced a mean (SD) ranking for each question, allowing us to produce the final ranking of the top 20 questions. In addition to the overall ranked list, we calculated mean (SD) rankings and generated ranked lists of the top 20 questions for three sub-groups: i) consumers; ii) clinicians; and iii) researchers. As few panelists were from organisations that influence the delivery of OA care and/or fund OA research, we did not generate an individual ranked list for this group, but their responses were included in the overall ranking.

Results

An overview of results across each research stage is shown in Fig. 1.

Stage 1: We identified 69 research questions from the literature. After removing duplicates and combining/rewriting questions, 61 questions remained (Appendix 2).

Stage 2: We recruited 276 panel experts (150 consumers, 69 clinicians spanning 5 disciplines, 54 researchers, and 3 representatives of funders/consumer organisations) from 26 countries. All panel members completed Survey 1 (Table 2). Panelists provided an additional 346 questions to the initial list from Stage 1 (Appendix 3).

Stage 3: Following review and consolidation of the total list of 407 questions, 31 were kept as they were, 259 were amalgamated, 78 were reworded, 4 were split into two questions each (Appendix 4)

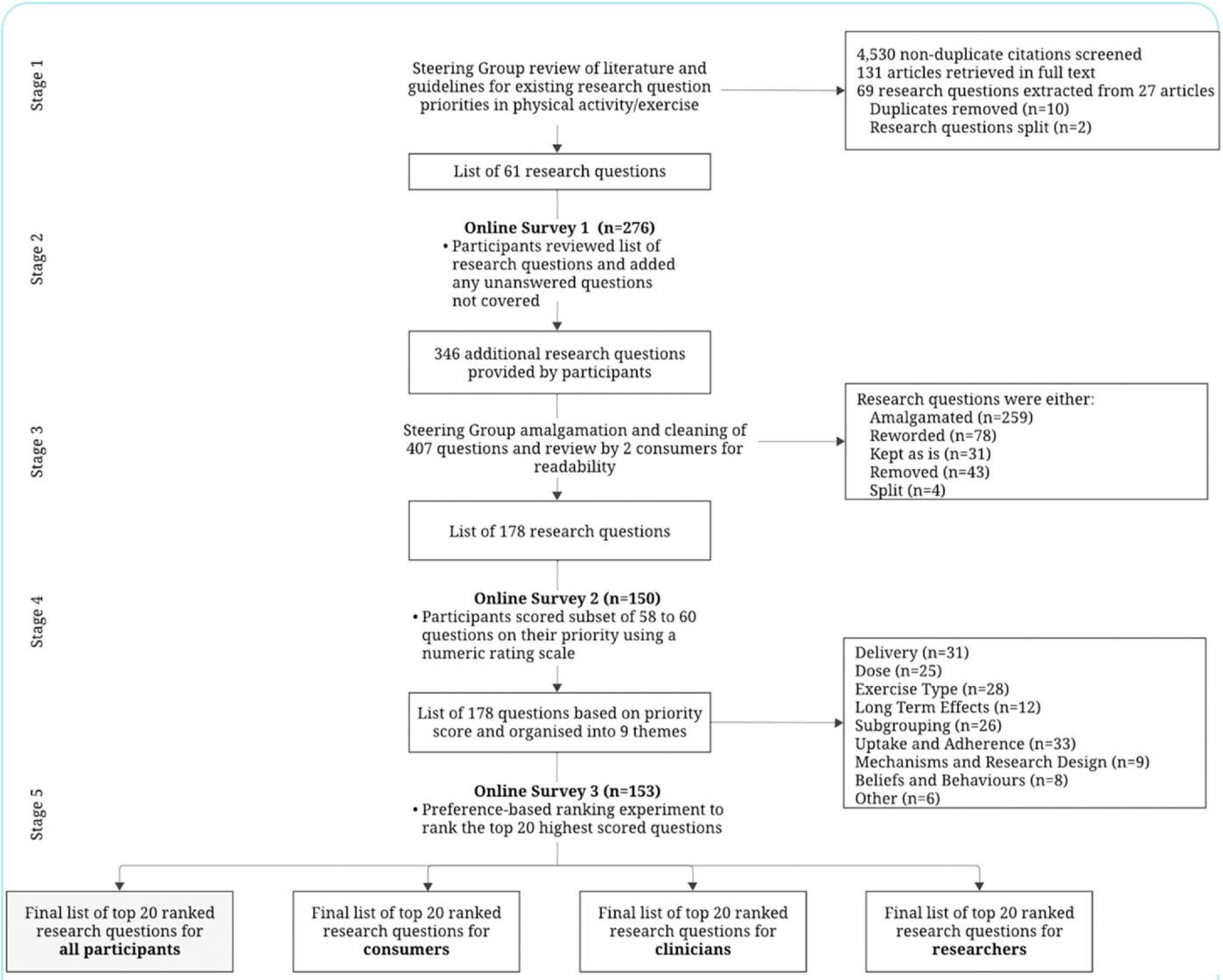

Fig. 1 Osteoarthritis and Cartilage

Flow diagram of study process.

and 43 were removed as they were out of scope or unclear (Appendix 5), leaving a total of 178 questions.

