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1 **What should a toolkit to aid the delivery of therapeutic exercise for hip and knee**  
2 **osteoarthritis look like? Qualitative analysis of an international survey of 318**  
3 **researchers, clinicians, and consumers by the OARSI Rehabilitation Discussion Group**

4

5 **Abstract** (250 words)

6 **Background:** We aimed to identify important components of, and practical resources relevant  
7 for inclusion in, a toolkit to aid exercise delivery for people with hip/knee osteoarthritis.

8 **Method:** An online international multi-disciplinary survey was conducted across 43 countries  
9 (139 clinicians, 44 people with hip/knee osteoarthritis, and 135 osteoarthritis researchers).

10 Participants were presented with the seeding statement “Practical resources to aid the  
11 implementation of exercise for people with hip/knee osteoarthritis should...” and asked to  
12 provide up to 10 open text responses. Responses underwent refinement and qualitative content  
13 analysis to create domains and categories.

14 **Results:** Refinement of 551 open text responses yielded 72 unique statements relevant for  
15 analysis. Statements were organized into nine broad domains, suggesting that resources to aid  
16 exercise delivery should: 1) be easily accessible; 2) be of high quality; 3) be developed by, and  
17 for, stakeholders; 4) include different ways of delivering information; 5) include different types  
18 of resources to support exercise and non-exercise components of self-management; 6) include  
19 resources on recommended exercises and how to perform/progress them; 7) include tools to  
20 support motivation and track progress; 8) include resources to enable tailoring of the program  
21 to the individual, and; 9) facilitate access to professional and peer support.

22 **Conclusion:** Our findings identified important components of, and practical resources to  
23 include within, a toolkit to aid delivery of exercise for people with hip/knee osteoarthritis.  
24 These findings have implications for exercise providers and lay the foundation for the

- 25 development of a toolkit to help ensure exercise provision aligns with current international
- 26 recommendations.

## 1 **Introduction**

2 Osteoarthritis (OA) affects more than 500 million adults globally ([Initiative., 2020](#); [Network,](#)  
3 [2018](#)), most commonly affecting the hip and knee joints. The condition causes joint pain and  
4 impaired function, and is one of the leading causes of physical disability worldwide ([Safiri et](#)  
5 [al., 2020](#)). The costs associated with OA are enormous ([Puig-Junoy & Zamora, 2015](#)). In 2013,  
6 OA was the second most expensive health condition treated at hospitals in the United States  
7 ([Torio & Moore, 2016](#)). Indirect healthcare costs are also significant, including restrictions on  
8 participation in the workforce, reduced ability to fulfill social roles, and premature mortality  
9 ([David J Hunter, Schofield, & Callander, 2014](#)). With the ageing population and rising obesity rates,  
10 the prevalence of hip and knee OA is projected to increase in the coming decades to become  
11 one of the most widespread diseases in high-income countries ([David J. Hunter & Bierma-Zeinstra,](#)  
12 [2019](#)). As such, developing strategies to help reduce the burden of the condition are urgently  
13 needed.

14  
15 To date, there is no known cure for OA. All current clinical guidelines recommend education,  
16 exercise, and if appropriate, weight loss as first-line management approaches ([Bannuru et al.;](#)  
17 [Kolasinski et al.;](#) [National Institute for Health and Care Excellence, 2022](#); [The Royal Australian College](#)  
18 [of General Practitioners](#)). A large body of high-quality evidence supports the effectiveness of  
19 therapeutic exercise for reducing pain, improving physical function, and increasing quality of  
20 life in people with OA ([M. Fransen et al., 2015](#); [Marlene Fransen, McConnell, Hernandez-Molina, &](#)  
21 [Reichenbach, 2014](#)). As such, exercise is a key element of management for all people with hip  
22 and/or knee OA, regardless of age, comorbidity, pain severity, or disability ([Bannuru et al., 2019](#);  
23 [Kolasinski et al.](#)). Despite its evidence-base and being universally recommended by all medical  
24 societies, exercise is underutilized by people with hip/knee OA and implementation remains a  
25 challenge world-wide, highlighted by the fact that only 1 in 3 receive a referral or

26 recommendation to exercise ([Abbate et al., 2018](#); [K. B. Hagen, G. Smedslund, N. Østerås, & G.](#)  
27 [Jamtvedt, 2016](#); [Power, Cott, Badley, & Hawker, 2005](#)). There is also evidence that clinicians report  
28 a lack of confidence, skills, and knowledge in how to implement best-practice OA care,  
29 including exercise ([Barton et al., 2021](#); [Briggs, Hinman, et al., 2019](#); [Briggs, Houlding, et al., 2019](#);  
30 [Christiansen et al., 2020](#)).

31

32 To improve the implementation of exercise care for hip/knee OA, we (the Osteoarthritis  
33 Research Society International (OARSI) Rehabilitation Discussion Group) conducted a review  
34 ([Holden et al., 2021](#)) and an international multi-disciplinary e-Delphi survey to develop  
35 evidence-informed recommendations about the delivery of best practice therapeutic exercise  
36 ([Holden MA et al., 2022](#)). In total, 54 recommendations mapping to 11 domains were identified,  
37 including using an evidence-based approach, considering exercise in the context of living with  
38 OA and pain, completing a comprehensive baseline assessment with follow-up, setting goals,  
39 considering the type and dose of exercise, modifying and progressing exercise, individualising  
40 and optimising the delivery of exercise, focusing on exercise adherence, and providing  
41 education about OA and the role of exercise. If widely adopted, these could potentially better  
42 standardise delivery of exercise within clinical practice and bridge the gap between exercise  
43 provision and current OA clinical guidelines. However, identifying patient/clinician resources  
44 to support the delivery of exercise in line with our recommendations is important. Indeed,  
45 common barriers to implementing OA care include low confidence in skills to provide  
46 recommended care, lack of resources to deliver non-surgical care, lack of skills in directing  
47 patients to resources or appropriately prescribe an exercise program, and lack of access to  
48 exercise resources for patients ([Briggs, Houlding, et al., 2019](#)). People with OA themselves face  
49 numerous barriers to exercise participation, including not knowing what type or intensity of

50 exercise is helpful and not having access to resources like printed exercise instructions ([Dobson](#)  
51 [et al., 2016](#)).

