

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

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25 **Competing interests:**

26 The authors declare that they have no competing interests.

27

28 **Author's Contribution**

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

35

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45

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48 (OARSI) World Congress, in May 2015, Seattle, USA.

1 **Abstract**

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

19

20 **Key words:** Osteoarthritis, Exercise, Barriers, Facilitators

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22 **Word count:** 4545

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25

26 **Introduction**

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

38
39 Several narrative reviews have described a complex array of barriers and facilitators that
40 influence the uptake and maintenance of exercise in people with hip and/or knee OA ¹²⁻¹⁴.
41 Factors identified have included those that encompass the physical environment (e.g. weather,
42 access to services), the social environment (e.g. time, supports), personal experiences (e.g.
43 previous exercise history) and individual attributes (e.g. motivation, knowledge, beliefs,
44 attitudes, confidence). Although a number of models have been proposed to assist clinicians
45 and researchers in identifying and assessing barriers and facilitators to exercise in order to
46 design treatments improve exercise adherence ¹⁴⁻¹⁷, no study to date has synthesised the
47 barriers and facilitators to exercise using an analytical framework grounded explicitly in
48 theories of behaviour change. Given that long-term exercise adherence usually requires
49 significant behaviour change on the part of individuals with OA, such an approach is needed to
50 drive the development of clinical strategies that are most likely to be effective in increasing
51 exercise participation.

52

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

67

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

78 *Regulation.* Strengths of the TDF include that it incorporates multiple theories of behaviour
79 change, that it provides a useful conceptual basis for understanding behaviour-change
80 processes and that it can be used to guide the choice of appropriate behaviour change
81 techniques to improve implementation of a given intervention^{21 23}.

82
83 The use of the TDF can ensure a comprehensive identification of all possible mediators of
84 behaviour and behaviour change²³. The TDF provides a useful conceptual basis for analysing
85 implementation problems and subsequently designing implementation interventions to improve
86 healthcare clinical practice. The TDF has been used to explore implementation problems in a
87 number of different clinical areas. For example, the TDF has been used to explore healthcare
88 professional barriers and facilitators in implementing weight management and obesity
89 guidelines in pregnant women²⁴, and to develop a complex intervention to improve acute low
90 back pain management in primary care²⁵. However, no study to date has used the TDF to
91 explore the patient-related barriers and facilitators to exercise participation and adherence.

92
93 A scoping study, defined as a method to map key concepts, main sources and available
94 evidence underpinning a research area²⁶, is an increasingly common approach to reviewing
95 literature²⁷. Arksey and O'Malley²⁶ described a number of reasons for conducting a scoping
96 study, including to examine the extent, range and nature of research activity; to summarise and
97 disseminate research findings; and to identify research gaps in existing literature. As such, a
98 scoping review, guided by the TDF, is an appropriate methodology to provide an overview and
99 analytic framework of barriers and facilitators to exercise participation in people with hip and
100 knee OA. The aims of this scoping review were to: i) identify barriers and facilitators to
101 participation in intentional exercise for people with hip and/or knee osteoarthritis (OA) and; ii)
102 map modifiable barriers and facilitators to the Theoretical Domains Framework (TDF).

103

104 **Methods**

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

111

112 ***Stage 1: Identifying the research question and operational definitions:***

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

117

118 ***Stage 2: Identifying relevant studies***

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

126

127 ***Stage 3: Study selection***

128 The titles and abstracts of all retrieved studies were initially screened by two independent
129 researchers, followed by an independent full-text review of potentially eligible studies by two
130 review authors. Any disagreements from either screening phase were discussed and resolved
131 with a third review author. Studies were included if they met the following criteria:

132 1. *Population*: participants were people 45 years or older with OA of the hip and/or knee,
133 diagnosed according to the definition of the original study investigators. This included
134 both clinical and radiological diagnoses.

135 2. *Intentional exercise*: defined according to the World Health Organization definition as the
136 participation (initiation, maintenance and/or adherence) in any physical activity that is
137 planned, structured, repetitive, and purposeful in the sense that the improvement or
138 maintenance of one or more components of physical fitness is the objective²⁸. That is, an
139 activity with the *intent* to exercise. The activity could be supervised (e.g. individual or
140 group sessions with a physical therapist or fitness instructor) or unsupervised (e.g. home
141 exercises, walking program), as well as prescribed (e.g. by a health professional), advised
142 (recommended by a website or support group) or self-initiated.