Stage 4: 150 of the original panelists (54%, Table 2) completed the second survey, where they scored the questions in terms of priority. Appendix 6 shows the overall mean (SD) score for each question, as well as scores for the consumers, clinicians and researchers separately grouped under nine themes (dose; exercise type; delivery; subgrouping; long-term effects; uptake and adherence; beliefs and behaviour; mechanisms and research design; "other"). For the overall group, mean scores for each question ranged from 5.0 to 8.4 out of 10. Scores for the top 20 research questions are shown in Appendix 7.

Stage 5: 153 of the original (55%) panelists (Table 2) completed the prioritisation ranking experiment. Results of the final top 20 rankings are shown in Table 3. The top 20 questions spanned 7 of the nine themes including 6 in long-term effects, 6 in dose, 3 in subgrouping, 2 in exercise type, 1 in beliefs and behaviour, 1 in mechanisms and research design and 1 in uptake and adherence. The themes of delivery and "other" were not represented among the top 20 questions. The top research question was investigating the impact of physical activity and exercise on delaying/avoiding joint replacement. The second and third were determining the most effective interventions to promote long-term adherence, and how can we effectively stratify people to the most appropriate form of support, respectively. There were similarities and differences in the top 20 rankings between the consumers, clinicians and researchers as displayed in Fig. 2.

Discussion

We identified research priorities in the field of physical activity and exercise management of knee and hip OA. To achieve this, we used a multi-stage process that involved an international expert panel of OA researchers, clinicians, consumers and representatives of funders/consumer organisations. Our study identified numerous research questions spanning themes of exercise type, uptake and adherence, dosage, delivery, long-term effects, subgrouping, mechanisms and research design, beliefs and behaviour and "other". Our results provide a prioritised list of the most important research questions across these themes, based on the extent to which they