52

53 The development of a widely accessible toolkit can support the delivery of exercise for people  
54 with OA in line with our published recommendations ([Holden MA et al., 2022](#)). Toolkits are  
55 curated resources that provide relevant information (e.g., instructions and links to external  
56 resources) to guide users on how to implement evidence-based practices. In other patient  
57 populations (including cancer and diabetes), there is evidence that exercise toolkits can  
58 improve clinician’s knowledge, skills, and confidence in providing exercise therapy to patients  
59 ([Dennett et al., 2022](#); [Lebret et al., 2010](#); [C. Shields et al., 2009](#); [C. A. Shields et al., 2013](#)). Currently,  
60 some online education and self-management toolkits for OA exist for clinicians ([Osteoarthritis](#)  
61 [Action Alliance, 2022b](#)), and for people with OA themselves ([Knowledge., 2022](#)), though neither  
62 are designed to specifically support the delivery of exercise-based care for hip/knee OA.  
63 Furthermore, it is unclear what the most important components and practical resources of such  
64 a toolkit should be. Thus, we aimed to identify important components of, and practical  
65 resources relevant for inclusion in, a toolkit to aid exercise delivery for people with hip/knee  
66 osteoarthritis (OA) according to patients, clinicians, and researchers.

67

## 68 **Methods**

### 69 *Study design*

70 An online international survey with open-ended questions were used to capture qualitative data  
71 was conducted in August 2020. Ethical approval was obtained from the University of  
72 Melbourne [1955859.1]. The study was overseen by an international multidisciplinary  
73 taskforce ([Holden MA et al., 2022](#)), including 20 members with expertise in OA and exercise  
74 from five different countries (Australia, Belgium, Denmark, United Kingdom, and United

75 States). The Consolidated Criteria for Reporting Qualitative Research checklist ([Tong,](#)  
76 [Sainsbury, & Craig, 2007](#)) and Consensus-Based Checklist for Reporting of Survey Studies  
77 ([Sharma et al., 2021](#)) was used to ensure complete and transparent reporting.

78

### 79 *Participants*

80 International multidisciplinary participants (including researchers/academics, healthcare  
81 professionals and exercise providers, and people with hip/knee OA) were recruited. Eligibility  
82 criteria for researchers/academics were either being first/last author on at least one systematic  
83 review or randomized controlled trial of exercise for hip/knee OA or having been invited to  
84 give a plenary or keynote presentation on exercise for hip/knee OA at an international  
85 conference in the last five years. Eligibility criteria for healthcare professionals and exercise  
86 providers were being registered to practice and having prescribed exercise for at least one  
87 patient with hip/knee OA per week over the past six months. Eligibility criteria for people with  
88 hip/knee OA were having experience participating in exercise for their OA.

89

90 Participants were recruited via advertisements on social media (e.g., Facebook, Twitter) as well  
91 as email advertisements to OARSI membership lists, and email invitations from taskforce  
92 members to their research and clinical networks. Those who were invited to participate were  
93 also encouraged to send the invitation to colleagues or contacts who may be eligible.

94

### 95 *Overview of procedures*

96 Participants completed the survey online using REDCap<sup>TM</sup> electronic data capture tools hosted  
97 at The University of Melbourne ([P. A. Harris et al., 2019](#); [Paul A Harris et al., 2009](#)). After eligibility  
98 screening, participants were asked to watch a 10-minute video created by the taskforce that  
99 summarized findings of our narrative review ([Holden et al., 2021](#)) before providing demographic

100 information as relevant (age, gender, discipline, country of residence, years of clinical or  
101 research experience and/or years with hip and/or knee OA symptoms). Participants were then  
102 presented with the seeding statement “*Practical resources to aid the implementation of*  
103 *therapeutic exercise for people with knee and hip osteoarthritis should...*” and were asked to  
104 provide up to 10 responses to the statement in an open-text box. Practical resources were  
105 defined for participants as “*anything that can be used in real life, to help put into place*  
106 *therapeutic exercise for hip and/or knee OA.*” The seeding statement was developed by the  
107 taskforce and pilot tested with 10 researchers/academics/clinical academics/healthcare  
108 professionals and people with hip/knee OA for feedback on the wording that was used.

109

#### 110 *Data analysis*

111 Data were downloaded from REDCap and organized using Excel (Microsoft Corporation,  
112 2020). Descriptive statistics (means, standard deviation [SD], frequency) were used to  
113 summarize participant characteristics. Responses to the seeding statement underwent a  
114 conventional approach to qualitative content analysis ([Hsieh & Shannon, 2005](#)). First, HM, JBL  
115 and HM reviewed all the statements to develop an initial coding framework. Then the data  
116 underwent rigorous review. Initially, this involved reviewing all responses for clarity and  
117 appropriateness. Those that were grammatically incorrect were rephrased and those that  
118 comprised multiple constructs were broken down into separate statements. Ambiguous  
119 statements and duplicate statements were removed. This process was undertaken by either BL,  
120 CB, PC, EG, CL, or AT. To overcome unintentional personal bias, a second taskforce member  
121 cross-checked all decisions made, with disagreements resolved between the two researchers.  
122 All remaining statements were then reviewed by HM and JBL (and checked by MH) and those  
123 that did not relate to the resource (defined as anything that can be used in real life, to help put  
124 into place therapeutic exercise for hip and/or knee OA) were also removed. Next, a coding



125 framework was optimized by re-reading responses and organizing them into categories of  
126 similar topics or concepts. Related categories were then grouped into broad domains. This  
127 coding framework of domains and categories was iteratively discussed and finalized by MH,  
128 HM, JBL, KB and BL before being checked for credibility by the taskforce.

