Barriers and facilitators to exercise participation in people with hip and/or knee osteoarthritis: synthesis of the literature using behaviour change theory.

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Competing interests:

The authors declare that they have no competing interests.

Author's Contribution

FD, KLB, RSH and SDF conceived the study question. FD led the search, data extraction and initial mapping stages. RK and PJN were the independent study screeners and conducted data extraction and mapping. MAH, SDF and LA led the mapping of each factor to the domains of the framework. All authors reached consensus and approved the final mapping of factors to the framework. All authors contributed to preparation of the manuscript and read and approved the final manuscript.

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Abstract

Exercise is recommended for hip and knee osteoarthritis (OA). Patient initiation of, and adherence to exercise is key to the success of managing symptoms. This study aimed to i) identify modifiable barriers and facilitators to participation in intentional exercise in hip and/or knee OA and; ii) synthesise findings using behaviour change theory. A scoping review with systematic searches was conducted through March 2015. Two reviewers screened studies for eligibility. Barriers and facilitators were extracted and synthesised according to the Theoretical Domains Framework (TDF) by two independent reviewers. Twenty-three studies (total of 4633 participants) were included. The greatest number of unique barriers and facilitators mapped to the *Environmental Context and Resources* domain. Many barriers related to *Beliefs about Consequences* and *Beliefs about Capabilities*, while many facilitators were related to *Reinforcement*. Clinicians should take a proactive role in facilitating exercise uptake and adherence, rather than trusting patients to independently overcome barriers to exercise. Strategies that may be useful include a personalised approach to exercise prescription, considering environmental context and available resources, personalised education about beneficial consequences of exercise and reassurance about exercise capability, and use of reinforcement strategies. Future research should investigate effectiveness of behaviour change interventions that specifically target these factors.

Key words: Osteoarthritis, Exercise, Barriers, Facilitators

Word count: 4545

Introduction

Hip and knee osteoarthritis (OA) are leading causes of disability in older adults worldwide [1]. Exercise is an integral component of non-surgical management of hip and knee OA and is recommended in all published international clinical guidelines [2]. High quality evidence of the benefits of exercise for improving pain and function is well-established in people with knee OA [3] and is mounting in those with hip OA [4]. However, these benefits are dependent on patient's initiation of, and adherence to, exercise [5]. There is a global under-utilisation of exercise in people with OA [6-9] and long-term adherence to exercise for people with OA is poor [10]. In order to facilitate development of effective strategies for people with OA to promote exercise adherence, and thus maximise clinical benefits of exercise for people with OA, identification of factors influencing exercise participation and adherence in people with hip and knee OA is recognised as an important research priority [11].

Several narrative reviews have described a complex array of barriers and facilitators that influence the uptake and maintenance of exercise in people with hip and/or knee OA [12-14]. Factors identified have included those that encompass the physical environment (e.g. weather, access to services), the social environment (e.g. time, supports), personal experiences (e.g. previous exercise history) and individual attributes (e.g. motivation, knowledge, beliefs, attitudes, confidence). Although a number of models have been proposed to assist clinicians and researchers in identifying and assessing barriers and facilitators to exercise in order to design treatments improve exercise adherence [14-17], no study to date has synthesised the barriers and facilitators to exercise using an analytical framework grounded explicitly in theories of behaviour change. Given that long-term exercise adherence usually requires significant behaviour change on the part of individuals with OA, such an approach is needed to drive the development of clinical strategies that are most likely to be effective in increasing exercise participation.

Although strategies to improve exercise participation can be used by health professionals in clinical practice, they are not currently implemented consistently. For example, although UK-based physical therapists report that they monitor exercise adherence in people with knee OA, few use specific strategies such as exercise diaries to encourage exercise adherence [18]. Approximately half do not supervise exercise during the initial treatment session, and very few monitor their patients over the long-term for exercise adherence. Indeed, exercise adherence is viewed by physical therapists as the patient's, not the therapist's, responsibility [19]. Failure of clinicians to recognise the important role they play in facilitating behaviour change in their patients may, at least partially, contribute to the poor adherence to exercise by people with OA. A comprehensive understanding of the modifiable barriers and facilitators to exercise experienced by people with OA, synthesised according to a broad based theoretical framework for behaviour change, is thus needed to inform clinical practice of healthcare professionals recommending and prescribing exercise, and to develop strategies that promote the behaviour change needed in patients for long-term exercise adherence.