Research question	Overall (n=153)		Consumers (n= 76)		Clinicians (n=37)		Researchers (n=38)	
	Rank number	Mean ranking (SD)	Rank number	Mean ranking (SD)	Rank number	Mean ranking (n=37)	Rank number	Mean ranking (SD)
What impact does participation in exercise and physical activity have on delaying/avoiding joint replacement?[a]	1	7.9 (5.3)	2	7.8 (5.4)	2	7.5 (4.7)	4	8.1 (5.5)
What are the most effective interventions to promote long-term adherence to different types of exercise?[b]	2	8.4 (5.4)	5	9.7 (5.5)	1	7.2 (4.4)	3	7.3 (5.4)
Recognising that different people may be suited to different forms of support to exercise, how can we most effectively stratify people to the most appropriate form of support for them?[c]	3	8.5 (6.0)	6	9.7 (6.2)	4	8.2 (5.8)	2	6.6 (5.1)
What outcomes matter most to people with OA who undertake an exercise program, including what would be considered a successful outcome?[d]	4	8.5 (5.7)	7	9.8 (5.4)	3	7.8 (5.8)	1	6.2 (5.5)
For people with multi-joint OA or widespread pain, what types of exercise and dosage should be considered to improve clinical outcomes?[c]	5	9.4 (5.5)	1	7.8 (4.9)	13	11.0 (5.7)	10	10.8 (5.8)
What is the comparative effectiveness of different exercise programs (e.g., non-weight-bearing strength exercises, weight-bearing strength exercises, aerobic exercise, aquatic exercise, stretching) on clinical outcomes?[e]	6	9.5 (5.3)	3	8.1 (5.3)	6	10.3 (4.9)	14	11.3 (5.2)
Is regular exercise and physical activity effective at reducing OA disease progression?[a]	7	9.8 (6.1)	4	9.3 (6.0)	5	10.1 (6.3)	8	10.3 (5.9)
What exercise dose is needed to change the trajectory of people away from invasive and expensive treatments?[f]	8	10.1 (5.4)	12	10.3 (5.4)	8	10.5 (5.0)	5	9.4 (5.3)
How does exercise workload (the combination of intensity, frequency, duration and rest) influence clinical outcomes?[f]	9	10.3 (5.1)	9	10.1 (5.3)	7	10.4 (4.4)	9	10.5 (5.2)
What are the long-term effects of exercise and physical activity on other co-morbidities such as cardiovascular disease, depression, obesity in people with OA?[a]	10	10.5 (6.3)	14	10.9 (6.1)	9	10.6 (6.3)	6	9.8 (6.5)
What is the safety and effectiveness of exercise compared to other recommended non-surgical treatments (eg. weight loss, medications) on preventing progression and disability?[a]	11	10.8 (5.5)	13	10.5 (5.3)	14	11.1 (5.6)	13	11.3 (5.8)
What are the long-term effects of different types of exercise programs on clinical outcomes?[a]	12	10.8 (5.1)	10	10.1 (4.9)	11	10.7 (5.4)	18	12.6 (4.7)
What is the optimal frequency of different types of exercise for sustained changes in clinical outcomes?[f]	13	10.9 (5.2)	8	10.0 (5.5)	10	10.7 (4.9)	19	12.9 (4.2)
What is the optimal intensity of different types of exercise for sustained changes in clinical outcomes?[f]	14	11.2 (4.9)	16	11.2 (4.8)	12	10.8 (4.7)	15	11.9 (4.9)
What is the optimal combination of different aerobic exercise combined with different strengthening exercises for clinical benefits?[e]	15	11.4 (5.3)	11	10.1 (5.3)	16	11.2 (4.8)	20	13.9 (4.8)
What is the interaction between exercise dosage and pain (i.e. effect of increased or reduced level of pain)?[f]	16	11.5 (5.5)	15	10.9 (5.5)	20	13.1 (5.4)	12	11.2 (5.3)
What is the optimal duration of different types of exercise for sustained changes in clinical outcomes?[f]	17	12.0 (4.9)	17	11.9 (4.9)	17	11.5 (5.5)	17	12.6 (4.3)
What are the links between physical activity behaviour and OA outcomes?[g]	18	12.6 (5.4)	18	12.6 (5.1)	18	13.0 (5.7)	16	12.3 (5.8)
What are the markers of response and non-response to exercise?[c]	19	12.9 (6.1)	20	15.0 (5.2)	15	11.2 (6.3)	7	9.9 (5.6)
What are the long-term effects of reducing sedentary behaviour on clinical outcomes?[a]	20	13.1 (5.5)	19	14.3 (5.3)	19	13.0 (5.2)	11	11.1 (5.6)

[a] = Long term effects
[b] = Uptake and adherence
[c] = Subgrouping
[d] = Mechanisms and research design
[e] = Exercise type
[f] = Dose
[g] = Beliefs and behaviour

Table 3

Osteoarthritis and Cartilage

Final ranking of the 20 top-rated research questions.

represent a perceived knowledge gap and have potential for future impact on patient outcomes. These findings can help guide the international research agenda and improve the relevance of research, reduce research waste, and secure optimal return on investment [34].

Of the assembled list of 178 research questions, the majority scored highly in terms of their priority. This indicates that within this specific field of OA research, stakeholders perceive that there are many important evidence gaps and potentials for future impact. While there was some variation in mean rankings across the three stakeholder groups (clinicians, consumers, researchers), overall, there was relatively good consistency. Looking specifically at the top 20 ranked questions (Table 3), there was minimal variation in mean priority scores both overall (ranging from 8.4 [SD 1.9] to 7.8 [SD 1.8]) and across stakeholder groups (see Appendix 7) indicating all questions are considered high priorities. For instance, researchers ranked the question "What outcomes matter most to people with OA who undertake an exercise program, including what would be considered a successful outcome?" as their top priority, while consumers ranked it seventh (see Table 3). Despite this, the mean scores suggest only a modest difference in perceived priority between the two groups (researchers: 7.3 [SD 2.3]; consumers: 8.4 [SD 1.9]). Within the top 20 ranked questions, several related to investigating the long-term impact of physical activity and exercise on joint health and disease progression, with the highest priority question focused on whether it can delay/avoid joint replacement. This highlights the current knowledge gap with limited but emerging evidence in both hip OA