129

## 130 **Results**

### 131 *Participant characteristics*

132 Of the 673 people who completed eligibility screening, 318 were eligible (Figure 1).  
133 Participants were academics or clinical researchers (n=135, 43%), healthcare professionals or  
134 exercise providers (n=139, 44%), and people with hip/knee OA (n=44, 14%) from 43 countries  
135 (most commonly Australia and the UK). Demographic characteristics of participants are  
136 described in detail elsewhere ([Holden MA et al., 2022](#)). Briefly, participants were from 43  
137 different countries (most commonly Australia [22%], the United Kingdom [12%], Canada  
138 [11%], and the United States [11%]), most healthcare professionals or exercise providers were  
139 physiotherapists (84%), most researchers or clinical academics has been researching OA for  
140 10 years or less (54%), and most people with OA had experiences symptoms for more than 10  
141 years (70%).

142

143 Most participants (n=202, 64%) provided at least one response to the seeding statement  
144 (median responses provided = 1; interquartile range 1). In total, 551 responses to the seeding  
145 statement were provided (Figure 1). From this, 395 [72%] were removed (332 [84%] were  
146 duplicates and were condensed/combined, 48 [12%] were ambiguous in meaning, and 15 [4%]  
147 were unrelated to exercise resources), leaving 156 to be used for further analysis. Finally, 72  
148 statements were included as they were of direct relevance to development of a toolbox. Nine  
149 overarching domains across 42 categories were developed, with between three to 8 categories

150 within each domain (Figure 2). The relationship between these nine domains and the 10  
151 recommendations for the delivery of exercise, established in our prior study ([Holden MA et al.,  
152 2022](#)), is shown in Table 1.

153

154 *1. Be easily accessible*

155 Participants believed that resources/components of a toolkit to support delivery of exercise  
156 should be easily accessible. This included being user-friendly and easy to use/navigate, using  
157 content/language that is easy to understand, and being available free of charge and in different  
158 languages. It was also perceived to be important that content/resources accounted for  
159 differences in culture, race, age, and gender.

160

161 *2. Be of high quality*

162 Participants believed it was important that resources/components were of a high quality,  
163 including having references to sources of information and/or evidence, being regularly  
164 updated, and being endorsed by an authoritative body.

165

166 *3. Be developed by, and for, stakeholders*

167 Participants believed resources/components should be developed by, and for consumers. This  
168 included being co-created with both those with hip and/or knee OA and healthcare  
169 professionals/exercise deliverers who provide care for people with hip and/or knee OA.

170

171 *4. Include different ways of delivering information*

172 Participants believed that resources/components should be delivered via a range of different  
173 methods, including online, paper/printed, as images or diagrams, via apps, videos, or virtual  
174 reality.

175

176       5. *Include different types of resources to support exercise and non-exercise components*  
177           *of self-management*

178 Participants believed a range of different types of information resources should be provided to  
179 support self-management of hip and/or knee OA. This included links to other external relevant  
180 information/resources, educational material, patient stories, and strategies and tips for other  
181 non-exercise management methods (including weight loss, a physically active lifestyle, and  
182 high-quality sleep).

183

184       6. *Include resources on recommended exercises and how to perform/progress them*

185 Participants believed that resources/components should include summaries of best available  
186 evidence regarding exercise for hip and/or knee OA, as well as current general  
187 recommendations for exercise and physical activity. It was also believed to be important to  
188 include links to tools for rating exercise intensity (e.g. “grade of difficulty” or “perceived  
189 exertion”) and provide access to exercise instructions. In addition, it was believed to be  
190 important to include links/access to a repository of exercise types/ideas and how to progress or  
191 modify them.

192

193       7. *Include tools to support motivation and track progress*

194 Participants believed it was important that resources/components include tools to help support  
195 patient motivation to exercise and to track progress. This included links to downloadable  
196 exercise logs/diaries, recommended methods for tracking and monitoring progress, example  
197 exercise goals, tools to measure symptoms, and tools to use for feedback/motivation (e.g.  
198 reward systems).

199

200       8. *Include a suite of options to support tailoring of the program to the individual*

201 Participants believed that it was important that resources/components include a range of tools  
202 to support tailoring of the exercise program to the individual. This included providing different  
203 options for remote (e.g. via apps, telehealth) and in-person delivery of an exercise program,  
204 and providing resources to support different types of exercise, using different types of exercise  
205 equipment, and delivery of exercise within different environments (e.g. home, clinic, gym).

206

207       9. *Facilitate access to professional and peer support*

208 Participants believed it was important that resources/components include information about  
209 how to access support if needed, such as providing ways in which to find qualified healthcare  
210 professionals to help problem solving, and including clinical indicators regarding when to seek  
211 help from a clinician. Providing access to peer interaction/support was also perceived to be  
212 important, including social media or other types of online peer support.

213

214 **Discussion**

215 From our international multi-disciplinary survey, important components of, and practical  
216 resources relevant for inclusion in, a toolkit to aid exercise delivery for people with hip and/or  
217 knee OA should: 1) be easily accessible; 2) be of high quality; 3) be developed by, and for,  
218 consumers; 4) include different ways of delivering information; 5) include different types of  
219 resources to support exercise and non-exercise components of self-management; 6) include  
220 resources on recommended exercises and how to perform/progress them; 7) include tools to  
221 support motivation and track progress; 8) include a suite of options to enable tailoring of the  
222 program to the individual, and; 9) facilitate access to support.

223

224 These findings complement our previously published evidence-informed recommendations for  
225 implementing best-practice therapeutic exercise for people with hip and/or knee OA ([Holden  
226 MA et al., 2022](#)) by providing guidance around practical resources to support the delivery of  
227 exercise (Table 1). For example, the recommendation from our previous study to ‘set goals’  
228 and ‘focus on exercise adherence’ can be broadly matched with our current finding that tools  
229 to support motivation and track progress are important practical resources relevant for an online  
230 exercise toolkit. The recommendations ‘consider the type and dose of exercise’ and ‘modify  
231 and progress exercise’ can be matched to our finding regarding the inclusion of resources on  
232 types of exercises and how to perform and progress them. Many of our toolkit  
233 recommendations are also reflected in international guidelines on exercise for people with OA  
234 ([Osthoff et al., 2018](#)), including that exercise should be individualised and that tools to support  
235 adherence should be included. In line with clinical guidelines for OA management, our  
236 recommendations also included having links to information and education regarding exercise  
237 as well as non-exercise management approaches ([Bannuru et al.](#); [Kolasinski et al.](#); [National  
238 Institute for Health and Care Excellence, 2022](#); [The Royal Australian College of General Practitioners](#)).