The Theoretical Domains Framework (TDF) was developed to simplify and integrate the plethora of behaviour change theories that exist into a single overarching framework [20]. The TDF can be used to assess and explain problems with implementing treatments known to be efficacious and to inform development of strategies designed to improve intervention implementation [20]. The TDF comprises theoretical domains that are considered to influence behaviour and behaviour change. The refined framework integrates 128 explanatory constructs from 33 theories by grouping them into 14 distinct domains [21 22]: *Knowledge, Skills, Social/Professional Role and Identity, Beliefs about Capabilities, Optimism, Beliefs about Consequences, Reinforcement, Intentions, Goals, Memory, Attention and Decision Processes, Environmental Context and Resources, Social Influences, Emotions,* and *Behavioural*

Regulation. Strengths of the TDF include that it incorporates multiple theories of behaviour change, that it provides a useful conceptual basis for understanding behaviour-change processes and that it can be used to guide the choice of appropriate behaviour change techniques to improve implementation of a given intervention [21 23].

The use of the TDF can ensure a comprehensive identification of all possible mediators of behaviour and behaviour change [23]. The TDF provides a useful conceptual basis for analysing implementation problems and subsequently designing implementation interventions to improve healthcare clinical practice. The TDF has been used to explore implementation problems in a number of different clinical areas. For example, the TDF has been used to explore healthcare professional barriers and facilitators in implementing weight management and obesity guidelines in pregnant women [24], and to develop a complex intervention to improve acute low back pain management in primary care [25]. However, no study to date has used the TDF to explore the patient-related barriers and facilitators to exercise participation and adherence.

A scoping study, defined as a method to map key concepts, main sources and available evidence underpinning a research area [26], is an increasingly common approach to reviewing literature [27]. Arksey and O'Malley [26] described a number of reasons for conducting a scoping study, including to examine the extent, range and nature of research activity; to summarise and disseminate research findings; and to identify research gaps in existing literature. As such, a scoping review, guided by the TDF, is an appropriate methodology to provide an overview and analytic framework of barriers and facilitators to exercise participation in people with hip and knee OA. The aims of this scoping review were to: i) identify barriers and facilitators to participation in intentional exercise for people with hip and/or knee osteoarthritis (OA) and; ii) map modifiable barriers and facilitators to the Theoretical Domains Framework (TDF).

Methods

The review was conducted according to the multi-stage framework of scoping reviews as described by Arksey and O'Malley [26]: (1) identifying the research question; (2) identifying relevant studies; (3) selecting studies, with the establishment of inclusion/exclusion criteria; (4) charting the data, including sifting, charting, and sorting information according to key issues and themes; and (5) collating, summarising, and reporting the results, including a thematic analysis.

Stage 1: Identifying the research question and operational definitions:

The key research question was: "For people with hip and/or knee osteoarthritis (OA), what are the barriers and facilitators to participation in intentional exercise?" Operational definitions for the key terms in the research question were developed by the authors and are further expanded in the inclusion criteria in Stage 3.

Stage 2: Identifying relevant studies

Electronic searches of databases from inception until March 2015 were performed using MEDLINE (via PubMed), CINAHL and SPORTSDiscus (via EBSCO), and the Cochrane Library (Wiley). Key search terms and synonyms were searched separately in three main filters: i) population terms (hip and knee OA); ii) exercise terms; and iii) barrier and facilitator terms. These were combined with the "AND" operator, without any further restrictions. Supplementary hand searching of references cited in retrieved articles was also conducted. A full search strategy for the MEDLINE database is provided in Appendix 1.

Stage 3: Study selection

The titles and abstracts of all retrieved studies were initially screened by two independent researchers, followed by an independent full-text review of potentially eligible studies by two

review authors. Any disagreements from either screening phase were discussed and resolved with a third review author. Studies were included if they met the following criteria:

1. *Population:* participants were people 45 years or older with OA of the hip and/or knee, diagnosed according to the definition of the original study investigators. This included both clinical and radiological diagnoses.
2. *Intentional exercise:* defined according to the World Health Organization definition as the participation (initiation, maintenance and/or adherence) in any physical activity that is planned, structured, repetitive, and purposeful in the sense that the improvement or maintenance of one or more components of physical fitness is the objective [28]. That is, an activity with the *intent* to exercise. The activity could be supervised (e.g. individual or group sessions with a physical therapist or fitness instructor) or unsupervised (e.g. home exercises, walking program), as well as prescribed (e.g. by a health professional), advised (recommended by a website or support group) or self-initiated.
3. *Barriers and facilitators:* any factor, characteristic, view or belief that either impedes or enables participation in exercise.
4. *Study design:* any primary empirical study, including qualitative, quantitative and mixed-method designs, and systematic reviews, that was published as a full paper, and had a primary and/or secondary aim of exploring or evaluating barriers/facilitators to participation in intentional exercise.
5. *Language of publication:* Studies published in English language.