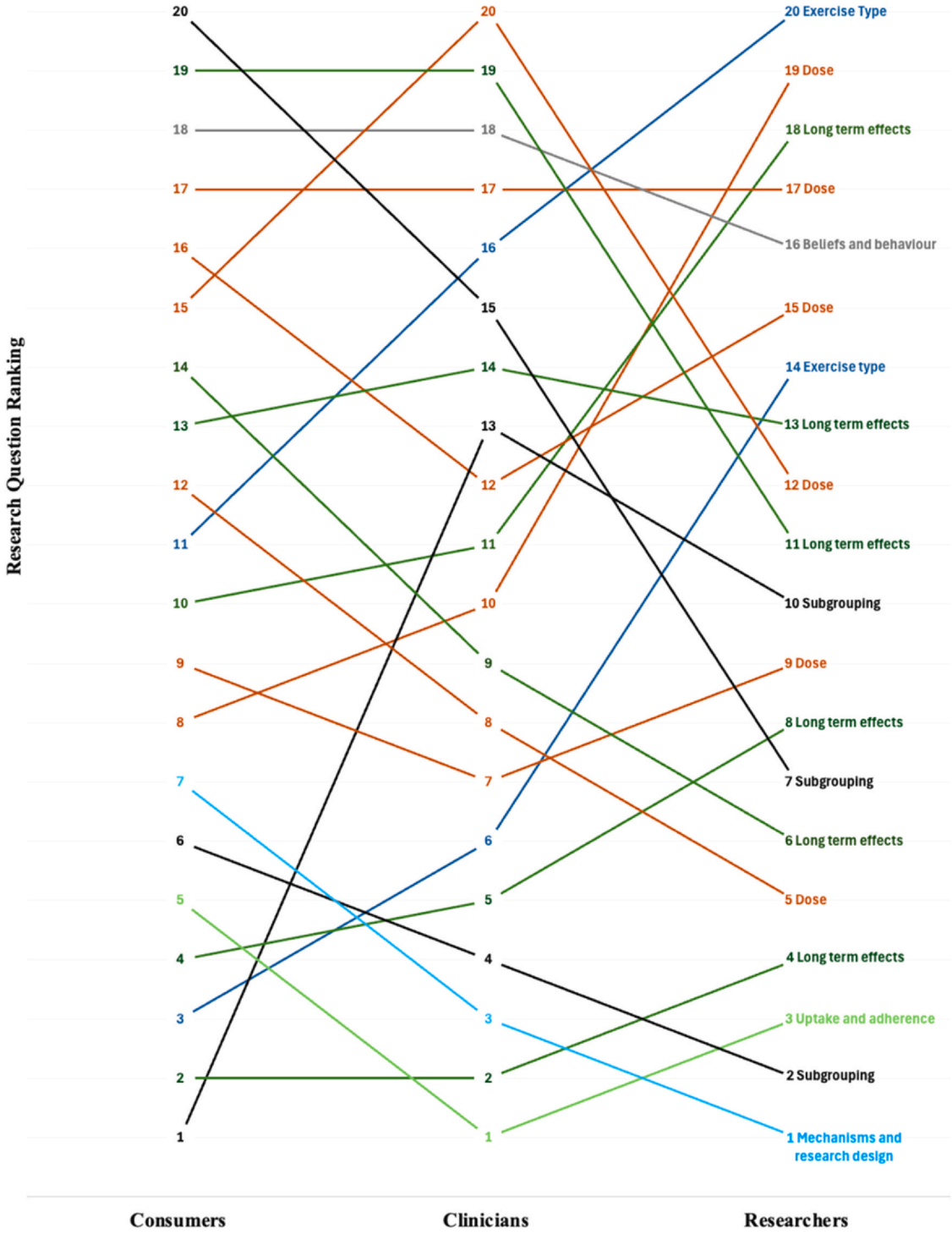

Fig. 2 Osteoarthritis and Cartilage

Line graph depicting the top 20 ranking of research questions across sub-groups of consumers, clinicians and researchers.

[35,36] and knee OA [37,36] that it may be possible to at least delay joint replacement; however, the limited number of randomised controlled trials with long-term follow-up cannot provide any conclusive evidence. Given the challenges associated with physical activity and exercise behaviour change [16], it is not surprising that several questions related to finding strategies to promote long-term adherence and support patients to exercise. A systemic review found limited evidence for the benefits of booster sessions and telephone-linked communication but concluded further studies with higher methodological quality are needed [38].