239

240 Many of our domains and categories for practical resources for delivery of exercise directly  
241 relate to barriers to exercise implementation among clinicians, including beliefs that exercise  
242 is outside their scope of practice ([Barton et al., 2021](#); [Briggs, Houlding, et al., 2019](#)), lack of  
243 exercise knowledge or resources, being unsure about how to appropriately prescribe an  
244 exercise program, and not knowing which information resources to provide to patients ([Barton  
245 et al., 2021](#); [Briggs, Houlding, et al., 2019](#); [Egerton, Nelligan, Setchell, Atkins, & Bennell, 2018](#)). Many  
246 of our domains and categories also relate to identified exercise barriers among those who have  
247 hip and/or knee OA, including lack of knowledge about what type or intensity of exercise is  
248 recommended, or not having access to printed exercise instructions or other resources ([Chou et](#)

249 [al., 2018](#); [Dobson et al., 2016](#)). As such, using our recommendations has the potential to  
250 overcome many of these barriers and help improve standardization of exercise in hip and/or  
251 knee OA, ensuring that current exercise provision aligns with recommendations provided in  
252 clinical guidelines ([Kåre B Hagen, Geir Smedslund, Nina Østerås, & Gro Jamtvedt, 2016](#)).

253

254 Our findings lay the foundation for the development of an exercise toolkit for hip and/or knee  
255 OA. For example, the recommendation that practical resources should be easily accessible  
256 suggests that it is important to host such a toolkit both online, as well as in hard-copy for those  
257 that prefer paper versions. However, further consideration regarding content and  
258 implementation is also required. For example, the identified domain to ‘include different types  
259 of resources to support self-management’ would need further consideration to establish exactly  
260 what resources should be included. People with OA seek information from a range of different  
261 sources ([Chou et al., 2018](#)), and there are numerous unique websites with information about OA,  
262 much of which is of poor-average quality ([K. E. Murray, Murray, O'Rourke, Low, & Veale, 2019](#)).  
263 Health apps for people with OA are also of a poor quality, and many have low potential for  
264 supporting behaviour change ([Bricca et al., 2022](#)). As such, it is important to decide exactly  
265 which sources of information to use, as well as how many different resources to include. The  
266 toolkit should be easy to use and navigate, and could be housed online by an international,  
267 trusted source of OA information – such as the OARSI website. However, the toolkit would  
268 likely require designated personnel to regularly review and update content to reflect current  
269 evidence and links to the most relevant resources/information, as well as translation into  
270 different languages. One of the suggested components for our toolkit was to facilitate access  
271 to support from qualified healthcare professionals and social/peer support networks. However,  
272 this would be difficult to include within a national or international toolkit. Methods for  
273 directing individual consumers to their local support networks will need further consideration.

274 Another potential challenge regarding creation and implementation of the toolkit will be how  
275 to best promote its use among healthcare providers and consumers across the world. Effective  
276 engagement with key stakeholders (e.g. government health authorities, decision makers, and  
277 community organisations) would also be needed to promote its uptake and use. Other studies  
278 ([Butler, 2007](#); [Keddem, Agha, Long, Werner, & Shea, 2017](#); [E. Murray, May, & Mair, 2010](#); [Thoele,  
279 Ferren, Moffat, Keen, & Newhouse, 2020](#)) have used multi-step processes to develop health  
280 toolkits to facilitate implementation of evidence-based interventions, including compiling  
281 resources and tools, creating new tools, and reflecting and refining the toolkit with consumers  
282 and stakeholders using a combination of quantitative and qualitative methods. This process  
283 will be a required next step necessary to build on the findings of this current study.

284

#### 285 *Comparison to other research*

286 Our findings within OA broadly reflect studies of other health conditions that have evaluated  
287 the most important components for toolkits to support implementation of exercise. For  
288 example, other studies that have evaluated the process of developing exercise toolkits for  
289 people with depression ([Glowacki et al., 2019](#)), cancer ([Dennett et al., 2022](#)), and diabetes ([C. A.  
290 Shields et al., 2013](#)) also included similar elements, such as being created with, and for,  
291 healthcare providers and consumers, including evidence-informed guidelines, individualisation  
292 of exercise, information on how to progress/regress exercise, how to monitor progress, links to  
293 information about other management methods, and access to support. The similarities between  
294 their findings and ours suggests that proposed practical resources to aid the delivery of exercise  
295 are broad and applicable across different health conditions, and thus our findings may have  
296 implications beyond OA.

297

298 Toolkits for OA management currently exist online ([Alberta Bone & Joint Health Institute, 2022](#);  
299 [Arthritis Society Canada, 2022](#); [Knowledge., 2022](#); [Osteoarthritis Action Alliance, 2022a](#); [SOPHE's](#)  
300 [Center for Online Resources & Education, 2022](#); [The College of Family Physicians of Canada, 2017](#)).  
301 However, none appear to meet all of the recommendations identified by our study. For  
302 example, many of these toolkits are only crafted for use by healthcare professionals, rather than  
303 also including components/resources for consumers with OA. Many do not include references  
304 to sources of information, are not available in different languages, do not always provide  
305 resources relating to recommended exercises and how to perform them, and often do not  
306 include tools to support motivation and track progress.

307

#### 308 *Research and clinical implications*

309 Nor only do the findings of this study lay the foundation for the design and development of an  
310 exercise toolkit for people with hip and/or knee OA (as discussed above), but may also provide  
311 useful insights for others developing toolkits for exercise-based interventions in other health  
312 conditions. Our findings also have implications beyond the development of a toolkit. Use of  
313 our recommendations in clinical practice may help standardise the delivery of exercise, help  
314 promote exercise adherence, and increase clinician confidence in exercise prescription. Our  
315 findings likely have relevance beyond OA, including other chronic health conditions where  
316 exercise is recommended, and implementation or delivery is a challenge. However, further  
317 research is required to evaluate the effects of a toolkit that is informed by our recommendations,  
318 and to explore the generalisability of our findings to other populations.

