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Author/s:
Hinman, RS;Hall, M;Comensoli, S;Bennell, KL

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Exercise & Sports Science Australia (ESSA) updated Position Statement on exercise and physical activity for people with hip/knee osteoarthritis.

Rana S Hinman[1] (BPhysio(Hons), PhD), Michelle Hall[1] (BSc (Hons), MSc, PhD), Sarah Comensoli[2] (BExScRehab, MBA), Kim L Bennell[1] (BAppSc(physio), PhD)

[1]Department of Physiotherapy, The University of Melbourne, Melbourne, VIC, Australia

[2]BJC Health, Sydney, NSW, Australia

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Correspondence and reprints:

Prof Rana Hinman ranash@unimelb.edu.au

Twitter handle: @HinmanRana

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Abstract

This Position Statement is an update to the existing statement. It is intended for all health practitioners who manage people with hip/knee osteoarthritis (OA). It synthesises the most recent evidence (with a focus on clinical guidelines and systematic reviews) for exercise in people with hip/knee OA, and provides guidance to practitioners about how best to implement exercise in clinical practice. Clinical practice guidelines for hip/knee OA advocate physical activity and exercise as fundamental core components of evidence-based management. Research evidence indicates that exercise can reduce joint pain, increase physical function, and improve quality of life in hip/knee OA, and that a range of exercise types (both supervised and unsupervised) may be beneficial. Exercise dosage should be guided by the principles of the American College of Sports Medicine. As people with OA experience many barriers to exercise, practitioners should take an active role in monitoring and promoting adherence to exercise in order to optimise therapeutic benefits.

Background

Osteoarthritis (OA) is considered a disease of the whole joint organ, arising from complex biological processes that involve cartilage, bone, muscles, ligaments, synovium, and the meniscus. There is currently no cure for OA. Thus, clinical guidelines from Australia and around the world emphasise non-invasive strategies as core treatments, with the aim of reducing symptoms, improving function and quality of life, and delaying the need for joint replacement surgery.[1] Exercise is strongly advocated for all people with hip/knee OA because of proven benefits with respect to pain, physical function, and quality of life.[1] This Position Statement is an update to the existing statement,[2] given the increasing burden of hip/knee OA and the large expansion of research evidence that has occurred over the past 10 years. It is intended for all health practitioners who manage people with hip/knee OA, including exercise practitioners, general practitioners, physiotherapists and lifestyle coaches.

Over the past 30 years, the number of people with OA has increased by 113%, with 528 million people across the world affected by OA in 2019 compared to 248 million in 1990.[3] Knee OA accounts for 61% of prevalent cases whilst hip OA accounts for 6%, and the remaining proportion occurs at the hand or other sites.[3] In Australia, around 2.2 million people (1 in 11) had OA at any joint in 2017-18.[4] Although OA can affect people at any age, its prevalence increases dramatically from middle age, such that 1 in 5 Australians aged over 45 years have OA.[4] In 2015–16, OA cost the Australian health system around $3.5 billion,[4] representing 28% of disease expenditure on musculoskeletal conditions. Much of this OA expenditure is driven by costly joint replacement surgeries. Alarmingly, the incidence of total knee replacement and total hip replacement for OA is estimated to rise by 276% (from 42,920 procedures in 2013) and 208% (from 25,945 procedures in 2013), respectively, by 2030.[5]

Osteoarthritis disproportionately affects women,[3] with 3 in 5 people with OA in Australia being female.[4] The cardinal sign is joint pain, which is often accompanied by swelling and stiffness.

67 Together these problems can limit activity, restrict participation, impair sleep, contribute to fatigue
68 and/or depressed or anxious mood, and ultimately result in loss of independence and reduced quality
69 of life. More than 1 in 2 Australians with OA suffer from moderate to very severe pain and Australians
70 with OA are 2.1 times more likely to describe their health as 'poor' compared to those without OA.[4]
71 Clinical presentation may differ somewhat between hip and knee OA. At time of presentation, people
72 with hip OA tend to be younger and have experienced a shorter duration of symptoms compared to
73 knee OA.[6] People with hip OA tend to have more problems with restricted range of joint motion,
74 whilst knee joint instability (buckling and giving way) occurs more freqently with knee OA.[6]
75 Compared to knee OA, people with hip OA often describe pain as intense or rapidly progressing from
76 mild to severe.[6]
77
78 The aim of this updated Position Statement is to provide practitioners with contemporary evidence-
79 based guidance for prescribing safe and effective exercise for adults with hip/knee OA. The evolving
80 evidence base continues to support exercise recommendations in the prior Position Statement, but
81 new clinical trials, systematic reviews and meta-analyses allow recommendations to be refined. In
82 addition, emerging evidence about the importance of physical activity warrants the inclusion of
83 recommendations specific to physical activity. Increased research into the barriers to exercise also
84 justifies the inclusion of recommendations about how best to maximise exercise adherence.
85
86 **Boundaries of evidence**
87 Relative to knee OA, there have been fewer clinical trials evaluating exercise for hip OA. Findings
88 from studies in people with knee OA cannot necessarily be generalised to those with hip OA given
89 differences in prevalence, prognosis, epigenetics, pathophysiology, anatomical and biomechanical
90 factors, clinical presentation, pain, and current practice.[6] Thus, recommendations for exercise for hip
91 OA are typically based on a smaller evidence base and uncertainty around the magnitude of benefits
92 (relative to knee OA). Additionally, there are some types of exercise (such as flexibility, balance and