We did not perform literature searches to verify that each of the identified research questions reflects an evidence gap. Given that the research questions are relatively broad, it is thus possible that some

will have emerging evidence, may be partially answered and/or require higher quality confirmatory studies. For example, recent studies including a meta-analysis [39] (that incorporated data from 151 resistance training studies) and clinical trials [40,41] of strength training and mixed exercise suggest that exercise benefits are not influenced by certain dosage parameters. Although further high quality randomized controlled trials are needed exploring different exercise types and dosage parameters there is an emerging evidence base already for several identified questions related to effects of exercise dose. It is also possible that some of the identified questions may reflect areas where the evidence/knowledge already exists but has not been effectively communicated to consumers and other stakeholders. An example of this is the question related to exercise safety, where extensive evidence has already proven that exercise is safe for OA [8]. In addition, the translation of exercise evidence to stakeholders may not have accurately reflected the accumulating evidence which suggests that exercise effectiveness is not as compelling as clinical guidelines or the current narrative might suggest [42]. Implementation research may be needed to better understand how we can effectively translate existing evidence into practice.

Our work is the first priority-setting study to exclusively focus on physical activity and exercise in knee and hip OA and involved a large international expert panel of 276 members including 150 consumers. A 2018 scoping review found seven health priority-setting studies related to OA [23]. These studies generated research priorities focused on treatment, [43] early OA [44], hip and knee replacement for OA [45], comparative effectiveness research [46], supplements for joint health [47], prevention and self-management strategies [48], and prevention of knee pain and disability [49], but none specifically focused on physical activity and exercise. Subsequent to this, an OA study with a large number of consumers (n=161), but confined to Australia, identified three broad research priority areas of treatment adherence and behaviour change, modification of disease, and prevention [24]. Topics within these areas that related to improving access, uptake and adherence to exercise align with some of the research questions identified in our study. A EULAR panel of 25 European experts including 3 consumers identified 13 broad physical activity priority areas for inflammatory arthritis and OA [25]. These areas included the evaluation of links between physical activity behaviour and disease-specific outcomes, and the investigation of facilitators and barriers that healthcare providers face when applying physical activity recommendations, some of which overlap with our findings [25]. Finally, in its 2022 OA guideline update, the National Institute for Health and Care Excellence (NICE) called for research evaluating the clinical and cost effectiveness of supervised exercise (group and/or individual) compared with unsupervised exercise for people with OA [50]. A limited number of questions identified in our study related to health economic evaluations, which may reflect our panel composition with few policy makers or funders.

Implementing the identified research priorities, including monitoring and evaluating the impact of research priority setting, is important to ensure it is achieving its intended goal [30]. The OARSI Rehabilitation Group Committee will lead implementation efforts and enact a plan to disseminate findings to stakeholders internationally using presentations, infographics, video summaries, social media and the extensive networks of OARSI and its members. The Committee also plans to revise the judging criteria for its annual publication of the year award to include the extent to which the publication addresses one of the top-ranked research priorities. In addition, the research priorities will be reviewed and updated within 5 years to reflect new evidence and different questions. Regarding evaluation, this can be identified by how many of the top priorities have been address/answered and by monitoring the alignment of research funding calls with the identified priorities.

Key strengths of our study include alignment with good practice principles of health research priority setting [22] , use of an accepted methodology [26], participation by a large number of consumers and clinicians on the panel, and global representation across 26 countries. Our study has some limitations. The list of questions generated as priorities may not reflect the range of possible future research. Although we aimed for diversity, most of the Steering Group and panelists were from high income countries (particularly Australia), and clinicians were predominantly physiotherapists, with few medical practitioners such as general practitioners and orthopaedic surgeons who play important roles in the management of OA. There were also few representatives from consumer organisations and organisations that influence the delivery of OA care and/or funding of OA research. As such, our results may not generalise to those with different characteristics. Further research is recommended to identify research questions that are priorities in different contexts such as low-middle income countries. There was attrition of panelists between Survey 1 and 2, and while there is no gold standard sample size for research priorisation studies, our final number is comparable with or well exceeds that of other OA studies [23–25] . Given the large number of research questions generated and to reduce panel participant burden, panelists only rated a random subset of the questions in survey two. However, all panelists ranked all questions in Survey 3. We used the extent of the knowledge gap and potential for impact as the criterion to determine a research priority. Other criteria not accounted for may also be important such as answerability, equity, cost and feasibility of conducting the research to answer the question.

In conclusion, we identified 178 research questions across several themes relating to physical activity and exercise management of knee and hip OA, and further prioritised the top 20 questions using a large panel of international stakeholders, the majority of which comprised consumers. The top three research priorities included investigating the impact of physical activity and exercise on delaying/avoiding joint replacement, developing effective interventions to promote long-term exercise adherence, and stratifying people to the most appropriate form of exercise support. This study will help guide the research agenda in the field with the aim of ensuring a greater return on research investment and improving outcomes for, and experiences of, people with knee and hip OA.