319

#### 320 *Strengths and limitations*

321 Our study has strengths and limitations. Strengths include the broad international sample with  
322 multiple end-users, including healthcare professionals and exercise providers who provide care



323 for people with OA, researchers in OA, and people with hip and/or knee OA. Our participants  
324 were diverse, representing 43 countries, and three stakeholder groups, increasing the  
325 generalizability of the toolkit content. We also utilized methods to improve credibility and  
326 trustworthiness of our findings, including iteratively developing a coding framework that was  
327 subsequently used for analysis, and having a researcher independently check refinement of  
328 statements. Our study also has limitations. Most of our healthcare provider participants were  
329 physiotherapists from Western countries where physiotherapy is well-accepted and accessible.  
330 This may limit the generalizability of our findings to those from countries without established  
331 rehabilitation providers and who may have different beliefs about resources for exercise  
332 implementation. We had a relatively low proportion of people with hip/knee OA, compared to  
333 clinicians and researchers, in our sample. Finally, our survey was in English only and was only  
334 available online, and therefore our findings may not be generalisable to non-English speaking  
335 regions or those with limited internet access.

336

337 In conclusion, our findings identified important components of, and practical resources to  
338 include within, a toolkit to aid delivery of exercise for people with hip/knee OA. These findings  
339 have implications for exercise providers and lay the foundation for the development of a toolkit  
340 to help ensure exercise provision aligns with current international recommendations.

341

## 342 **References**

343 Abbate, L. M., Jeffreys, A. S., Coffman, C. J., Schwartz, T. A., Arbeeve, L., Callahan, L. F., .  
344 . . Vina, E. (2018). Demographic and clinical factors associated with nonsurgical  
345 osteoarthritis treatment among patients in outpatient clinics. *Arthritis care &*  
346 *research, 70*(8), 1141-1149.

347 Alberta Bone & Joint Health Institute. (2022). Osteoarthritis toolkit. Retrieved from  
348 <https://toolkit.albertaboneandjoint.com/osteoarthritis/>

349 Arthritis Society Canada. (2022). Osteoarthritis Resources for Clinicians. Retrieved from  
350 [https://arthritis.ca/about-arthritis/arthritis-types-\(a-](https://arthritis.ca/about-arthritis/arthritis-types-(a-z)/types/osteoarthritis/osteoarthritis-resources-for-clinicians)  
351 [z\)/types/osteoarthritis/osteoarthritis-resources-for-clinicians](https://arthritis.ca/about-arthritis/arthritis-types-(a-z)/types/osteoarthritis/osteoarthritis-resources-for-clinicians)

352 Bannuru, R. R., Osani, M., Vaysbrot, E., Arden, N., Bennell, K., Bierma-Zeinstra, S., . . .  
353 Bhandari, M. (2019). OARSI guidelines for the non-surgical management of knee,  
354 hip, and polyarticular osteoarthritis. *Osteoarthritis and Cartilage*, 27(11), 1578-1589.

355 Barton, C., King, M., Dascombe, B., Taylor, N., de Oliveira Silva, D., Holden, S., . . .  
356 Shields, N. (2021). Many physiotherapists lack preparedness to prescribe physical  
357 activity and exercise to people with musculoskeletal pain: a multi-national survey.  
358 *Physical Therapy in Sport*, 49, 98-105.

359 Bricca, A., Pellegrini, A., Zangger, G., Ahler, J., Jäger, M., & Skou, S. T. (2022). The  
360 Quality of Health Apps and Their Potential to Promote Behavior Change in Patients  
361 With a Chronic Condition or Multimorbidity: Systematic Search in App Store and  
362 Google Play. *JMIR Mhealth Uhealth*, 10(2), e33168.

363 Briggs, A. M., Hinman, R. S., Darlow, B., Bennell, K. L., Leech, M., Pizzari, T., . . . Larmer,  
364 P. J. (2019). Confidence and Attitudes Toward Osteoarthritis Care Among the Current  
365 and Emerging Health Workforce: A Multinational Interprofessional Study. *ACR Open*  
366 *Rheumatology*, 1(4), 219-235.

367 Briggs, A. M., Houlding, E., Hinman, R. S., Desmond, L. A., Bennell, K. L., Darlow, B., . . .  
368 Larmer, P. (2019). Health professionals and students encounter multi-level barriers to  
369 implementing high-value osteoarthritis care: a multi-national study. *Osteoarthritis*  
370 *and Cartilage*, 27(5), 788-804.

371 Butler, K. M. (2007). The development of an evidence-based toolkit to prevent  
372 meningococcal disease in college students. *Family and Community Health*, 93-111.

373 Chou, L., Ellis, L., Papandony, M., Seneviwickrama, K. M. D., Cicuttini, F. M., Sullivan, K.,  
374 . . . Wluka, A. E. (2018). Patients' perceived needs of osteoarthritis health  
375 information: A systematic scoping review. *PLoS One*, 13(4), e0195489.

376 Christiansen, M. B., White, D. K., Christian, J., Waugh, E., Gakhal, N., King, L., . . .  
377 Webster, F. (2020). "It... doesn't always make it [to] the top of the list": Primary care  
378 physicians' experiences with prescribing exercise for knee osteoarthritis. *Canadian  
379 Family Physician*, 66(1), e14-e20.

380 Dennett, A. M., Tang, C. Y., Chiu, A., Osadnik, C., Granger, C. L., Taylor, N. F., . . . Barton,  
381 C. (2022). A Cancer Exercise Toolkit Developed Using Co-Design: Mixed Methods  
382 Study. *JMIR cancer*, 8(2), e34903.