Studies were excluded if: i) participants were not specifically described as having hip or knee OA; ii) >50% of study participants had conditions other than OA, such as systematic or inflammatory joint conditions, or if hip/knee pain was not clearly attributed to OA (unless a sub-group analysis was provided of the OA participants); iii) the majority of study participants were

less than 45 years of age (unless sub-group analysis was provided); iv) the majority of study participants included people with hip and/or knee OA following joint replacement surgery, as barriers and facilitators to exercise for these people may be different; v) there was no exercise component to the intervention evaluated; vi) in the case of multimodal interventions (e.g. physical therapy), the relationship between the barriers/facilitators and the specific exercise component of the intervention was not evaluated; and it was a narrative review.

Stage 4: Charting the data (data extraction)

Characteristics of each eligible study, including details of the participants, study design, type of exercise, and reported barriers and facilitators to exercise participation, were extracted by one author. The extracted barriers and facilitators were checked by a second review author.

Stage 5: Collating, summarising and reporting the results

Each extracted modifiable barrier and facilitator was mapped to the 14 domains of the TDF by two independent review authors and mediated by a third review author in cases of disagreement. All authors subsequently confirmed the mapping of each identified barrier/facilitator to each TDF domain, one of whom is a health psychologist who is an expert in behaviour change. As acknowledged by the developers of the TDF, domains in the framework are not necessarily mutually exclusive and factors may have membership across multiple domains. Accordingly, each barrier and facilitator was mapped to all relevant domains of the TDF.

Results

Description of included studies

Selection of studies is summarized in Figure 1. Twenty-three eligible studies [16 17 29-49] were identified and are described in Table 1. A total of 4633 participants were included in the review,

with individual study sample sizes ranging from 11 to 1021 participants. Studies were conducted in the United States of America (6 studies), Australia (5 studies), United Kingdom (4 studies), Canada (2 studies), Netherlands (2 studies), Germany (1 study), Iceland (1 study), Turkey (1 study) and New Zealand (1 study). Fourteen studies included people with both hip and/or knee OA, nine included people with primarily knee OA, while none included people with primarily hip OA. There were 15 quantitative studies, six qualitative studies and two mixed-methods studies.

Types of exercise

A range of exercise programs were focused on in the included studies: aerobic activity [29 30 33 35 37-41 45], strengthening exercise [16 31 39 41 43 47 48], flexibility exercise [31], range of motion exercise [37], or a combination of strengthening, flexibility and endurance exercises [44 46 49]. The exercise type was not specified in three studies [34,36,42.] Eleven studies evaluated structured, supervised, exercise programs that were prescribed by a health professional [16 30 31 37-39 43-45 47 48] and three studies addressed exercise programs that had been advised by a health professional but were performed mostly unsupervised [29 33 41]. Six studies evaluated exercise that had been self-initiated by the participants [17 32 35 36 40 42 49] and a further two studies addressed a mixture of prescribed, advised and self-initiated exercise programs [34 46].

Barriers and facilitators to exercise participation

Barriers and facilitators to exercise identified by each of the included studies are described in Table 1. These mapped across all 14 domains of the TDF (Table 2). Many modifiable barriers related to the domains of *Environmental Context and Resources* and *Beliefs about Consequences*, while many facilitators were mapped to *Environmental Context and Resources* as well as *Reinforcement*. A small number of the barriers and facilitators identified in the selected studies were non-modifiable. Non-modifiable barriers included low educational level [40], older

age [35 36 40], history of poor exercise adherence [37] and being a long-term sedentary person [35 43 46]. Non-modifiable facilitators included increased OA disease duration [44], being a long-term active person [36], being male and having a higher education level [48]. A summary of the most common types of modifiable barriers and facilitators in each TDF domain follows.

i. Knowledge: an awareness of the existence of something

Lack of knowledge and/or education about OA and/or lack of adequate instructions about exercise and its benefits were identified as barriers, whereas education and/or knowledge about OA and/or clinicians demonstrating exercises were reported as facilitators.

ii. Skills: an ability or proficiency acquired through practice.