93 yoga) that have a smaller evidence base compared to others (such as resistance training) and often
94 the trials are of lower quality. There is also currently limited evidence about which subgroups of
95 people with hip/knee OA respond best to exercise. Finally, incomplete descriptions of exercise
96 interventions upon which current clinical guideline recommendations are based[7] can make it
97 challenging for replication in clinical practice.
98
99 **Role of exercise in hip/knee OA**
100 Physical activity and exercise are considered core components of evidence-based management for all
101 people with hip/knee OA.[1] Physical activity may be considered to be “any bodily movement produced
102 by skeletal muscles that results in energy expenditure”.[8] Thus, physical activity refers to all planned
103 and incidental movement, including that occurring during daily living, leisure, sport, transport, and
104 occupational tasks. Exercise is "a subset of physical activity that is planned, structured, and repetitive”
105 with the goal of improving or maintaining physical fitness.[8]
106
107 Like most adults, people with hip/knee OA are not sufficiently physically active. A systematic review
108 showed that only 48% of people with knee and hip OA achieve ≥7,000 steps per day,[9] and data from
109 the Osteoarthritis Initiative (USA) has revealed that over 50% of men and nearly 80% of women with
110 or at risk of knee OA do not perform at least 150 minutes of moderate-vigorous physical activity each
111 week.[10] Insufficient physical activity may lead to loss of muscle strength, which may exacerbate OA
112 symptoms, reduce functional capacity, and may increase risk of structural changes within the joint. It
113 is also possible that loss of muscle strength contributes to declines in physical activity in the first
114 instance. Low quality evidence suggests that lower knee extensor muscle strength is associated with
115 incident symptomatic and radiographic knee OA,[11] leading to speculation that increasing knee
116 extensor muscle strength in adults may help to prevent knee OA. In people with established knee OA,
117 lower knee extensor strength is associated with an increased risk of worsening pain and declining
118 physical function (e.g. walking ability) but not necessarily structural changes.[12]

119

120 Insufficient physical activity can contribute to co-morbidities in people with hip/knee OA. Two out
121 of three people with OA (at any joint) suffer from at least one other chronic comorbid medical
122 condition,[13] with the most common including hypertension, dyslipidaemia, back pain, thyroid
123 conditions, and depression. Multimorbidity is common, with around a quarter of people with OA
124 having three or more comorbidities.[13] In addition, overweight and obesity are well-established risk
125 factors for both incidence and progression of knee OA.[14] People with OA (at any joint) are at
126 increased risk of death due to cardiovascular disease,[15] and there is increasing evidence that
127 symptomatic or radiographic knee OA increases risk of death from any cause.[16] In the USA, if even
128 20% of the inactive knee OA population were instead active, modelling suggests that 95,920 cases of
129 cancer, 222,413 of cardiovascular disease, and 214,725 of diabetes mellitus could potentially be
130 averted.[17]

131

132 Sedentary behaviour and insufficient physical activity can lead to an increased risk of falls and falls-
133 related injuries, particularly for people with knee OA.[18] The odds of falling increases with an
134 increasing number of hip/knee joints affected by symptomatic OA. Compared to people without knee
135 or hip OA, people with 1 symptomatic OA hip/knee joint have 53% higher odds of falling, those with
136 2 OA hip/knee joints have 74% higher odds, and those with 3–4 OA hip/knee joints have 85% higher
137 odds.[19] Impaired balance, muscle weakness, presence of comorbidities, and increasing number of
138 symptomatic joints, are all risk factors for falls in people with knee OA.[20]

139

140 **Types of exercise**

141 Many different types of exercise can help people with hip/knee OA, with typical benefits including
142 improvements in joint pain, physical function, and health-related quality of life,[21] lasting up to 6
143 months following cessation of a defined program.[22] Whilst there are far fewer clinical trials of
144 exercise in hip OA (relative to knee OA), a Cochrane review in hip OA reported immediate

145 improvements in pain and physical function with land-based exercise which were still evident 3-6
146 months later.[23] Limited but emerging evidence suggests that an exercise intervention can reduce the
147 need for arthroplasty by 44% 6 years later in people with hip OA[24] and by 68% at 2 years in knee
148 OA.[25] Exercise may be supervised (either individually part of a group), performed unsupervised, or
149 via a combination of methods, however clinical benefits appear to be greater when exercise is
150 supervised by a clinician.[26] Land-based and water-based exercise are both effective,[22] noting that
151 water-based exercise can harness the benefits of buoyancy, thereby reducing joint impact and
152 presenting a viable exercise option for those who find land-based exercise too difficult or painful.
153 Whilst meta-analyses show that exercise effect sizes on pain and physical function are generally only
154 small to moderate in magnitude, the benefits achieved with exercise appear to be similar to those
155 observed with common analgesic drugs.[27] It is also important to note the many other health benefits
156 of exercise over and above analgesics, many of which will be reviewed below.
157
158 *Aerobic (cardiovascular) exercise*
159 Aerobic exercise (typically involving walking, running, cycling, and/or swimming) is aimed at
160 increasing cardiovascular fitness. Low-impact aerobic exercise that is gentle and places less stress on
161 the joint (such as walking, cycling, or swimming) may be best for people with hip/knee OA rather
162 than high-impact activities that involve running and/or jumping. Walking is a popular choice of
163 aerobic exercise, given it is readily implemented by most people with hip/knee OA, can be done on
164 a variety of surfaces, settings, or environments (treadmill, indoors, outdoors, in the water) and may
165 be undertaken independently or in a group. For people with knee OA, practitioners should aim for a
166 daily walking goal of at least >6,000 steps/day, as research shows this may prevent declines in
167 walking speed and physical functioning during daily tasks in the future.[28] Aerobic exercise improves
168 cardiovascular fitness in people with hip/knee OA and inflammatory arthritis,[29] and improves both
169 pain and physical function in people with knee OA.[26] Aerobic walking combined with resistance
170 training over 18 months can lead to modest amounts of weight loss (approximately 1.8 kgs or 2% of