383 Dobson, F., Bennell, K. L., French, S. D., Nicolson, P. J., Klaasman, R. N., Holden, M. A., . .  
384 . Hinman, R. S. (2016). Barriers and facilitators to exercise participation in people  
385 with hip and/or knee osteoarthritis: Synthesis of the literature using behavior change  
386 theory. *American journal of physical medicine & rehabilitation*, 95(5), 372-389.

387 Egerton, T., Nelligan, R. K., Setchell, J., Atkins, L., & Bennell, K. L. (2018). General  
388 practitioners' views on managing knee osteoarthritis: a thematic analysis of factors  
389 influencing clinical practice guideline implementation in primary care. *BMC  
390 rheumatology*, 2(1), 30.

391 Fransen, M., McConnell, S., Harmer, A. R., Van der Esch, M., Simic, M., & Bennell, K. L.  
392 (2015). Exercise for osteoarthritis of the knee. *Cochrane Database of Systematic  
393 Reviews*, 1, CD004376. doi:<http://dx.doi.org/10.1002/14651858.CD004376.pub3>

394 Fransen, M., McConnell, S., Hernandez-Molina, G., & Reichenbach, S. (2014). Exercise for  
395 osteoarthritis of the hip. *The Cochrane Library*.

396 Glowacki, K., Arbour-Nicitopoulos, K., Burrows, M., Chesick, L., Heinemann, L., Irving, S.,  
397 . . . Scott, A. (2019). It's more than just a referral: development of an evidence-  
398 informed exercise and depression toolkit. *Mental Health and Physical Activity*, *17*,  
399 100297.

400 Hagen, K. B., Smedslund, G., Østerås, N., & Jamtvedt, G. (2016). Quality of Community-  
401 Based Osteoarthritis Care: A Systematic Review and Meta-Analysis. *Arthritis care &*  
402 *research*, *68*(10), 1443-1452. doi:10.1002/acr.22891

403 Hagen, K. B., Smedslund, G., Østerås, N., & Jamtvedt, G. (2016). Quality of community-  
404 based osteoarthritis care: a systematic review and meta-analysis. *Arthritis care &*  
405 *research*, *68*(10), 1443-1452.

406 Harris, P. A., Taylor, R., Minor, B. L., Elliott, V., Fernandez, M., O'Neal, L., . . . Duda, S. N.  
407 (2019). The REDCap consortium: Building an international community of software  
408 platform partners. *J Biomed Inform*, *95*, 103208. doi:10.1016/j.jbi.2019.103208

409 Harris, P. A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., & Conde, J. G. (2009).  
410 Research electronic data capture (REDCap)—a metadata-driven methodology and  
411 workflow process for providing translational research informatics support. *Journal of*  
412 *biomedical informatics*, *42*(2), 377-381.

413 Holden MA, Metcalf B, Lawford BJ, Hinman RS, Boyd M, Button K, . . . KL, B. (2022).  
414 Recommendations For The Delivery Of Therapeutic Exercise For People With Knee  
415 And/Or Hip Osteoarthritis. An International Consensus Study From The Oarsi  
416 Rehabilitation Discussion Group. *Osteoarthritis & Cartilage*,  
417 <https://doi.org/10.1016/j.joca.2022.10.009>.

418 Holden, M. A., Button, K., Collins, N. J., Henrotin, Y., Hinman, R. S., Larsen, J. B., . . .  
419 Thoma, L. M. (2021). Guidance for Implementing Best Practice Therapeutic Exercise

420 for Patients With Knee and Hip Osteoarthritis: What Does the Current Evidence Base  
421 Tell Us? *Arthritis care & research*, 73(12), 1746-1753.

422 Hsieh, H.-F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis.  
423 *Qualitative health research*, 15(9), 1277-1288.

424 Hunter, D. J., & Bierma-Zeinstra, S. (2019). Osteoarthritis. *The Lancet*, 393(10182), 1745-  
425 1759. doi:10.1016/S0140-6736(19)30417-9

426 Hunter, D. J., Schofield, D., & Callander, E. (2014). The individual and socioeconomic  
427 impact of osteoarthritis. *Nature Reviews Rheumatology*, 10(7), 437-441.

428 Initiative., U. S. B. a. J. (2020). The Burden of Musculoskeletal Diseases in the United States.  
429 . Retrieved from [www.boneandjointburden.org](http://www.boneandjointburden.org)

430 Keddem, S., Agha, A. Z., Long, J. A., Werner, R. M., & Shea, J. A. (2017). Creating a toolkit  
431 to reduce disparities in patient engagement. *Medical care*, 55, S59-S69.

432 Knowledge., T. R. E. a. (2022). Welcome to My Knee. Retrieved from  
433 <https://myknee.trekeeducation.org/>

434 Kolasinski, S. L., Neogi, T., Hochberg, M. C., Oatis, C., Guyatt, G., Block, J., . . . Felson, D.  
435 (2020). 2019 American College of Rheumatology/Arthritis Foundation Guideline for  
436 the Management of Osteoarthritis of the Hand, Hip, and Knee. *Arthritis &*  
437 *Rheumatology*, 72(2), 149-162.

438 Lebret, T., Coloby, P., Descotes, J. L., Droupy, S., Geraud, M., & Tombal, B. (2010).  
439 Educational tool-kit on diet and exercise: survey of prostate cancer patients about to  
440 receive androgen deprivation therapy. *Urology*, 76(6), 1434-1439.

441 Murray, E., May, C., & Mair, F. (2010). Development and formative evaluation of the e-  
442 Health Implementation Toolkit (e-HIT). *BMC Med Inform Decis Mak*, 10(1), 1-8.