143 3. *Barriers and facilitators*: any factor, characteristic, view or belief that either impedes or
144 enables participation in exercise.

145 4. *Study design*: any primary empirical study, including qualitative, quantitative and mixed-
146 method designs, and systematic reviews, that was published as a full paper, and had a
147 primary and/or secondary aim of exploring or evaluating barriers/facilitators to
148 participation in intentional exercise.

149 5. *Language of publication*: Studies published in English language.

150

151 Studies were excluded if: i) participants were not specifically described as having hip or knee
152 OA; ii) >50% of study participants had conditions other than OA, such as systematic or

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

162

163 ***Stage 4: Charting the data (data extraction)***

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

167

168 ***Stage 5: Collating, summarising and reporting the results***

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

177

178 **Results**

179 *Description of included studies*

180 Selection of studies is summarized in Figure 1. Twenty-three eligible studies^{16 17 29-49} were
181 identified and are described in Table 1. A total of 4633 participants were included in the
182 review, with individual study sample sizes ranging from 11 to 1021 participants. Studies were
183 conducted in the United States of America (6 studies), Australia (5 studies), United Kingdom
184 (4 studies), Canada (2 studies), Netherlands (2 studies), Germany (1 study), Iceland (1 study),
185 Turkey (1 study) and New Zealand (1 study). Fourteen studies included people with both hip
186 and/or knee OA, nine included people with primarily knee OA, while none included people
187 with primarily hip OA. There were 15 quantitative studies, six qualitative studies and two
188 mixed-methods studies.

189

190 *Types of exercise*

191 A range of exercise programs were focused on in the included studies: aerobic activity^{29 30 33 35}
192^{37-41 45}, strengthening exercise^{16 31 39 41 43 47 48}, flexibility exercise³¹, range of motion exercise³⁷,
193 or a combination of strengthening, flexibility and endurance exercises^{44 46 49}. **The exercise type**
194 **was not specified in three studies**^{34,36,42}. Eleven studies evaluated structured, supervised,
195 exercise programs that were prescribed by a health professional^{16 30 31 37-39 43-45 47 48} and three
196 studies addressed exercise programs that had been advised by a health professional but were
197 performed mostly unsupervised^{29 33 41}. Six studies evaluated exercise that had been self-
198 initiated by the participants^{17 32 35 36 40 42 49} and a further two studies addressed a mixture of
199 prescribed, advised and self-initiated exercise programs^{34 46}.

200

201 *Barriers and facilitators to exercise participation*

202 Barriers and facilitators to exercise identified by each of the included studies are described in
203 Table 1. These mapped across all 14 domains of the TDF (Table 2). Many modifiable barriers

204 related to the domains of *Environmental Context and Resources* and *Beliefs about*
205 *Consequences*, while many facilitators were mapped to *Environmental Context and Resources*
206 as well as *Reinforcement*. A small number of the barriers and facilitators identified in the
207 selected studies were non-modifiable. Non-modifiable barriers included low educational level
208 ⁴⁰, older age ^{35 36 40}, history of poor exercise adherence ³⁷ and being a long-term sedentary
209 person ^{35 43 46}. Non-modifiable facilitators included increased OA disease duration ⁴⁴, being a
210 long-term active person ³⁶, being male and having a higher education level ⁴⁸. A summary of
211 the most common types of modifiable barriers and facilitators in each TDF domain follows.

212 *i. Knowledge: an awareness of the existence of something*

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

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

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

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

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

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

225 Seven different studies identified barriers to exercise related to this domain ^{16 17 34-36 40 41 48},
226 primarily focussed on negative beliefs about the severity of symptoms (eg pain, stiffness,
227 fatigue and disability) adversely impacting capability to exercise. Believing that excess weight
228 and the presence of comorbidities leads to a perceived inability to exercise were also barriers.

229 Exercise facilitators for this domain included perceptions of being physically active, of having
230 low levels of physical limitation and positive beliefs about taking control of disability.

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

233 Fatalism regarding OA and a negative attitude to exercise were barriers to exercise while
234 positive health and exercise attitudes were regarded as facilitators across four studies^{16 17 36 45}.