171 body weight) in people with knee OA and overweight/obesity.[30] Weight loss of 5-10% of body weight
172 is required for pain reduction[31] and dietary interventions should be combined with exercise to
173 maximise weight loss.[30] Of all types of exercise for hip/knee OA, aerobic exercise may be the best
174 for improving objective physical performance (e.g., gait and walking parameters) and is one of the
175 most effective for reducing joint pain, at least in the short-term.[21] For people with hip/knee OA who
176 have overweight or obesity, aerobic exercise may be particularly appropriate to assist with weight
177 loss.
178
179 *Resistance (strength) training*
180 For hip/knee OA, resistance training should target the lower limb muscle groups appropriate for the
181 affected joint(s) (e.g., hip flexors, extensors, abductors, adductors, and rotators, knee flexors and
182 extensors, calf muscles) and based on individual impairments.[32] In people with hip/knee OA, meta-
183 analyses confirm that resistance training increases muscle strength[29] and improves pain, physical
184 function, objective measures of performance, and quality of life.[21, 26] For people with knee OA,
185 resistance training of both hip and quadriceps muscles improves walking function more than
186 quadriceps training alone.[33] Current evidence also suggests that resistance training is the most
187 beneficial type of exercise for improving mental health and depressive symptoms in people with knee
188 OA,[34] compared to aerobic, mind-body and stretching exercise. A recent high-quality RCT suggests
189 that high-intensity strength training (75-90% of 1 repetition maximum) does not reduce knee pain or
190 compressive forces compared to low-intensity strength training (30-40% of 1 repetition maximum)
191 or attention control over 18 months in people with knee OA.[35]
192
193 *Flexibility (stretching) exercise*
194 The goal of flexibility exercises is to improve joint range of motion and muscle pliability. In people
195 with knee OA, two low quality clinical trials with small sample sizes suggest stretching exercises in
196 isolation may relieve pain compared to no exercise.[36] Limited evidence suggests that stretching, when

197 combined with resistance training or aerobic exercises, does not change flexibility in people with
198 hip/knee OA.[29] Given the more robust evidence base and broader beneficial effects of aerobic and
199 resistance exercise, practitioners should prioritise these forms of exercise in preference to stretching
200 for hip/knee OA.
201
202 *Neuromotor (neuromuscular) exercise*
203 Neuromotor exercise, typically performed in functional weightbearing positions, incorporates motor
204 skills such as balance, coordination, agility, and proprioception. Research evaluating effects of
205 neuromotor exercise in hip/knee OA is scarce and it is not clear if neuromotor performance can be
206 improved with neuromotor exercise.[29] Given that balance exercises can reduce the rate of falls in
207 older adults by 23%,[37] inclusion of balance exercises in an exercise program may be warranted in
208 people with hip/knee OA who have a history of falls or where increased falls risk is identified. It
209 should also be noted that yoga and Tai Chi (below) incorporate elements of neuromotor exercise.
210
211 *Mind-body exercise*
212 Mind-body exercise, such as yoga and Tai Chi, combines body movement, mental focus, and
213 controlled breathing with the goals of increasing strength, balance, flexibility, and overall health.
214 Research evidence, often from trials of low quality, suggests that mind-body exercise may be one of
215 the most effective exercise types for improving self-reported physical function and for reducing joint
216 pain in hip/knee OA.[21] Specifically, Tai Chi has been shown to have moderate benefits on pain,
217 physical function, and stiffness in people with OA (any joint).[38] The evidence around yoga is
218 somewhat conflicting, with a systematic review suggesting there is only very low quality evidence it
219 improves pain, physical function, and stiffness (compared to exercise and non-exercise controls)[39]
220 and a new RCT in 212 people with knee OA[40] showing an unsupervised online yoga program
221 improved physical function but not knee pain (compared to online education).
222

223 **Recommendations for physical activity**

224 For adults and older adults, the World Health Organization[41] recommends at least 150-300 minutes
225 of moderate intensity aerobic physical activity per week, or at least 75-150 minutes of vigorous
226 intensity activity, along with muscle strengthening (on at least two days) for additional health
227 benefits. In people with knee/hip OA, doing some physical activity is better than none and health
228 benefits can be gained even if recommendations are not met. People with hip/knee OA should be
229 advised to start with small amounts of physical activity, and gradually increase the frequency,
230 intensity, and duration over time.[41] For people with hip/knee OA who find it difficult to achieve
231 World Health Organization recommendations, practitioners should, at a minimum, aim for at least 45
232 minutes of moderate-vigorous physical activity each week, as research in adults with lower extremity
233 symptoms (pain, aching or stiffness) shows this amount predicts improved or sustained high physical
234 function over two years.[42]

235

236 The European League Against Rheumatism has recognised that public health physical activity
237 recommendations may be challenging for people with hip/knee OA to achieve, and developed ten
238 recommendations (Table 1).[43] These emphasise that all healthcare providers have a responsibility to
239 promote general physical activity (consistent with public health recommendations) as an integral
240 component of care throughout the OA disease course. When clinicians advise people with arthritis to
241 be more physically active, patients are more likely to increase physical activity levels.[29] In partnership
242 with the patient, practitioners should develop a patient-centred plan to increase weekly participation
243 in moderate-vigorous physical activity. Increased sedentariness is related to poorer physical function
244 in adults with knee OA,[44] independent of the amount time spent participating in moderate-vigorous
245 physical activity. Thus, practitioners should encourage adults with knee OA to reduce time spent in
246 sedentary activities and postures as much as possible.