443 Murray, K. E., Murray, T. E., O'Rourke, A. C., Low, C., & Veale, D. J. (2019). Readability  
444 and Quality of Online Information on Osteoarthritis: An Objective Analysis With  
445 Historic Comparison. *Interact J Med Res*, 8(3), e12855. doi:10.2196/12855

446 National Institute for Health and Care Excellence. (2022). *Osteoarthritis in over 16s:  
447 diagnosis and management*. London Retrieved from  
448 <http://www.nice.org.uk/Guidance/CG177>

449 Network, G. C. (2018). Global burden of disease study 2017 (GBD 2017) results. *Seattle,  
450 United States*.

451 Osteoarthritis Action Alliance. (2022a). OACareTools - Healthcare Providers. Retrieved  
452 from <https://oaaction.unc.edu/oacaretools/oacaretools-healthcare-providers/>

453 Osteoarthritis Action Alliance. (2022b). Provider Education Toolkit. Retrieved from  
454 <https://oaaction.unc.edu/resource-library/modules/>

455 Osthoff, A.-K. R., Niedermann, K., Braun, J., Adams, J., Brodin, N., Dagfinrud, H., . . .  
456 Hurkmans, E. (2018). 2018 EULAR recommendations for physical activity in people  
457 with inflammatory arthritis and osteoarthritis. *Annals of the Rheumatic Diseases*,  
458 77(9), 1251-1260.

459 Power, J. D., Cott, C. A., Badley, E. M., & Hawker, G. A. (2005). Physical therapy services  
460 for older adults with at least moderately severe hip or knee arthritis in 2 Ontario  
461 counties. *The Journal of rheumatology*, 32(1), 123-129.

462 Puig-Junoy, J., & Zamora, A. R. (2015). *Socio-economic costs of osteoarthritis: a systematic  
463 review of cost-of-illness studies*. Paper presented at the Seminars in arthritis and  
464 rheumatism.

465 Safiri, S., Kolahi, A.-A., Smith, E., Hill, C., Bettampadi, D., Mansournia, M. A., . . . Almasi-  
466 Hashiani, A. (2020). Global, regional and national burden of osteoarthritis 1990-2017:

467 a systematic analysis of the Global Burden of Disease Study 2017. *Annals of the*  
468 *Rheumatic Diseases*, 79(6), 819-828.

469 Sharma, A., Minh Duc, N. T., Luu Lam Thang, T., Nam, N. H., Ng, S. J., Abbas, K. S., . . .  
470 Kwok, J. (2021). A consensus-based checklist for reporting of survey studies  
471 (CROSS). *Journal of General Internal Medicine*, 36(10), 3179-3187.

472 Shields, C., Dillman, C., Fowles, J., Perry, A., Murphy, R., & Dunbar, P. (2009). The  
473 Physical Activity and Exercise Tool-kit: Effectiveness of a new resource for diabetes  
474 educators. *Canadian Journal of Diabetes*, 33(3), 213.

475 Shields, C. A., Fowles, J. R., Dunbar, P., Barron, B., McQuaid, S., & Dillman, C. J. (2013).  
476 Increasing diabetes educators' confidence in physical activity and exercise  
477 counselling: the effectiveness of the “physical activity and exercise toolkit” training  
478 intervention. *Canadian Journal of Diabetes*, 37(6), 381-387.

479 SOPHE's Center for Online Resources & Education. (2022). SOPHE Toolkit to Support  
480 Remote Delivery of Arthritis-Appropriate Evidence-Based Interventions. Retrieved  
481 from <https://elearn.sophe.org/healthy-aging-toolkit-sophe>

482 The College of Family Physicians of Canada. (2017). Osteoarthritis Tool. Retrieved from  
483 [https://www.cfpc.ca/CFPC/media/Resources/Education/OATOOL\\_FINAL\\_Sept14\\_E](https://www.cfpc.ca/CFPC/media/Resources/Education/OATOOL_FINAL_Sept14_ENG.pdf)  
484 [NG.pdf](https://www.cfpc.ca/CFPC/media/Resources/Education/OATOOL_FINAL_Sept14_ENG.pdf)

485 The Royal Australian College of General Practitioners. (2018). *Guideline for the*  
486 *management of knee and hip osteoarthritis*. East Melbourne, VIC: RACGP

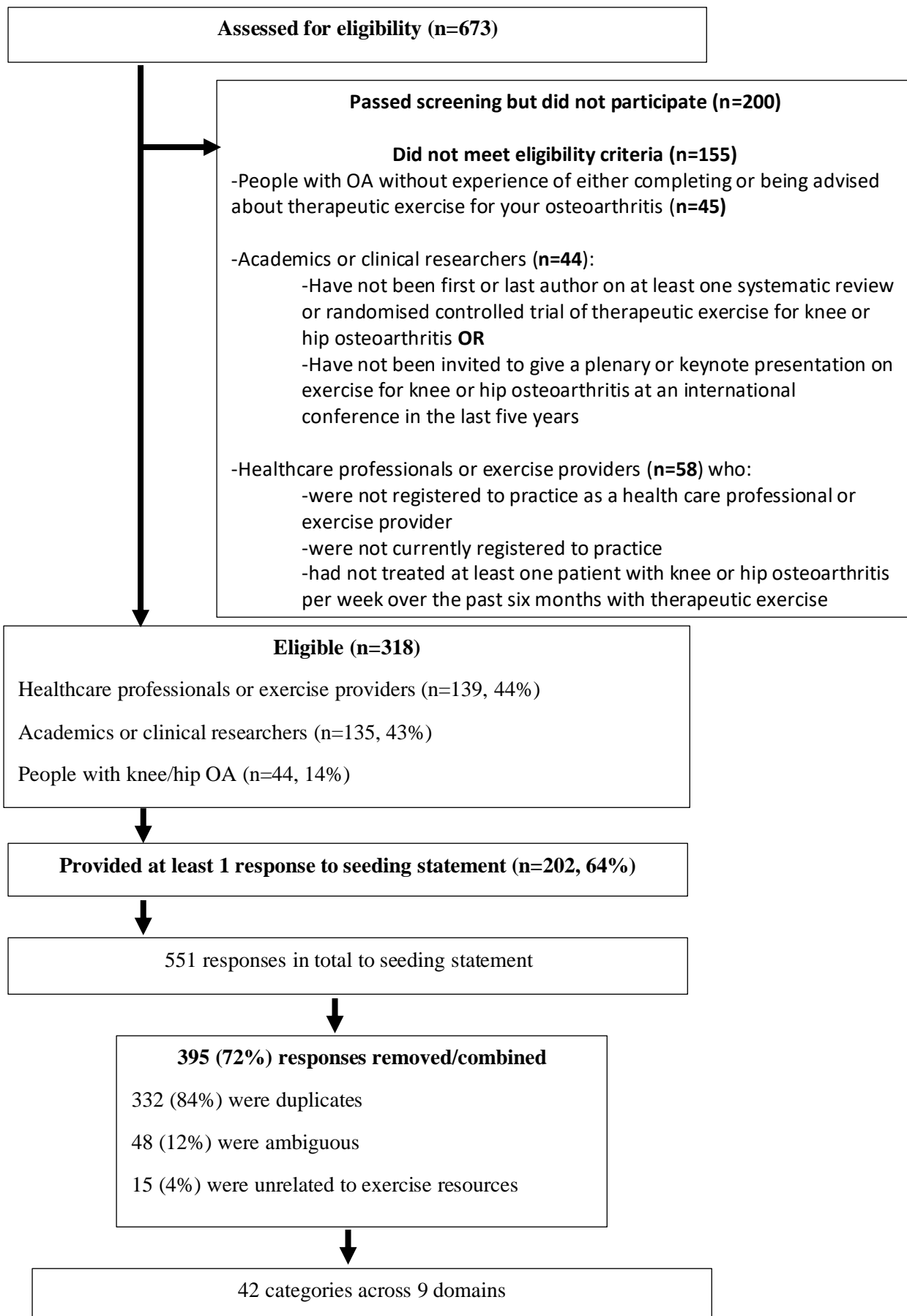
487 Thoele, K., Ferren, M., Moffat, L., Keen, A., & Newhouse, R. (2020). Development and use  
488 of a toolkit to facilitate implementation of an evidence-based intervention: a  
489 descriptive case study. *Implementation Science Communications*, 1(1), 1-12.

