Physical activity considerations among people with knee and hip osteoarthritis

Physical activity, in particular low-impact aerobic activity and resistance training, is recognized as a critical component of knee and hip osteoarthritis (OA) management. Several randomized controlled trials and systematic reviews show physical activity interventions have a beneficial impact on decreasing pain and increasing physical functioning, at least over short-term periods. Low-impact aerobic activity and resistance training are now widely recommended for people with OA. Physical activity prescription for this population, however, is quite complex given the potential musculoskeletal and neuromuscular deficits that could be present at proximal and distal joints. Thus, while some people with knee and hip OA may be able to engage in the recommended levels of physical activity as defined, modification of physical activity regimens may be warranted for others. In this article, we discuss the scientific evidence regarding physical activity among persons with knee and hip OA, general considerations that should be considered regarding physical activity programs for people with knee and hip OA, and musculoskeletal factors that may warrant modification of physical activity regimens. Lastly, we discuss why the acquisition of physical activity programs may be challenging for people with arthritis and what healthcare providers can do to help foster physical activity for their patients.

KEYWORDS: arthritis ▪ exercise recommendations ▪ physical activity

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Physical activity is widely recognized as an important aspect of optimal health and well-being. People who live active lifestyles have a lower risk of mortality and morbidity than persons who are sedentary [1,2,101]. Being physically active decreases one's risk of mortality by approximately 30% compared with inactive individuals [101]. Physical activity can range from low-impact activities such as swimming and dancing to high-impact activities such as running and jumping. Activities can be performed at a high intensity for short or long periods of time; activities can be performed a few days a week or every day of the week.

Physical activity is recognized as an important component in the management of knee and hip osteoarthritis (OA) [3–11]. In 2008, the Centers for Disease Control and Prevention (CDC) released updated physical activity guidelines for people with arthritis [101]:

- Persons should engage in a total of 150 min of moderate exercise/week;
- Activity should be enough to raise the heart rate and break a sweat;
- Activity should be low impact;
- Short durations of activity (e.g., 10 min) are acceptable;
- Resistance training should be performed 2 days/week, with enough resistance employed to the muscle to result in muscle overload.

The questions that will be answered in this article are: How did we get to these recommendations? What outcomes are expected with physical activity programs? What, if anything, needs to be taken into consideration when designing physical activity programs for people with arthritis? The purpose of this article is also to: present an evidence-based review of current physical activity guidelines for persons with knee and hip OA; discuss considerations of physical activity prescription for people with arthritis based on scientific evidence and clinical opinion; and develop a rationale as to why initiating and maintaining physical activity programs is difficult for people with OA, and review some strategies that may help people with OA engage in physical activity.

Prior to discussing physical activity considerations for OA, it is important to clarify terms related to physical activity. Physical activity is defined as any bodily movement produced by skeletal muscles that result in energy expenditure beyond resting expenditure [12]. Exercise is a subset of physical activity defined as "planned, structured, and repetitive bodily movement done

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to improve or maintain one or more components of physical fitness" [12]. While we acknowledge that important differences exist between these terms, for the purposes of this review, we do not distinguish between the terms. Rather, we use the broad definition of 'physical activity' that incorporates 'exercise'.

Methods

The electronic databases of MEDLINE, PubMed and the Cochrane Library were searched from 1995 to the present using a combination of text and indexed terms to identify articles related to the following areas: physical activity (exercise, strengthening, physical activity, aerobic activity and walking); osteoarthritis (osteoarthritis, knee, tibiofemoral, patellofemoral, hip); and outcomes (pain, function, walking, performance, disability). Articles were selected for Part A of this review if they were systematic reviews, meta-analyses and randomized controlled trials. Reviews, observational and randomized controlled trials were selected for Part B. Reference sections of papers selected for Part A and Part B were reviewed for additional references.

Where possible in this review, we include citations for statements that are evidence based. Statements that are based on clinical opinion are not referenced with citations and include phrasing indicating 'clinical opinion' or 'limited evidence.'

Part A: Physical activity for persons with OA: what does the evidence show?

Over the past decade, empirical evidence examining the effects of physical activity among persons with OA has increased substantially. There are a number of well-conducted randomized controlled trials and several systematic reviews to guide evidence-based clinical recommendations regarding physical activity. In a 2008 Cochrane meta-analysis of physical activity among persons with knee or hip OA, Fransen and McConnell [5] reported that of 32 randomized controlled trials with over 3600 participants, land-based physical activity (e.g., aerobic and/or strengthening exercises) had a small-to-moderate effect at decreasing pain and improving function (e.g., walking, climbing stairs and going shopping), with other reviews showing similar findings [3,4,6–11,13,14]. The strength of evidence behind these findings is very good, with most authors concluding the beneficial effects of land-based physical activity programs are supported by level 1 research evidence (see **Box 1**). In addition, the systematic reviews show that resistance strength training has at least a small effect on increasing muscle strength, decreasing pain and improving function [3,5,7–11,13–15]. The strength of evidence for resistance training is also level 1.