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

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

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

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

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

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

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

255 Goal setting emerged as being important to exercise participation across four different studies
256 ^{30 31 38 45} with lack of goal setting being a barrier and use of long and short-term goals being a
257 facilitator.

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

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

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

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

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

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

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

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

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

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

286

287 **Discussion**

288 This review utilised a systematic approach to identify the previously published barriers and
289 facilitators that people with hip and/or knee OA encounter when participating in intentional
290 exercise, and mapped these barriers and facilitators to the theoretical domains of the TDF.

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

305

306 Our findings highlight the importance of environmental context and available resources in
307 influencing participation and adherence to exercise. When prescribing or recommending
308 exercise for a person with hip/knee OA, our results suggest that clinicians should consider the
309 circumstances of each individual's situation and environment, and identify barriers that may
310 impede exercise participation and ongoing adherence. To do so, clinicians would be advised to
311 engage in a meaningful discussion with patients about their preferences for exercise, including
312 their ability and willingness to access facilities (considering both transportation and cost).
313 Clinicians should also take an active role in assisting their patients to determine the most
314 appropriate exercise program for their individual circumstances, and not trust that a patient can
315 successfully navigate their own way towards following generic and non-personalised advice to
316 exercise. Research into UK-based physiotherapists attitudes to exercise shows less than 50% of
317 therapists believe the patient is the best person to decide if they should do their exercises at
318 home or in a group setting ¹⁹, suggesting that many clinicians are not using a person-centred
319 approach to exercise management and that this could be contributing to poor exercise
320 adherence in people with OA. Our findings show that patient beliefs, about their capabilities
321 for, and the consequences of, exercise are important barriers to exercise for people with OA.
322 Given that research has shown that older adults with knee pain have considerable uncertainty
323 about the benefits of exercise for knee pain ³⁶, clinicians must make concerted efforts to
324 educate their patients regarding exercise benefits, prior to prescribing an exercise program.
325 Presence of x-ray changes appears to be an important factor influencing a person's belief about
326 exercise effectiveness ³⁶- approximately 40% of people believe exercise is effective in the
327 presence of mild radiographic OA and this drops to around 20% with respect to severe OA. For
328 patients with radiographic changes of OA, clinicians should emphasise that such individuals
329 are capable of exercise and are also likely to experience benefits of exercise, irrespective of x-
330 ray findings. Fear of causing increased pain or further joint damage, and beliefs that exercise is
331 beyond one's capabilities or will not provide benefit, stems from lack of knowledge ³⁶.

332 Clinicians play a crucial role in providing accurate information about OA and the role of
333 exercise. However, given that only 56% of physical therapists largely/totally agree that
334 exercise is effective for knee OA ¹⁹, it seems that education directed to clinicians is also
335 required to ensure that patients are given accurate, unbiased and evidence-based information.
336 Our review shows reinforcement plays a major role in facilitating participation and adherence
337 to exercise. Although allied health clinicians, such as physiotherapists, are traditionally
338 responsible for exercise prescription for people with OA, encouragement and endorsement
339 from doctors is also important ^{17 32 35}. This reinforces the need for a multi-disciplinary team-
340 based approach to OA management where medical practitioners actively endorse and support
341 non-pharmacological approaches to OA. Our findings also highlight that internal reinforcement
342 mechanisms are important facilitators to exercise; people who notice improvements in
343 symptoms with exercise are more likely to continue exercising. This could be achieved by
344 patients via simple self-reported pain scales and exercise log books which could help reinforce
345 the benefits of exercise by increasing self-awareness of symptom changes over time. Only 57%
346 of physiotherapists report using self-reported measures of pain and function to monitor
347 progress with exercises, and only 12% instruct their patients in the use of exercise diaries ¹⁸,
348 which highlights areas of clinical practice that could be changed in order to improve exercise
349 adherence in people with OA.