490 Tong, A., Sainsbury, P., & Craig, J. (2007). Consolidated criteria for reporting qualitative  
491 research (COREQ): a 32-item checklist for interviews and focus groups. *International*  
492 *Journal for Quality in Health Care*, 19(6), 349-357.

493 Torio, C. M., & Moore, B. J. (2016). National inpatient hospital costs: the most expensive  
494 conditions by payer, 2013: statistical brief# 204.

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1

2 **Figure 1. Overview of study flow and data analysis**



### 1. Be easily accessible:

- User-friendly and easy to navigate, irrespective of comfort level with use of technologies
- Available in, or easily translatable to, different languages
- Free of charge
- Easy to understand content/resources (accounting for different levels of health literacy)
- Content/resources that account for cultural, racial, age and gender differences



### 2. Be of high quality:

- References to sources of information/content (e.g., societies such as OARSI, NICE, NHS, or reference specific research studies)
- Regularly updated
- Endorsed by an authoritative body



### 3. Be developed by, and for, stakeholders:

- Co-created with people with OA and healthcare professionals
- Instructions/advice for healthcare professionals about **how** to implement exercise (eg monitor progress, test fitness, tailor exercise to individuals), as well as resources to use with patients
- Information/resources that healthcare professionals can refer to and people with OA can use themselves



### 4. Include different ways of delivering information:

- Printable materials
- Digital materials
- Written materials
- Audio commentary
- Phone apps
- Images
- Videos
- Virtual reality



### 5. Include different types of resources to support self-management:

- Weblinks to other relevant information/resources
- Educational materials
- Patient stories
- Strategies and tips for other management methods (weight loss, a physically active lifestyle, good sleep)



### 6. Include resources on recommended exercises and how to perform/progress them:

- Summaries of best available evidence and current recommendations (eg ACSM physical activity recommendations)
- Tools for rating "grade of difficulty" or "perceived exertion" of exercise
- Instructions on how to perform exercises
- Demonstrations about how to perform exercises
- Repository of exercise types/ideas, including variations for progression



### 7. Include tools to support motivation and track progress:

- Online/downloadable exercise logs/diaries
- Methods of tracking progress and monitoring the condition/symptoms
- Example exercise goals to aim for
- Questionnaires/tools to monitor pain and function
- Tools for feedback/award systems (eg stickers or electronic "medals" and words of affirmations)



### 8. Include a suite of options to enable tailoring of the program to the individual:

- Remote exercise delivery options (eg app-based, telehealth technologies)
- In-person exercise delivery options
- Different types of exercise
- Varying availability of exercise equipment
- Different exercise/training environments (eg gym, outdoors, home)



### 9. Facilitate access to professional and peer support:

- Access to a qualified healthcare professional to help with problem solving/overcoming barriers
- Clinical indicators about when to seek help from healthcare professionals
- Information about who people can contact should they have trouble
- Access to social interaction/peer support (eg social media, online support)

4 **Figure 2. Domains and categories related to practical resources to aid implementation of exercise for**  
5 **people with osteoarthritis applicable to the development of an online toolbox**

6 OARSI = Osteoarthritis Research Society International; NICE = National Institute for Health Care  
7 Excellence; NHS = National Health Service; ACSM = The American College of Sports Medicine

**Table 1. Practical resources that support the recommendations for implementing exercise in people with hip/knee osteoarthritis**

	Recommendations for delivery of exercise for people with OA ( <a href="#">Holden MA et al., 2022</a> )									
Categories of practical resources	Consider exercise in the context of living with osteoarthritis and pain	Undertake a comprehensive baseline assessment with follow-up	Set goals	Consider the type of exercise	Consider the dose of exercise	Modify and progress exercise	Individualise exercise	Optimise the delivery of exercise	Focus on exercise adherence	Provide education about osteoarthritis and the role of exercise
1. Be easily accessible	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Be of high quality	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3. Be developed by, and for, consumers	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4. Include different ways of delivering information	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5. Include different types of resources to support exercise and non-exercise components of self-management	✓									✓
6. Include resources on recommended exercises and how to perform/progress them				✓	✓	✓	✓	✓		
7. Include tools to support motivation and track progress			✓						✓	
8. Include a suite of options to enable tailoring of the program to the individual				✓	✓	✓				
9. Facilitate access to support	✓									✓