Contributions

All authors conceived the study, contributed to its design and interpretation of findings, and read and approved the manuscript. KLB obtained research funding. RKN and KLB drafted the study protocol with all authors providing input. JJP coordinated the surveys and data collection. KLB, SS, RKN, RSH, JJP, MAH, BJL, LMT, YH, KB, HM, NJC, STS, EW, DKW, JBL reviewed and consolidated questions. KLB oversaw data analysis and drafted the manuscript.

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Declaration of Competing Interest

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.joca.2025.07.006.

References

[1] Global Burden of Disease Collaborators. Global, regional, and national burden of osteoarthritis, 1990-2020 and projections to 2050: a systematic analysis for the Global Burden of Disease Study 2021. Lancet Rheumatol. 2023;5(9):e508–22. https://doi.org/10.1016/S2665-9913(23)00163-7

[2] Bannuru RR, Osani MC, Vaysbrot EE, *et al*. OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. Osteoarthr. Cartil. 2019;27(11):1578–89. https://doi.org/10.1016/j.joca.2019.06.011

[3] Sabha M, Hochberg MC. Non-surgical management of hip and knee osteoarthritis; comparison of ACR/AF and OARSI 2019 and VA/DoD 2020 guidelines. Osteoarthr. Cartil. Open 2022;4(1), 100232. https://doi.org/10.1016/j.ocarto.2021.100232

[4] Kolasinski SL, Neogi T, Hochberg MC, *et al*. 2019 American College of Rheumatology/Arthritis Foundation guideline for the management of osteoarthritis of the hand, hip, and knee. Arthritis Care Res. (Hoboken 2020;72(2):149–62. https://doi.org/10.1002/acr.24131

[5] Moseng T, Vliet Vlieland TPM, Battista S, *et al*. EULAR recommendations for the non-pharmacological core management of hip and knee osteoarthritis: 2023 update. Ann. Rheum. Dis. 2024;83(6):730–40. https://doi.org/10.1136/ard-2023-225041

[6] Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep. 1985;100(2):126–31.

[7] Varongot-Reille C, Barrero-Santiago L, Cuenca-Martinez F, Paris-Alemany A, La Touche R, Herranz-Gomez A. Effectiveness of exercise on pain intensity and physical function in patients with knee and hip osteoarthritis: an umbrella and mapping review with meta-meta-analysis. Disabil. Rehabil. 2024;46(16):3475–89. https://doi.org/10.1080/09638288.2023.2252742

[8] Quicke J, Foster N, Thomas M, Holden M. Is long-term physical activity safe for older adults with knee pain? A systematic review. Osteoarth. Cartil. 2015.

[9] Hall M, Dobson F, Van Ginckel A, *et al*. Comparative effectiveness of exercise programs for psychological well-being in knee osteoarthritis: a systematic review and network meta-analysis. Semin. Arthritis Rheum. 2021;51(5):1023–32. https://doi.org/10.1016/j.semarthrit.2021.07.007

[10] Bricca A, Harris LK, Jager M, Smith SM, Juhl CB, Skou ST. Benefits and harms of exercise therapy in people with multimorbidity: a systematic review and meta-analysis of randomised controlled trials. Ageing Res. Rev. 2020;63, 101166. https://doi.org/10.1016/j.arr.2020.101166

[11] Muckelt PE, Roos EM, Stokes M, *et al*. Comorbidities and their link with individual health status: a cross-sectional analysis of 23,892 people with knee and hip osteoarthritis from primary care. 2235042X20920456 J. Comorb 2020;10. https://doi.org/10.1177/2235042X20920456

[12] Han S, Li T, Cao Y, *et al*. Quantitative analysis of effectiveness and associated factors of exercise on symptoms in osteoarthritis: a pharmacodynamic model-based meta-analysis. Br. J. Sports Med. 2024;58(24):1539–50. https://doi.org/10.1136/bjsports-2023-107625

[13] Lawford BJ, Hall M, Hinman RS, *et al*. Exercise for osteoarthritis of the knee. Cochrane Database Syst. Rev 2024;12(12):CD004376. https://doi.org/10.1002/14651858.CD004376.pub4

[14] Goh SL, Persson MSM, Stocks J, *et al*. Efficacy and potential determinants of exercise therapy in knee and hip osteoarthritis: a systematic review and meta-analysis. Ann. Phys. Rehabil. Med. 2019. https://doi.org/10.1016/j.rehab.2019.04.006

[15] Hall M, van der Esch M, Hinman RS, *et al*. How does hip osteoarthritis differ from knee osteoarthritis? Osteoarthr. Cartil. 2022;30(1):32–41. https://doi.org/10.1016/j.joca.2021.09.010