247

248 **Recommendations for prescription of exercise**

249 Exercise for hip/knee OA should follow American College of Sports Medicine (ACSM) 'FITT-VP'
250 exercise prescription principles.[45] In people with knee OA, strength gains are maximised when
251 exercise is prescribed according to ACSM recommendations for resistance training.[46] In people with
252 hip OA, exercise only reduced pain when exercise dose meets the ACSM recommendations for
253 cardiorespiratory fitness, muscular strength, and flexibility.[47] The FITT-VP principles incorporate:
254 Frequency (how often to exercise), Intensity (how hard to exercise), Time (how long to exercise for),
255 Type (mode of exercise), Volume (total amount of exercise), and Progression (how to progress the
256 exercise program). Table 2 summarises these principles for cardiovascular, resistance, flexibility, and
257 neuromotor exercise in healthy adults. These principles also apply to all people with hip/knee OA
258 (any age or disease severity).
259
260 Any exercise program prescribed (including the dosage) should be within the capability of the
261 individual to perform. It is quite normal for people with hip/knee OA to experience some joint
262 discomfort with exercise, particularly with exercise in weight-bearing postures. Exercise practitioners
263 may be afraid of aggravating pain, with data suggesting that 83% of accredited exercise physiologists
264 always or most of the time prescribe 'nonpainful' exercise for knee OA.[48] There is no evidence that
265 exercising with tolerable levels of joint pain is harmful, and in fact, exercise programs where pain is
266 allowed/encouraged may be more beneficial for reducing pain in the short-term in chronic
267 musculoskeletal disorders compared to pain-free exercises.[49] It is possible that exercising with some
268 pain or discomfort may help reduce fear avoidance, kinesiophobia and catastrophising, and/or
269 increase self-efficacy. Whilst exercising, joint pain should remain within a range that is considered
270 tolerable by the individual and practitioners may wish to advise their patients to consider exercising
271 at a time of day when pain levels are typically at their lowest. Monitoring pain during exercise with
272 simple numerical rating or visual analog scales can be helpful.[50] Although each individual should
273 determine an "acceptable" level for themselves, pain scores up to 5 out of 10 are tolerable with
274 exercise in hip/knee OA.[50] An increase in joint pain immediately after exercise is also not uncommon,

275 however research shows that there is a decrease in the magnitude of acute exercise-induced pain flares
276 with increasing numbers of exercise sessions.[51] A simple method to judge whether a person with
277 hip/knee OA has ‘overdone’ it with exercise is that any increase in joint pain (from normal pain
278 levels) should return to normal levels within 24 hours after exercise.[50] If pain remains elevated beyond
279 this timeframe, the practitioner should review the exercise program and modify it accordingly.
280
281 It is important practitioners are aware of the potential for exercise to aggravate pain at other sites,
282 such as the lower back or foot. Hip OA is often accompanied by low back pain, and it is important to
283 ensure that any exercise program for the hip does not flare up problems in the lower back. Thus,
284 practitioners should always be cognisant of the potential for aggravating joint pain (at the site of OA
285 or other body areas) when choosing exercise postures/positions, amount of resistance and the dosage
286 of exercise programs. Programs should always be individualised and tailored to the unique needs and
287 presentation of the individual.
288
289 It is also important for practitioners to recognise and consider the heterogeneity of the hip/knee OA
290 population when selecting an exercise program/modality. Individuals typically present with their own
291 unique OA-related problems (e.g. while one person may experience knee instability, another may
292 have problems getting in and out of the car) and personal goals of exercise therapy (e.g. one person
293 may want to get stronger whilst another may want to be able to walk for longer distances). Thus, an
294 exercise program/modality that is appropriate for a 75 year old retired woman with knee OA and
295 obesity may not be suitable for a 50 year old active man with hip OA who is employed as a carpenter
296 (for example).
297
298 **Maximising exercise adherence**
299 Clinical benefits of exercise in hip/knee OA may decrease over time if exercise adherence declines
300 and promoting exercise adherence is a clinical challenge frequently encountered by exercise

301 practitioners.[52] A complex variety of factors can influence exercise participation,[53] including
302 physical, personal, social, and environmental. Barriers to exercise in people with hip/knee OA can
303 include joint pain and physical disability, negative exercise experiences, inaccurate beliefs and
304 misinformation, lack of motivation, and inadequate professional support. In particular, barriers
305 related to environmental context and resources (e.g. financial costs of exercise, accessibility, weather,
306 equipment),[53] beliefs about the consequences of exercise, and beliefs about capability to exercise are
307 all important for the practitioner to understand and consider (Table 3). Table 4 outlines a checklist of
308 factors that practitioners should consider with an individual with hip/knee OA when prescribing an
309 exercise program, to assist identifying those at increased risk of poor exercise adherence. It is
310 important that practitioners monitor adherence at each consultation. Although there is no gold
311 standard method for monitoring adherence, practitioners may use verbal questioning or ask the person
312 to record participation/adherence in a calendar, log-book, mobile app, diary, or via a wearable device
313 (e.g., steps per day).
314
315 Table 3 outlines suggested strategies that practitioners may consider if they encounter problems with
316 exercise adherence. Practitioner support is important to assist people to participate in, and adhere, to
317 exercise.[53] Some evidence suggests “booster sessions” with a practitioner, or a behavioural graded
318 approach (where activity is gradually increased in a time-contingent manner) may help.[54] A strong
319 and positive therapeutic alliance can improve pain outcomes from treatments, including exercise, for
320 chronic musculoskeletal pain.[55] Agreeing on exercise goals, provision of clear communication and
321 positive feedback, showing genuine interest, trust in the practitioner, and a feeling of self-
322 empowerment, along with developing individualised care plans, may all help promote adherence. It
323 is also important that clinicians carefully consider the language they use when describing OA and the
324 role of exercise in its management to their patients,[56] as terms such as ‘wear and tear’ and ‘bone on
325 bone’ can reinforce misconceptions about OA, perpetuate beliefs that individuals have little control