No barriers mapped to the skills domain. Prior experience with exercising was a facilitator.

iii. Social/Professional Role and Identity: a coherent set of behaviours and displayed personal qualities of an individual in a social setting

Poor self-image or the self-perception of being inactive were viewed as exercise barriers, whereas a positive self-image and feelings of being able to contribute to a study/program were considered to be facilitators.

iv. Beliefs about Capabilities: acceptance of the truth, reality or validity about an ability, talent or facility that a person can put to constructive use

Seven different studies identified barriers to exercise related to this domain [16 17 34-36 40 41 48], primarily focused on negative beliefs about the severity of symptoms (eg pain, stiffness, fatigue and disability) adversely impacting capability to exercise. Believing that excess weight and the presence of comorbidities leads to a perceived inability to exercise were also barriers. Exercise facilitators for this domain included perceptions of being physically active, of having low levels of physical limitation and positive beliefs about taking control of disability.

v. Optimism: the confidence that things will happen for the best or that desired goals will be attained

Fatalism regarding OA and a negative attitude to exercise were barriers to exercise while positive health and exercise attitudes were regarded as facilitators across four studies [16 17 36 45].

vi. Beliefs about Consequences: acceptance of the truth, reality or validity about outcomes of a behaviour in a given situation

Eight different studies identified barriers to exercise that were related to patient beliefs about the consequences of exercise [16 17 30 35 36 40 44 46]. Barriers centred around perceptions that exercise has limited effectiveness for OA and/or that exercise would result in negative consequences such as increased pain or other symptoms. Similarly, positive expectations about exercise effects were facilitators to exercise.

vii. Reinforcement: increasing the probability of a response by arranging a dependent relationship between the response and a given stimulus

While only three studies identified lack of reinforcement as a barrier to exercise [16 17 35], nine different studies identified a range of factors related to positive reinforcement that were facilitators to exercise participation, including use of incentives, pain improvement and encouragement from medical practitioners [17 31 32 35-37 44 48 49].

viii. Intentions: a conscious decision to perform a behaviour or a resolve to act in a certain way

Lack of motivation, laziness and self-belief about being sufficiently active were all barriers to exercise participation, whereas strong motivation, determination, initiative and loyalty to therapists were all reported to be facilitators.

ix. Goals: mental representations of outcomes or end states that an individual wants to achieve

Goal setting emerged as being important to exercise participation across four different studies [30 31 38 45] with lack of goal setting being a barrier and use of long and short-term goals being a facilitator.

x. Memory, Attention and Decision Processes: the ability to retain information, focus selectively on aspects of the environment and choose between alternatives

Tiredness, forgetfulness and inactive habits were barriers to exercise in this domain of the TDF, whereas good sleep, previous exercise adherence and being physically active were facilitators. Lack of patient input into the exercise program was a barrier to participation while active involvement of the patient in the content of the intervention was a facilitator.

xi. Environmental Context and Resources: any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence and adaptive behaviour

Twelve of the 23 included studies (52%) identified factors related to environmental context and resources as either barriers and/or facilitators to exercise. Barriers included poor weather conditions, access to facilities, use of a walking aid, hills/stairs during walking programs, costs of exercise, safety concerns, transport and parking, whereas good weather conditions and easy access to suitable, low-cost classes were regarded as facilitators.

xii. Social influences: those interpersonal processes that can cause individuals to change their thoughts, feelings or behaviours

Family commitments, lack of family/social support and lack of a training partner were all regarded as barriers to exercise. Increased family/social support and exercising with a partner were most commonly viewed as facilitators in this domain of the TDF.

xiii. Emotions: a complex reaction pattern by which an individual attempts to deal with a personally significant matter or event

Anxiety, boredom and lack of enjoyment were emotional barriers to exercise, while enjoyment and improved depression with exercise were facilitators.

xiv. Behavioural Regulation: anything aimed at managing or changing objectively observed or measured actions

Although no study identified any barriers to exercise in the behavioural regulation domain of the TDF, a range of facilitators were identified including performing exercise at one's own pace, prioritisation and integration of exercise into daily lifestyle and ongoing monitoring.

Discussion

This review utilised a systematic approach to identify the previously published barriers and facilitators that people with hip and/or knee OA encounter when participating in intentional exercise, and mapped these barriers and facilitators to the theoretical domains of the TDF. Many barriers were mapped to *Environmental Context and Resources* and *Beliefs about Consequences* whereas many facilitators were mapped to *Environmental Context and Resources* and *Reinforcement.* These results provide a useful basis for clinicians to better assist their patients with OA to change their behaviour towards long-term exercise adherence, and to guide the development and evaluation of strategies designed to increase adherence to exercise in people with hip and/or knee OA. This review has highlighted that people with hip and/or knee OA are faced with a wide and complex variety of barriers and facilitators to exercise participation. The complex, and often inter-related, nature of factors influencing exercise participation means that a single approach to promoting exercise participation is unlikely to be effective across all people with hip and/or knee OA, or across all points of the disease trajectory in a given individual patient. Nonetheless, our study has highlighted the TDF domains most commonly represented by barriers and facilitators. Research to evaluate whether interventions that targets these domains improve outcomes in people with hip and/or knee OA is now required.