[16] Dobson F, Bennell K, French S, *et al*. Barriers and facilitators to exercise participation in people with hip and/or knee osteoarthritis: synthesis of the literature using behaviour change theory. Am. J. Phys. Med. Rehab. May 2016;95:372–89. https://doi.org/10.1097/PHM.0000000000000448

[17] Pisters MF, Veenhof C, van Meeteren NL, *et al*. Long-term effectiveness of exercise therapy in patients with osteoarthritis of the hip or knee: a systematic review. Rev.. Arthr. Rheum. 2007;57(7):1245–53. https://doi.org/10.1002/art.23009

[18] Nicolson PJA, Hinman RS, Kasza J, Bennell KL. Trajectories of adherence to home-based exercise programs among people with knee osteoarthritis. Osteoarthr. Cartil. 2018;26(4):513–21. https://doi.org/10.1016/j.joca.2018.01.009

[19] Holden MA, Hattle M, Runhaar J, *et al*. Moderators of the effect of therapeutic exercise for knee and hip osteoarthritis: a systematic review and individual participant data meta-analysis. Lancet Rheumatol. 2023;5(7):E386–400.

[20] Bandak E, Christensen R, Overgaard A, *et al*. Exercise and education versus saline injections for knee osteoarthritis: a randomised controlled equivalence trial. Ann. Rheum. Dis. 2022;81(4):537–43. https://doi.org/10.1136/annrheumdis-2021-221129

[21] Dean BJF, Collins J, Thurley N, Rombach I, Bennell K. Exercise therapy with or without other physical therapy interventions versus placebo interventions for osteoarthritis -Systematic review. Osteoarthr Cartil Open 2021;3(3), 100195. https://doi.org/10.1016/j.ocarto.2021.100195

[22] Viergever R. al. e. Checklist for health research priority setting. Health Res. Policy Syst. 2010;8:36.

[23] Bourne AM, Johnston RV, Cyril S, *et al*. Scoping review of priority setting of research topics for musculoskeletal conditions. BMJ Open 2018;8(12), e023962. https://doi.org/10.1136/bmjopen-2018-023962

[24] Hunter DJ, Nicolson PJA, Little CB, Robbins SR, Wang X, Bennell KL. Developing strategic priorities in osteoarthritis research: proceedings and recommendations arising from the 2017 Australian Osteoarthritis Summit. BMC Musculoskelet. Disord. 2019;20(1):74. https://doi.org/10.1186/s12891-019-2455-x

[25] Rausch Osthoff AK, Niedermann K, Braun J, *et al*. 2018 EULAR recommendations for physical activity in people with inflammatory arthritis and osteoarthritis. Ann. Rheum. Dis. 2018;77(9):1251–60. https://doi.org/10.1136/annrheumdis-2018-213585

[26] Yoshida S. Approaches, tools and methods used for setting priorities in health research in the 21(st) century. J. Glob. Health 2016;6(1), 010507. https://doi.org/10.7189/jogh.06.010507

[27] Paskins Z, Farmer CE, Manning F, *et al*. Research priorities to reduce the impact of musculoskeletal disorders: a priority setting exercise with the child health and nutrition research initiative method. Lancet Rheumatol. 2022. Published online July 27, 2022.

[28] Eyles JP, Hunter DJ, Bennell KL, *et al*. Priorities for the effective implementation of osteoarthritis management programs: an OARSI international consensus exercise. Osteoarthr. Cartil. 2019;27(9):1270–9. https://doi.org/10.1016/j.joca.2019.05.015

[29] Holden MA, Metcalf B, Lawford BJ, *et al*. Recommendations for the delivery of therapeutic exercise for people with knee and/or hip osteoarthritis. An international consensus study from the OARSI Rehabilitation Discussion Group. Osteoarthr. Cartil. 2023;31(3):386–96. https://doi.org/10.1016/j.joca.2022.10.009

[30] Tong A, Synnot A, Crowe S, *et al*. Reporting guideline for priority setting of health research (REPRISE). BMC Med. Res. Methodol. 2019;19(1):243. https://doi.org/10.1186/s12874-019-0889-3

[31] Woodcock C., English E., C J., et al. Clinical guideline research recommendations for the non-surgical management of osteoarthritis: a thematic synthesis. 2024.

[32] Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. J. of Biomed. Inform. 2009;42(2):377–81.