over symptoms, and discourage individuals from engaging in effective self-management strategies such as exercise.

Special considerations: safety of exercise in hip/knee OA

People with hip/knee OA (and sometimes, healthcare providers) may fear that exercise is not safe for their joint. However, research suggests that low-impact (e.g., cycling, swimming, walking) exercise (lasting 3 to 30 months) is safe for most older adults with knee pain and/or OA.[57] Mild adverse events do occur, in up to a quarter of exercise participants, which usually involve muscle soreness and/or temporary or mild increases in joint pain.[57] Whilst the current evidence base is uncertain regarding the safety of high-impact exercise,[22] a cohort study suggested that running was associated with improvements in knee pain without increasing structural progression in people over 50 years with knee OA.[58]

Based on the current limited (often low-quality) research available, it appears that exercise is safe for articular cartilage. Magnetic resonance imaging studies suggests that knee joint loading exercise is not harmful for articular cartilage in people at risk of, or with, established knee OA, although the quality of evidence is low.[59] These findings are supported by research showing that exercise does not increase the concentration of molecular biomarkers related to cartilage turnover and inflammation, suggesting exercise is not harmful.[60] Data suggest that up to 10,000 steps/day of physical activity does not increase the risk of progression on magnetic resonance imaging in people with knee OA,[22] although there may be an increased risk with ≥10,000 steps/day. Whilst running has some immediate effects on knee cartilage, the effects appear to be only transient (possibly due to natural fluid dynamics) and moderate evidence suggests that running does not lead to new cartilage lesions.[61] Collectively, the current evidence does not show that exercise increases the risk of structural progression in people with established knee OA.

352 Given the high rates of comorbidity observed in people with hip/knee OA,[13] exercise practitioners
353 are encouraged to screen individuals before prescribing an exercise program to identify those at risk
354 for exercise-related cardiovascular events. People at risk should receive medical clearance before
355 undertaking moderate-vigorous intensity exercise or increasing exercise program intensity. Some
356 individuals may not be able to safely participate in exercise until the relevant medical condition has
357 been managed adequately by an appropriate healthcare professional. Practitioners may wish to use
358 the Exercise & Sports Science Australia Adult Pre-Exercise Screening System
359 (https://www.essa.org.au/Public/ABOUT_ESSA/Pre-Exercise_Screening_Systems.aspx) and/or the
360 ACSM Preparticipation Screening Algorithm for exercise screening purposes.[46]
361
362 **Using technology to assist exercise management**
363 Digital health technologies provide opportunities to enhance care of people with knee OA. Consumer-
364 based wearable devices[62] and smart phone-based interventions including apps and text messaging[63]
365 can be effective at increasing amounts of physical activity in adults. Wearable devices offer exercise
366 practitioners and people with hip/knee OA an accessible and inexpensive method for monitoring
367 markers of physical activity. In particular, steps per day can be readily measured and may be used by
368 practitioners to establish a baseline level of activity and/or determine agreed physical activity goals
369 with an individual. Access to exercise practitioners can be an issue for many people with hip/knee
370 OA and digital/telehealth models of care[64-67] may help overcome barriers. A recent systematic review
371 evaluated the efficacy of remotely-delivered exercise interventions for knee OA including via online,
372 telephone, SMS, or app-based methods.[68] Although the evidence is limited, studies that used an active
373 comparator suggested that magnitude of pain relief with remote exercise programs is similar to in-
374 person care. Thus, practitioners may wish to consider telehealth models of service delivery for people
375 who find it difficult to attend for in-person care. Research in people with musculoskeletal problems
376 also suggests that web- and app-based systems for exercise programming/prescription can improve
377 adherence to unsupervised home-based exercise, compared with providing paper-based exercise

instructions.[69, 70] Digital interventions (SMS, telephone, web or apps) also appear to be effective for improving exercise adherence in people with musculoskeletal conditions at 1-6 months follow-up.[71]

Assessment and monitoring outcomes of exercise

The Osteoarthritis Research Society International recommends that exercise interventions be monitored using outcomes that assess domains of pain, physical function, and patient global assessment. Practitioners may select from a variety of patient-reported outcomes and/or physical performance measures to choose a measure that is suitable to the context of their practice and is feasible for administration (e.g., time/space/resources required) (Table 5). Pain may be readily measured via self-report using simple patient-reported outcome measures such as a numerical rating scale or a visual analogue scale. Although physical function may also be measured via self-report using disease-specific questionnaires, the Osteoarthritis Research Society International has recommended a set of performance-based tests of physical function for people with hip/knee OA that are suited for clinical purposes (https://oarsi.org/research/physical-performance-measures), including the 30 second chair test, 40 m fast-paced walk, stair climb test, timed up and go test, and/or the 6 minute walk.