Our findings highlight the importance of environmental context and available resources in influencing participation and adherence to exercise. When prescribing or recommending exercise for a person with hip/knee OA, our results suggest that clinicians should consider the circumstances of each individual's situation and environment, and identify barriers that may impede exercise participation and ongoing adherence. To do so, clinicians would be advised to engage in a meaningful discussion with patients about their preferences for exercise, including their ability and willingness to access facilities (considering both transportation and cost).

Clinicians should also take an active role in assisting their patients to determine the most appropriate exercise program for their individual circumstances, and not trust that a patient can successfully navigate their own way towards following generic and non-personalised advice to exercise. Research into UK-based physiotherapists attitudes to exercise shows less than 50% of therapists believe the patient is the best person to decide if they should do their exercises at home or in a group setting [19], suggesting that many clinicians are not using a person-centred approach to exercise management and that this could be contributing to poor exercise adherence in people with OA. Our findings show that patient beliefs, about their capabilities for, and the consequences of, exercise are important barriers to exercise for people with OA. Given that research has shown that older adults with knee pain have considerable uncertainty about the benefits of exercise for knee pain [36], clinicians must make concerted efforts to educate their patients regarding exercise benefits, prior to prescribing an exercise program. Presence of x-ray changes appears to be an important factor influencing a person's belief about exercise effectiveness [36]- approximately 40% of people believe exercise is effective in the presence of mild radiographic OA and this drops to around 20% with respect to severe OA. For patients with radiographic changes of OA, clinicians should emphasise that such individuals are capable of exercise and are also likely to experience benefits of exercise, irrespective of x-ray findings. Fear of causing increased pain or further joint damage, and beliefs that exercise is beyond one's capabilities or will not provide benefit, stems from lack of knowledge [36]. Clinicians play a crucial role in providing accurate information about OA and the role of exercise. However, given that only 56% of physical therapists largely/totally agree that exercise is effective for knee OA [19], it seems that education directed to clinicians is also required to ensure that patients are given accurate, unbiased and evidence-based information. Our review shows reinforcement plays a major role in facilitating participation and adherence to exercise. Although allied health clinicians, such as physiotherapists, are traditionally responsible for exercise prescription for people with OA, encouragement and endorsement from doctors is also important [17 32 35]. This

reinforces the need for a multi-disciplinary team-based approach to OA management where medical practitioners actively endorse and support non-pharmacological approaches to OA. Our findings also highlight that internal reinforcement mechanisms are important facilitators to exercise; people who notice improvements in symptoms with exercise are more likely to continue exercising. This could be achieved by patients via simple self-reported pain scales and exercise log books which could help reinforce the benefits of exercise by increasing self-awareness of symptom changes over time. Only 57% of physiotherapists report using self-reported measures of pain and function to monitor progress with exercises, and only 12% instruct their patients in the use of exercise diaries [18], which highlights areas of clinical practice that could be changed in order to improve exercise adherence in people with OA.

This is the first review we are aware of to map the barriers and facilitators to exercise participation for people with hip and/or knee OA to the domains of the TDF. Our findings provide a useful basis to develop new strategies that may help increase long-term adherence to exercise in people with hip/knee OA, and thus ultimately optimise the clinical benefits of exercise in this patient group. In development, the TDF was informed by theoretical constructs of behaviour change and thus domains within this framework can be theoretically linked to interventions of behaviour change [21]. Michie et al [21] suggested three main reasons for using theory in designing behaviour change interventions. First, interventions are likely to be more effective if they target the theoretical mechanisms of change. Second, theory can be tested and developed by evaluations of interventions only if those interventions and evaluations are theoretically informed. Third, theory-based interventions facilitate an understanding of what works and thus are a basis for developing better theory across different contexts, populations, and behaviours. Our review has highlighted many barriers and facilitators to exercise participation in the *Environmental Context and Resources, Beliefs about Consequences* and *Reinforcemen*t domains of the TDF, thus behaviour change techniques associated with these

domains warrant further consideration and future research efforts. Future research should evaluate the effects of explicit behaviour change strategies on exercise and participation and adherence in people with OA.