[33] Harris PA, Taylor R, Minor BL, *et al*. The REDCap consortium: building an international community of software platform partners. J. Biomed. Inform. 2019;95, 103208. https://doi.org/10.1016/j.jbi.2019.103208

[34] Grill C. Involving stakeholders in research priority setting: a scoping review. Res. Involv. Engagem. 2021;7(1):75. https://doi.org/10.1186/s40900-021-00318-6

[35] Svege I, Nordsletten L, Fernandes L, Risberg MA. Exercise therapy may postpone total hip replacement surgery in patients with hip osteoarthritis: a long-term follow-up of a randomised trial. Ann. Rheum. Dis. 2015;74(1):164–9. https://doi.org/10.1136/annrheumdis-2013-203628

[36] Ackerman IN, Johansson MS, Gronne DT, *et al*. Are outcomes from an exercise therapy and patient education program for osteoarthritis associated with hip and knee replacement within two years? A register-based study of 9,339 patients with osteoarthritis. Arthritis Care Res. ((Hoboken)) 2024;76(6):802–12. https://doi.org/10.1002/acr.25303

[37] Skou ST, Roos EM, Laursen MB, *et al*. Total knee replacement and non-surgical treatment of knee osteoarthritis: 2-year outcome from two parallel randomized controlled trials. Osteoarthr. Cartil. 2018;26(9):1170–80. https://doi.org/10.1016/j.joca.2018.04.014

[38] Cinthuja P, Krishnamoorthy N, Shivapatham G. Effective interventions to improve long-term physiotherapy exercise adherence among patients with lower limb osteoarthritis. A systematic review. BMC Musculoskelet Disord 2022;23(1):147. https://doi.org/10.1186/s12891-022-05050-0

[39] Marriott KA, Hall M, Maciukiewicz JM, *et al*. Are the effects of resistance exercise on pain and function in knee and hip osteoarthritis dependent on exercise volume, duration, and adherence? A systematic review and meta-analysis. Arthritis Care Res. (Hoboken 2024;76(6):821–30. https://doi.org/10.1002/acr.25313

[40] Messier SP, Mihalko SL, Beavers DP, *et al*. Effect of high-intensity strength training on knee pain and knee joint compressive forces among adults with knee osteoarthritis: the START randomized clinical trial. JAMA 2021;325(7):646–57. https://doi.org/10.1001/jama.2021.0411

[41] Torstensen TA, Osteras H, LoMartire R, Rugelbak GM, Grooten WJA, Ang BO. High- versus low-dose exercise therapy for knee osteoarthritis: a randomized controlled multicenter trial. Ann. Intern. Med. 2023;176(2):154–65. https://doi.org/10.7326/M22-2348

[42] Haber T, Lawford BJ, Bennell KL, Holden M, White DK, Hinman RS. Recent highlights and uncertainties in exercise management of knee osteoarthritis. Published online Jun 26 J. Physiother.2025. https://doi.org/10.1016/j.jphys.2025.06.010. Published online Jun 26.

[43] Tallon D, Chard J, Dieppe P. Relation between agendas of the research community and the research consumer. Lancet 2000;355:2037–40.

[44] Chu CR, Beynnon BD, Buckwalter JA, *et al*. Closing the gap between bench and bedside research for early arthritis therapies (EARTH): report from the AOSSM/NIH U-13 Post-Joint Injury Osteoarthritis Conference II. Am. J. Sports. Med. 2011;39(7):1569–78. https://doi.org/10.1177/0363546511411654

[45] Crowe S., Regan S. Description of a process and workshop to set research priorities in hip and knee replacement for osteoarthritis. 2014;

[46] Gierisch JM, Myers ER, Schmit KM, *et al*. Prioritization of patient-centered comparative effectiveness research for osteoarthritis. Ann. Intern. Med. 2014;160(12):836–41. https://doi.org/10.7326/m14-0318

[47] Henrotin Y, Chevalier X, Herrero-Beaumont G, *et al*. Physiological effects of oral glucosamine on joint health: current status and consensus on future research priorities. BMC Res. Notes 2013;6:115. https://doi.org/10.1186/1756-0500-6-115

[48] Jaramillo A, Welch VA, Ueffing E, *et al*. Prevention and self-management interventions are top priorities for osteoarthritis systematic reviews. .e4 J. Clin. Epidemiol. 2013;66(5):503–10. https://doi.org/10.1016/j.jclinepi.2012.06.017

[49] Jinks C, Ong BN, O'Neill TJ. The Keele community knee pain forum: action research to engage with stakeholders about the prevention of knee pain and disability. Res. Support, Non-U. S. Gov't. BMC Musculoskeletal Disord. 2009;10:85. https://doi.org/10.1186/1471-2474-10-85

[50] NICE. Osteoarthritis in over 16s: diagnosis and management. NICE guideline [NG226]. 2022.