Summary

Hip and knee OA are a leading cause of global disability burden and exercise is a core component of recommended care for people with OA. Many people with hip/knee OA are insufficiently physically active to meet public health physical activity recommendations for good health. Exercise can improve joint pain, physical function, and quality of life and may delay the need for joint replacement surgery. People with hip/knee OA should be encouraged to be as physically active as possible in order to minimise the risk of functional decline over time. There are many barriers to exercise for people with hip/knee OA. Exercise practitioners have a responsibility to monitor and discuss exercise adherence

403 with their clients, as well as suggest strategies to overcome obstacles to adherence in order to optimise

404 outcomes from exercise.

405

406

407

408 **Table 1: Physical activity recommendations from the European League Against Rheumatism[43]**

409 **for people with hip/knee osteoarthritis (OA).**

Recommendations
1. Promoting physical activity, consistent with general physical activity recommendations, should be an integral part of standard care throughout the disease course.
2. All healthcare providers should take responsibility for promoting physical activity and should cooperate, including making necessary referrals, to ensure that people receive appropriate physical activity interventions.
3. Physical activity interventions should be delivered by healthcare providers competent in their delivery.
4. Healthcare providers should evaluate the type, intensity, frequency, and duration of an individual's actual physical activity via standardised methods to identify which can be targeted for improvement.
5. General and disease-specific contraindications for physical activity should be identified and taken into account.
6. Physical activity interventions should have clear personalised aims, which should be evaluated over time, preferably via both subjective and objective measures (including self-monitoring when appropriate).
7. General and disease-specific barriers and facilitators related to performing physical activity, including knowledge, social support, symptom control, and self-regulation should be identified and addressed.
8. Where individual adaptations to general physical activity recommendations are needed, these should be based on a comprehensive assessment of physical, social, and psychological factors including fatigue, pain, depression, and disease activity.
9. Healthcare providers should plan and deliver physical activity interventions that include behaviour change techniques of self-monitoring, goal setting, action planning, feedback, and problem solving.
10. Healthcare providers should consider different modes of delivery of physical activity in line with people's preferences.

410
411

Table 2: American College of Sports Medicine[45] FITT-VP principles for exercise prescription applicable to people with hip/knee osteoarthritis.

	Aerobic (cardiovascular) exercise	Resistance (strengthening) exercise	Flexibility (stretching) exercise	Neuromotor (neuromuscular) exercise
Frequency	≥3 days/week Spreading exercise sessions across 3-5 days/week may be optimal.	Beginner: at least 2 days/week Experienced: frequency is secondary to training volume; choose frequency according to personal preference	≥2-3 days/week (daily may be optimal)	≥2–3 days/week
Intensity	Moderate (40-59% HRR) and/or vigorous (60-89% HRR).	Beginner: 60-70% of 1-RM (moderate to hard) for strength Older &/or sedentary beginners: beginners: 40-50% of 1-RM (very light to light) for strength Experienced: ≥80% of 1-RM (hard to very hard) for strength ≤50% of 1-RM (light to moderate) for muscular endurance 20-50% of 1-RM in older people to improve power	Stretch to point of feeling tightness or slight discomfort.	Not yet determined.
Time	30-60 mins/day (≥150 mins/week) of moderate intensity or 20-60 min/day (≥75 mins/week) of vigorous intensity or combination	No specific duration	Hold static stretch for 10-30 secs. Older people: holding for 30-60 secs may confer greater benefit.	≥20–30 mins/day

	Performed in one continuous session/day or in multiple bouts of ≥10 mins.			
Type	Regular, purposeful exercise involving major muscles and performed in a continuous or intermittent in nature. Activities with low joint stress (e.g., walking, cycling, swimming, aquatic exercise) may be most appropriate in people with osteoarthritis.	Multi-joint exercises affecting more than one muscle group and targeting agonist and antagonist muscle groups. Single-joint and core exercises may be included. Exercise equipment and/or body weight can be used.	Flexibility exercises for each of the major muscle–tendon units. Static flexibility, dynamic flexibility, ballistic flexibility and, proprioceptive neuromuscular facilitation may be appropriate.	Exercises involving motor skills (e.g., balance, agility, coordination and gait), proprioceptive training and multifaceted activities (eg, Tai Chi and yoga) are recommended for older people.
Volume	≥500–1000 MET/min/week. Increasing step counts by ≥2000 steps/day to reach a daily step count ≥7000 steps per day is beneficial.	1-3 sets (of 8-12 repetitions) to improve strength and power. Single set of 10-15 repetitions in older, beginners may be effective for strength. ≤2 sets of 15-20 repetitions for muscular endurance.	Total of 90 secs of discontinuous flexibility exercise per joint.	Not yet determined.
Progression	Gradual progression by adjusting duration, frequency, and/or intensity until the desired exercise goal (maintenance) is attained.	Gradual progression of greater resistance and/or more repetitions/set and/or increasing frequency.	Not yet determined.	Not yet determined.

HRR=heart rate reserve; MET= metabolic equivalents; 1-RM= one-repetition max

Table 3 Common barriers to exercise in hip/knee osteoarthritis (OA) informed by behaviour change theory[53] and suggested strategies to improve exercise adherence.