Strengths of this scoping review included the use of a theoretically-informed systematic approach to identify and synthesise the findings of relevant qualitative and quantitative research. The TDF is arguably one of the most comprehensive frameworks for systematically identifying moderators of behaviour [25]. Using a broad theoretical framework, as opposed to a single theory, enabled a more encompassing examination of potential barriers and facilitators. The synthesis of findings in this scoping review adds to existing reviews and models by providing a framework grounded explicitly in theories of behaviour change. Further, the inclusion of findings from qualitative study designs helps to add depth of understanding, which is useful for describing complex phenomena such as exercise participation. A potential limitation of this review is, as acknowledged by the developers of the TDF, that domains in the framework are not mutually exclusive, meaning that some barriers and facilitators can be mapped across multiple domains. This means that multiple behavioural change strategies may be required to address factors related to exercise participation in people with OA. Another important limitation is that, unlike a systematic review, this scoping review did not incorporate a risk of bias assessment of included studies and identified barriers and facilitators were mapped to the TDF regardless of the methodological quality of the originating study. As the purpose of a scoping review is to map the body of literature and present a broad scope overview of a diverse body of literature [26], it has been argued that scoping reviews should include all relevant literature regardless of methodological quality, given that their intent is to present an overview of the existing literature in a field of interest [50]. Further, scoping reviews are more commonly used for hypothesis generation and the stimulation of future research[50], rather the synthesis of new evidence from high quality studies as in a systematic review. Future research should include a systematic review

of the efficacy of interventions for overcoming barriers to exercise using evidence from high quality studies. The identified barriers and facilitators in this review were derived from quantitative, qualitative and mixed designs, hence estimates of the strength and precision of relationships was not appropriate for many factors. Significant results derived from quantitative studies were mapped to the TDF regardless of the strength and precision of relationships found in these studies. Finally, we did not identify any studies from Asia, Africa or South America. It is acknowledged that cultural differences can influence exercise participation, particularly to practitioner-prescribed interventions [12] and this may influence the generalizability of our results. More primary research is required to identify culturally-specific barriers and facilitators in these populations.

Many modifiable barriers and facilitators to intentional exercise are related to the circumstances of a person's situation or environment that either discourages or encourages the development of exercise skills and abilities, independence, social competence and adaptive behaviour. Negative beliefs about the consequences of exercise are also barriers. Clinicians advising exercise for people with OA should take a personalised approach that considers the environmental context and resources available to the individual, as well as educate patients regarding the beneficial effects of exercise, in order to maximise exercise participation and adherence. Use of reinforcement strategies should be considered to promote exercise adherence. Future research is required to investigate the effectiveness of behaviour change interventions that specifically target these barriers and facilitators to exercise.

References

1. Vos T, Flaxman AD, Naghavi M, Lozano R, Michaud C, Eszzati M, et al. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990—2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012;380:2163-96.
2. Nelson AE, Allen KD, Golightly YM, Goode AP, Jordan JM. A systematic review of recommendations and guidelines for the management of osteoarthritis: The Chronic Osteoarthritis Management Initiative of the U.S. Bone and Joint Initiative. *Seminars in arthritis and rheumatism* 2014;43:701-12.
3. Fransen M, McConnell S, Harmer AR, Van der Esch M, Simic M, Bennell KL. Exercise for osteoarthritis of the knee. *The Cochrane database of systematic reviews* 2015;1:Cd004376.
4. Fransen M, McConnell S, Hernandez-Molina G, Reichenbach S. Exercise for osteoarthritis of the hip. *The Cochrane database of systematic reviews*: John Wiley & Sons, Ltd, 2014.
5. Ettinger WH, Jr., Burns R, Messier SP, Applegate W, Rejeski WJ, Morgan T, et al. A randomized trial comparing aerobic exercise and resistance exercise with a health education program in older adults with knee osteoarthritis. The Fitness Arthritis and Seniors Trial (FAST). *JAMA* 1997;277(1):25-31.
6. Jordan KM, Sawyer S, Coakley P, Smith HE, Cooper C, Arden NK. The use of conventional and complementary treatments for knee osteoarthritis in the community. *Rheumatology* 2004;43(3):381-4.
7. Mitchell HL, Hurley MV. Management of chronic knee pain: a survey of patient preferences and treatment received. *BMC musculoskeletal disorders* 2008;9:123.