350
351 This is the first review we are aware of to map the barriers and facilitators to exercise
352 participation for people with hip and/or knee OA to the domains of the TDF. Our findings
353 provide a useful basis to develop new strategies that may help increase long-term adherence to
354 exercise in people with hip/knee OA, and thus ultimately optimise the clinical benefits of
355 exercise in this patient group. In development, the TDF was informed by theoretical constructs
356 of behaviour change and thus domains within this framework can be theoretically linked to
357 interventions of behaviour change ²¹. Michie et al ²¹ suggested three main reasons for using

358 theory in designing behaviour change interventions. First, interventions are likely to be more
359 effective if they target the theoretical mechanisms of change. Second, theory can be tested and
360 developed by evaluations of interventions only if those interventions and evaluations are
361 theoretically informed. Third, theory-based interventions facilitate an understanding of what
362 works and thus are a basis for developing better theory across different contexts, populations,
363 and behaviours. Our review has highlighted many barriers and facilitators to exercise
364 participation in the *Environmental Context and Resources*, *Beliefs about Consequences* and
365 *Reinforcement* domains of the TDF, thus behaviour change techniques associated with these
366 domains warrant further consideration and future research efforts. Future research should
367 evaluate the effects of explicit behaviour change strategies on exercise and participation and
368 adherence in people with OA.

369
370 Strengths of this scoping review included the use of a theoretically-informed systematic
371 approach to identify and synthesise the findings of relevant qualitative and quantitative
372 research. The TDF is arguably one of the most comprehensive frameworks for systematically
373 identifying moderators of behaviour ²⁵. Using a broad theoretical framework, as opposed to a
374 single theory, enabled a more encompassing examination of potential barriers and facilitators.
375 The synthesis of findings in this scoping review adds to existing reviews and models by
376 providing a framework grounded explicitly in theories of behaviour change. Further, the
377 inclusion of findings from qualitative study designs helps to add depth of understanding, which
378 is useful for describing complex phenomena such as exercise participation. A potential
379 limitation of this review is, as acknowledged by the developers of the TDF, that domains in the
380 framework are not mutually exclusive, meaning that some barriers and facilitators can be
381 mapped across multiple domains. This means that multiple behavioural change strategies may
382 be required to address factors related to exercise participation in people with OA. Another
383 | important limitation is that, unlike a systematic review, this scoping review did not incorporate

384 a risk of bias assessment of included studies and identified barriers and facilitators were
385 mapped to the TDF regardless of the methodological quality of the originating study. As the
386 purpose of a scoping review is to map the body of literature and present a broad scope
387 overview of a diverse body of literature ²⁶, it has been argued that scoping reviews should
388 include all relevant literature regardless of methodological quality, given that their intent is to
389 present an overview of the existing literature in a field of interest ⁵⁰. Further, scoping reviews
390 are more commonly used for hypothesis generation and the stimulation of future research ⁵⁰,
391 rather the synthesis of new evidence from high quality studies as in a systematic review. Future
392 research should include a systematic review of the efficacy of interventions for overcoming
393 barriers to exercise using evidence from high quality studies. The identified barriers and
394 facilitators in this review were derived from quantitative, qualitative and mixed designs, hence
395 estimates of the strength and precision of relationships was not appropriate for many factors.
396 Significant results derived from quantitative studies were mapped to the TDF regardless of the
397 strength and precision of relationships found in these studies. Finally, we did not identify any
398 studies from Asia, Africa or South America. It is acknowledged that cultural differences can
399 influence exercise participation, particularly to practitioner-prescribed interventions ¹² and this
400 may influence the generalizability of our results. More primary research is required to identify
401 culturally-specific barriers and facilitators in these populations.

402
403 Many modifiable barriers and facilitators to intentional exercise are related to the
404 circumstances of a person's situation or environment that either discourages or encourages the
405 development of exercise skills and abilities, independence, social competence and adaptive
406 behaviour. Negative beliefs about the consequences of exercise are also barriers. Clinicians
407 advising exercise for people with OA should take a personalised approach that considers the
408 environmental context and resources available to the individual, as well as educate patients
409 regarding the beneficial effects of exercise, in order to maximise exercise participation and

410 adherence. Use of reinforcement strategies should be considered to promote exercise
411 adherence. Future research is required to investigate the effectiveness of behaviour change
412 interventions that specifically target these barriers and facilitators to exercise.

413 **References**

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566

567 **List of Tables**

568 **Table 1.** Characteristics of the eligible studies included in the scoping review.

569

570 **Table 2.** Identified barriers and facilitators to exercise participation mapped to the domains on
571 the Theoretical Domains Framework.

Figure Legends

Figure 1. Flow diagram of study selection processes.

Appendices

Appendix 1. Full search strategy in MEDLINE (PubMed)