Barrier to adherence	Potential solutions
Knowledge: insufficient or incorrect knowledge about OA and its prognosis; inadequate instruction about how to perform exercise or dosage; inadequate understanding about safety of exercise in OA and its benefits.	Education & information: may include information about OA, its prognosis, causes and role of exercise relative to other management strategies. Open discussion: provide opportunity for patient to ask questions and express doubts regarding the benefits of exercise for OA and have any misconceptions adressed. Ask the patient what their understanding of OA is and correct any misinformation. Exercise instruction: provide clear demonstrations and instructions about correct execution of exercises along with the presecribed dosage. Verbal and written instructions should be provided (consider diagrams, photos or videos).
Capability: belief that not capable of exercise because of OA symptoms (e.g., pain, stiffness, fatigue) or because of comorbidities or excess body weight.	Education and information: reassurance that all people with hip/knee OA are capable of exercise, that exercise can benefit many comorbidities along with OA symptoms and that radiographic OA severity does not dictate exercise capability. Individualise exercise: offer exercise options using a shared decision-making process. Individualise physical activity advice and prescribe tailored exercise programs according to the capability of the patient. Use a graded approach, gradually building up the exercise program and dosage slowly as the patient gains confidence in their capability to exercise. Consider aquatic exercise for people with overweight/obesity to reduce load on joints whilst exercising. Monitor: check patient is confident to safely and independently undertake the exercise program unsupervised. Consider supervised individual or group sessions if confidence with unsupervised exercise is low.
Consequences: belief that exercise will not be effective for managing OA symptoms; belief that exercise and physical activity will be harmful for the hip/knee joint.	Education and information: discuss benefits of exercise, including for pain, physical function, strength and ability to participate in meaningful activities. Discuss safety of exercise for OA, including that exercise is not harmful for the joint or articular cartilage. Monitor: pain during exercise and reassure patient that tolerable levels of joint pain are OK. Teach patient how to recognize pain flares from exercise and what

	to do should this occur. Review and revise the exercise program if joint pain is being aggravated to unacceptable levels. Monitor the impact of the exercise program on any other comorbid health conditions and particularly, any other other pain sites. Adjust the program if pain at other sites is being aggravated.
Environmental context/resources: circumstances that discourage exercise and physical activity such as weather conditions, access to exercise facilities/equipment, financial costs of exercise, physical environment, transport and parking.	Open discussion: proactively ask patients about their potential environmental barriers to exercise adherence and brainstorm potential solutions should these be encountered. Discuss what exercise equipment is readily available to the patient or is feasible for purchase and devise a suitable exercise program. Consider costs and willingness to attend exercise facilities/classes etc when devising an exercise program and ensure there are no transport or financial barriers to access. Consider home-based or local exercise options that are free of charge or low cost whenever possible. Monitor: when reviewing patient progress, ask specifically about any barriers to adherence encountered and offer solutions.
Intentions: lacks motivation to exercise or belief that already sufficiently physically active.	Plan: encourage patients to plan when to undertake exercise. Consider using a calender or diary to schedule time for exercise and physical activity. Realistic: ensure the exercise program is feasible for the patient, considering time-constraints, lifestyle, occupation and other demands. Accountability and monitoring: regular review by the clinician to monitor exercise progress and adherence. Encourage self-monitoring of exercise adherence and physical activity (e.g., log books, exercise diaries, using wearables to monitor daily steps). Encourage exercise with a friend or as part of a group class. Preferences: ask about patient pereferences for exercise and choose exercises and physical activities that the person is most likely to enjoy.
Memory: forgets to exercise.	Cueing and reminders: encourage patient to pair exercise performance with an established behaviour, such as undertaking exercise after eating breakfast. Use visual reminders (such as exercise instructions pinned to the wall) or digital tools to prompt exercise (e.g., email reminders, SMS alerts, mobile apps). Monitoring: encourage using a calendar, diary, log book, wearables, or mobile apps to track exercise adherence.

Reinforcement: fails to see any benefits from exercise or frustrated with slow progress.	Positive reinforcement: encourage patient to reward self for exercise adherence. Review exercise adherence and praise patient for adhering to the exercise program. Goal-setting: with the patient, set realistic and meaningful short-term and long-term goals related to physical function or a meaningful task/activity. Encourage patient to focus on these, rather than just joint pain. Education and information: about the likely time-frames for benefits of exercise, noting these may be different depending on the goal. Monitoring and feedback: measure changes in pain, physical function, strength and physical activity as appropriate and feedback to patient positive improvements as they occur. Monitor progress against individual goals and be sure to set new goals as goals are achieved. Encourage self-awareness and self-monitoring of improvements in symptoms and other meaningful outcomes.

Table 4: Adapted checklist[72] for exercise practitioners to screen for individual factors that might indicate potential for reduced adherence with exercise in people with hip/knee osteoarthritis.

Any unchecked item may require intervention:
☐ Does the person have accurate knowledge about osteoarthritis and the importance of exercise, including its benefits?
☐ Does the person have realistic expectations about when to anticipate experiencing benefits from exercise?
☐ Does the person show signs of forgetfulness?
☐ Does the person have any comorbidities that may make exercising difficult?
☐ Does the person understand how to perform the exercises, including how often and at what dosage?
☐ Does the person have equipment (if required), clothing, and footwear suitable for exercise?
☐ Does the person understand that some joint pain is normal with exercise, and possibly for a short time after?
☐ Does the person have concerns about their ability to exercise or how exercise will affect their joint?
☐ Will the person find it difficult to accommodate the exercise routine into their regular life (e.g considering work and/or caring responsibilities)?
☐ Will the person find it financially challenging to participate in the prescribed program?
☐ Has the person had a bad experience with exercise before or previously found it aggravated their problems?