8. Haskins R, Henderson JM, Bogduk N. Health professional consultation and use of conservative management strategies in patients with knee or hip osteoarthritis awaiting orthopaedic consultation. *Australian journal of primary health* 2014;20(3):305-10.
9. Hinman RS, Nicolson PJ, Dobson FL, Bennell KL. Use of nondrug, nonoperative interventions by community-dwelling people with hip and knee osteoarthritis. *Arthritis care & research* 2015;67(2):305-9.
10. Pisters MF, Veenhof C, Schellevis FG, Twisk JW, Dekker J, De Bakker DH. Exercise adherence improving long-term patient outcome in patients with osteoarthritis of the hip and/or knee. *Arthritis care & research* 2010;62(8):1087-94.
11. Jordan JL, Holden MA, Mason EE, Foster NE. Interventions to improve adherence to exercise for chronic musculoskeletal pain in adults. *The Cochrane database of systematic reviews* 2010;20(1):CD005956.
12. Marks R, Allegrante JP. Chronic osteoarthritis and adherence to exercise: a review of the literature. *Journal of aging and physical activity* 2005;13(4):434-60.
13. Mazieres B, Thevenon A, Coudeyre E, Chevalier X, Revel M, Rannou F. Adherence to, and results of, physical therapy programs in patients with hip or knee osteoarthritis. Development of French clinical practice guidelines. *Joint Bone Spine* 2008;75(5):589-96.
14. Marks R. Knee osteoarthritis and exercise adherence: a review. *Current Aging Science* 2012;5:72-83.
15. Bennell K. Physiotherapy management of hip osteoarthritis. *Journal of physiotherapy* 2013;59(3):145-57.
16. Campbell R, Evans M, Tucker M, Quilty B, Dieppe P, Donovan J. Why don't patients do their exercises? Understanding non-compliance with physiotherapy in patients with osteoarthritis of the knee. *Epidemiol Community Health* 2001;55:132-8.

17. Petursdottir U, Arnadottir S, Halldorsdottir S. Facilitators and barriers to exercising among people with osteoarthritis: A phenomenological study. *Phys Ther* 2010;90(7):1014-25.
18. Holden MA, Nicholls EE, Hay EM, Foster NE. Physical therapists' use of therapeutic exercise for patients with clinical knee osteoarthritis in the United kingdom: in line with current recommendations? *Phys Ther* 2008;88(10):1109-21.
19. Holden MA, Nicholls EE, Young J, Hay EM, Foster NE. UK-based physical therapists' attitudes and beliefs regarding exercise and knee osteoarthritis: findings from a mixed-methods study. *Arthritis Rheum* 2009;61(11):1511-21.
20. Michie S, Johnston M, Abraham C, Lawton R, Parker D, Walker A, et al. Making psychological theory useful for implementing evidence based practice: a consensus approach. *Qual Saf Health Care* 2005;14(1):26-33.
21. Michie S, Johnston M, Francis J, Hardeman W, Eccles M. From theory to intervention: mapping theoretically derived behavioural determinants to behaviour change techniques. *Appl Psychol* 2008;57(4):660-80.
22. Cane J, O'Connor D, Michie S. Validation of the theoretical domains framework for use in behaviour change and implementation research. *Implement Sci* 2012;7(1):37.
23. Francis JJ, O'Connor D, Curran J. Theories of behaviour change synthesised into a set of theoretical groupings: introducing a thematic series on the theoretical domains framework. *Implement Sci* 2012;7:35.
24. Heslehurst N, Newham J, Maniatopoulos G, Fleetwood C, Robalino S, Rankin J. Implementation of pregnancy weight management and obesity guidelines: a meta-synthesis of healthcare professionals' barriers and facilitators using the Theoretical Domains Framework. *Obesity reviews : an official journal of the International Association for the Study of Obesity* 2014;15(6):462-86.
25. French SD, Green SE, O'Connor DA, McKenzie JE, Francis JJ, Michie S, et al. Developing theory-informed behaviour change interventions to implement evidence into practice: a

systematic approach using the Theoretical Domains Framework. *Implement Sci* 2012;7(1):38.

26. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol* 2005;8(1):19-32.

27. Daudt HM, van Mossel C, Scott SJ. Enhancing the scoping study methodology: a large, inter-professional team's experience with Arksey and O'Malley's framework. *BMC medical research methodology* 2013;13:48.

28. World Health Organization. http://www.who.int/dietphysicalactivity/pa/en/index.html.

29. Bossen D, Veenhof C, Dekker J, de Bakker D. The usability and preliminary effectiveness of a web-based physical activity intervention in patients with knee and/or hip osteoarthritis. *BMC medical informatics and decision making* 2013;13:61.

30. Brosseau L, Wells GA, Kenny GP, Reid R, Maetzel A, Tugwell P, et al. The implementation of a community-based aerobic walking program for mild to moderate knee osteoarthritis (OA): a knowledge translation (KT) randomized controlled trial (RCT): Part I: The Uptake of the Ottawa Panel clinical practice guidelines (CPGs). *BMC public health* 2012;12:871.

31. Damush TM, Perkins SM, Mikesky AE, Roberts M, O'Dea J. Motivational factors influencing older adults diagnosed with knee osteoarthritis to join and maintain an exercise program. *J Aging Phys Act* 2005;13(1):45-60.

32. Dexter PA. Joint exercises in elderly persons with symptomatic osteoarthritis of the hip or knee. Performance patterns, medical support patterns, and the relationship between exercising and medical care. *Arthritis care & research* 1992;5(1):36-41.