Table 5: Selected exercise assessment and monitoring strategies for people with hip/knee osteoarthritis (OA).

	Measure	Description	Clinical interpretation
Self-reported pain			
	Visual analogue scale	A mark is placed on a 100 mm line with terminal anchors of 'none' to 'extreme' to indicate the severity of joint pain felt	Minimal clinically important difference in people with OA estimated at 18mm.[73] Cut points have been recommended:[74] 0-4mm: no pain 5-44mm: mild pain 45-74mm: moderate pain 75-100mm: severe pain
	Numeric rating scale	A number from 0 to 10 along a scale is ticked to indicate the severity of joint pain felt	Minimal clinically important difference for people with OA estimated at 1.8 units.[73]
Self-reported composite measures (including pain and physical function)			
	Knee Injury and Osteoarthritis Outcome Score (KOOS)	Knee-specific questionnaire that assesses five outcomes: pain, symptoms, activities of daily living, sport and recreation function, and knee-related quality of life	Minimal clinically important differences have not been calculated for patients with knee OA undergoing non surgical, non-drug treatment but the scale developers consider a score of 8-10 to be appropriate.[75] Minimal detectable change for each subscale has been reported as:[76] -pain=15.1 -symptoms=10.5 -activities of daily living=9.6 -sports/recreation=15.5 -quality of life=16.2 An online score calculator can be found at https://orthotoolkit.com/koos/
	Hip disability and osteoarthritis outcome score (HOOS)	Hip-specific questionnaire that assesses five outcomes: pain, symptoms, activities of daily living, sport and recreation function, and hip-related quality of life	Minimal clinically important differences have not been calculated for patients with hip OA. An online score calculator can be found at https://orthotoolkit.com/hoos/

	Western Ontario and McMaster Universities (WOMAC) OA index	A questionnaire with subscales assessing pain, stiffness and difficulties with activities of daily living (physical function)	The minimal clinically important difference for the physical function subscale is 6 non-normalized units in people with knee OA undergoing non-surgical treatment.[77]
Self-reported global assessment			
	Global rating of change	A 5-point Likert scale with response options of much worse, slightly worse, no change, slightly better, much better since beginning exercise.	Can be used to quickly evaluate patient's perceived change in status from one category to the next
Self-reported exercise adherence			
	Number of exercise sessions	Use a diary or log book to tick which days exercise were performed over the prior week, fortnight or month	No threshold level of optimal exercise adherence has been determined
Muscle strength			
	30-second chair stand test*	Maximum number of chair stand repetitions possible in 30 seconds	Based on 3 different methods to assess the minimal clinically important difference in patients with hip OA undergoing physical therapy, an increase of greater than or equal to 2.0, 2.6, and 2.1 repetitions were associated with a major improvement on a global rating scale.[78]
	One-repetition maximum	Using hand-held or isokinetic dynamometry to assess maximal muscle strength of lower limb muscles particularly quadriceps, hamstrings and hip abductors	No consensus in the literature and dependent on equipment used, patient set up, patient age, muscle group, force value reported.[79]
Gait and walking performance			

	40m fast-paced walk test*	A fast-paced walking test that is timed over 4 x 10m for a total of 40m	Change scores of 0.2 to 0.3 m/s were associated with a minimum clinically important improvement in patients with hip OA undergoing manual therapy and exercise.[78] A score less than 1.0 m/s is a well-established risk factor for poor future health outcomes in older people.[80]
	Timed up and go*	Time to rise from a standard armchair, walk as quickly but as safely as possible for a distance of 3m, turn, walk back to the chair and sit down	Change scores of 0.8 to 1.4 seconds were associated with a minimally clinically important improvement in patients with hip OA undergoing physical therapy.[78] A score more than 14 seconds is associated with poor health outcomes including falls in older adults.[81]
	6-minute walk test*	The maximum distance that can be walked over a 6-min interval	'Slight' or 'more' improvement at 26-weeks post knee joint replacement surgery was associated with a minimal clinically important change between 26-55 m.[82] A score less than 350 m is associated with future poor health outcomes in older adults.[83]
	Stair climb test*	Time in seconds it takes to ascend and descend a flight of stairs.	There are no normative data for the nine-step stair climb test. Normative values for the 12-step stair test in a healthy population over the age of 60 are 8.72 (standard deviation 2.58) seconds for men and 10.22 (SD 2.61) seconds for women.* Minimal clinically important differences are not available for OA populations.
Balance performance			
	Step test	One foot is repeatedly placed on top of a 7.5cm step and returned back down to the ground as many times as able in 15 sec.	Normative value for those aged 60-79 years = 16 repetitions.[84]
	Single or tandem leg stance test	Performed with eyes open or closed, the test times how	If unable to stand for more than 5 seconds with eyes open, then at greater risk of injury from a fall.

		long the person can stand on one leg or in tandem leg stance with the hands on the hips	Normative values by age group and gender are found at: https://www.sralab.org/rehabilitation-measures/single-leg-stance-or-one-legged-stance-test
	Functional reach	Measures the maximum distance an individual can reach forward without losing balance while standing in a fixed position	In elderly male adults:[85] 25cm or more – low risk of falls 15-25cm – falls risk 2x greater than normal 15cm or less – falls risk 4x greater than normal Unable to reach- falls risk 8x greater than normal

*These tests make up the set of physical performance measures for hip and knee osteoarthritis recommended by the Osteoarthritis Research Society International (https://oarsi.org/sites/default/files/docs/2013/manual.pdf)

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