33. Halbert J, Crotty M, Weller D, Ahern M, Silagy C. Primary care-based physical activity programs: effectiveness in sedentary older patients with osteoarthritis symptoms. *Arthritis Rheum* 2001;45(3):228-34.

34. Heesch KC, Ng N, Brown W. Factors associated with physical activity in Australians with hip or knee osteoarthritis. *Journal of physical activity & health* 2011;8(3):340-51.
35. Hendry M, Williams NH, Markland D, Wilkinson C, Maddison P. Why should we exercise when our knees hurt? A qualitative study of primary care patients with osteoarthritis of the knee. *Family practice* 2006;23(5):558-67.
36. Holden MA, Nicholl EE, Young J, Hay EM, Foster NE. Role of exercise for knee pain: what do older adults in the community think? *Arthritis care & research* 2012;64(10):1554-64.
37. Minor MA, Brown JD. Exercise maintenance of persons with arthritis after participation in a class experience. *Health Educ Q* 1993;20(1):83-95.
38. Pisters MF, Veenhof C, de Bakker DH, Schellevis FG, Dekker J. Behavioural graded activity results in better exercise adherence and more physical activity than usual care in people with osteoarthritis: a cluster-randomised trial. *Journal of physiotherapy* 2010;56(1):41-7.
39. Rejeski WJ, Brawley LR, Ettinger W, Morgan T, Thompson C. Compliance to exercise therapy in older participants with knee osteoarthritis: implications for treating disability. *Medicine and science in sports and exercise* 1997;29(8):977-85.
40. Rosemann T, Kuehlein T, Laux G, Szecsenyi J. Factors associated with physical activity of patients with osteoarthritis of the lower limb. *J Eval Clin Pract* 2008;14(2):288-93.
41. Williams NH, Amoakwa E, Belcher J, Edwards RT, Hassani H, Hendry M, et al. Activity Increase Despite Arthritis (AIDA): phase II randomised controlled trial of an active management booklet for hip and knee osteoarthritis in primary care. *The British journal of general practice : the journal of the Royal College of General Practitioners* 2011;61(589):e452-8.
42. Cotter KA, Sherman AM. Love hurts: The influence of social relations on exercise self-efficacy for older adults with osteoarthritis. *Journal of aging and physical activity* 2008;16(4):465-83.

531 43. Schoo AMM, Morris ME, Bui QM. Predictors of Home Exercise Adherence in Older People
532 with Osteoarthritis. *Physiother Can* 2005;57(3):179-87.
533 44. Seçkin Ü, Gündüz S, Borman P, Akyüz M. Evaluation of the compliance to exercise therapy
534 in patients with knee osteoarthritis. *J Back Musculoskelet Rehabil* 2000;14(3):133-37.
535 45. Veenhof C, van Hasselt TJ, Koke AJ, Dekker J, Bijlsma JW, van den Ende CH. Active
536 involvement and long-term goals influence long-term adherence to behavioural graded
537 activity in patients with osteoarthritis: a qualitative study. *The Australian Journal of*
538 *Physiotherapy* 2006;52(4):273-8.
539 46. Poitras S, Rossignol M, Avouac J, Avouac B, Cedraschi C, Nordin M, et al. Management
540 recommendations for knee osteoarthritis: how usable are they? *Joint Bone Spine*
541 2010;77(5):458-65.
542 47. Bennell KL, Kyriakides M, Hodges PW, Hinman RS. Effects of two physiotherapy booster
543 sessions on outcomes with home exercise in people with knee osteoarthritis: a
544 randomized controlled trial. *Arthritis care & research* 2014;66(11):1680-7.
545 48. Desai PM, Hughes SL, Peters KE, Mermelstein RJ. Impact of telephone reinforcement and
546 negotiated contracts on behavioral predictors of exercise maintenance in older adults with
547 osteoarthritis. *American journal of health behavior* 2014;38(3):465-77.
548 49. Fisken A, Keogh JW, Waters DL, Hing WA. Perceived Benefits, Motives, and Barriers to
549 Aqua-based Exercise Among Older Adults With and Without Osteoarthritis. *Journal of*
550 *applied gerontology : the official journal of the Southern Gerontological Society*
551 2015;34(3):377-96.
552 50. Pham MT, Rajić A, Greig JD, Sargeant JM, Papadopoulos A, McEwen SA. A scoping review
553 of scoping reviews: advancing the approach and enhancing the consistency. *Research*
554 *Synthesis Methods* 2014;5(4):371-85.

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List of Tables

Figure Legends

Figure 1. Flow diagram of study selection processes.

Appendices

Appendix 1. Full search strategy in MEDLINE (PubMed)