The systematic reviews, however, showed substantial heterogeneity among the randomized controlled trials. Sample recruitment varied, with the majority of participants recruited from clinic populations [5,15]. The type of exercise intervention varied widely and included focused quadriceps strengthening, general aerobic conditioning (mostly walking programs) and complex, comprehensive programs including overall muscle strengthening, balance and manual therapy. Two randomized control trials examined Tai Chi [16,17]. Treatment dosage also varied with monitored sessions ranging from 30 min [18,19] to 90 min [20]. The number of monitored exercise sessions and treatment durations were also highly variable [5]. The effects of low versus high intensity activity (i.e., cycling) was examined in one study with the authors reporting similar effects with both interventions [21,22]. This high degree of heterogeneity limits the ability to generate evidence-based recommendations regarding the optimal type, frequency or duration of physical activity programs. Nonetheless, the published recommendations do suggest low-impact activity for persons with knee OA is an important nonpharmacological treatment intervention, with the evidence to date generally supporting walking activity and strength training.

Many questions remain regarding the effects of aquatic exercise. There are only a few randomized controlled trials of this type of exercise among persons with arthritis and the quality of these studies is lower than the land-based exercise programs [23]. Of the limited evidence currently available, aquatics seems to have a beneficial effect at decreasing pain among persons with hip OA at least over the short term, but does not currently support a long-term effect on pain and function [23].

The literature examining the effects of physical activity specifically among persons with hip OA is more limited than knee OA. Many of the trials of physical activity among persons with hip OA include people with knee OA, and it is difficult to discern the outcomes of these trials between persons with hip and knee OA. One meta-analysis shows a beneficial effect of physical activity specifically among persons with hip OA [24]; however, others suggest data pertaining to the efficacy of physical activity programs among persons with hip OA are limited [10,25]. Nonetheless, general guidelines for physical

management of persons with hip OA are similar to those of persons with knee OA [10,25], but the level of evidence warrants continued research and monitoring in this area.

In summary, while the evidence continues to grow and support the notion that people with arthritis should maintain physically active lifestyles, there remains very limited empirical evidence regarding the type, duration or frequency of activity that is optimal. There is, however, a potential bias in the published studies towards people who are motivated to engage in physical activity programs and who have less severe disease and comorbidity. Thus, the notion that 'all' people with OA can engage in 'similar' physical activity programs could be reaching too far – or at least other factors may need to be taken into consideration. Below we review some general considerations for physical activity programs for persons with knee and hip OA, as well as biophysiological, biomedical and behavioral factors that may need to be taken into consideration.

Part B: OA & physical activity

General considerations

Low-impact aerobic and strengthening activities are currently the recommended activities of choice for persons with OA, and it is recommended that these activities be initiated at a low intensity, for short durations and progressed as tolerated [101]. General soreness in muscles after an activity is acceptable. Joint pain during or after exercise lasting longer than 2 h could indicate detrimental forces to the joint and should be avoided [26]. This does not, however, necessarily indicate the activity should be avoided, but prevailing clinical opinion is that the mode (type), duration (length of time), intensity (amount of effort) and frequency of the activity may need to be altered or decreased to allow the person to engage in the activity without joint symptoms.

Walking is the aerobic activity most widely studied and recommended [101]. People should be encouraged to wear flat, supportive walking shoes [27,28], and seek consultation from a physical therapist or podiatrist regarding bracing and/or orthotic inserts if warranted, although the evidence supporting this therapeutic strategy is inconclusive [7–11,27]. Cycling is another low-impact aerobic activity that has been performed successfully among persons with knee or hip OA, with one study showing both high-intensity and low-intensity cycling had similar beneficial effects on decreasing pain and improving function [22]. Persons with patellofemoral OA may have difficulty cycling and caution is needed to minimize the compressive joint forces on the patellofemoral joint during cycling. Other low-impact activities such as aquatic exercise, Tai Chi and yoga have limited evidence to support their use in addressing the consequences of arthritis [7–11].

Box 1. Levels of evidence.

1A = Systematic review of RCTs
1B = RCTs with narrow confidence interval
1C = All or none case series
2A = Systematic review cohort studies
2B = Cohort study/low-quality RCTs
2C = Outcomes research
3A = Systematic review of case-controlled studies
3B = Case-controlled study
4 = Case series, poor cohort case controlled
5 = Expert opinion

RCT: Randomized controlled trial.

Strengthening exercises can be performed by persons with OA without increasing their symptoms [29,30]. As with low-impact aerobic activities, strengthening programs should be initiated with light weights and low repetitions, and progressed over time. Since the quadriceps, hamstrings, gluteal muscles, and hip abductors and adductors are frequently weak in this population [31,32], these muscles are often targeted for strengthening programs [15,32]. Strengthening exercises can be performed in weightbearing and non-weightbearing conditions, and with or without commercial strength training equipment [15,33]. Strength training with commercial strength training equipment is generally safe, particularly among persons without joint malalignment, although persons should adhere to proper strength training principles. Persons with joint malalignment should use commercial equipment with caution and under the direction of a trained strengthening specialist, although no evidence supports these notions.

Biophysiological considerations

In addition to the principles described above, several biophysiological factors should be considered when developing physical activity programs. First, hip and knee OA, while primarily affecting the involved joint, are impacted by and can impact the biomechanics and kinetics of the body above and below the joint during weightbearing activities. Thus, knee OA may be impacted by the foot, hip or spine, and malalignment or abnormal kinematics at these joints may need to be addressed to allow for optimal joint function and dynamics at the involved joint. These alignment issues need to be taken into consideration when developing physical activity programs.

Second, articular cartilage needs moderate intermittent loading to remain healthy [34]. Excessive loading may be detrimental to joint cartilage [35], whereas moderate levels of exercise have been shown to increase the glycoaminoglycan component of articular cartilage in persons at high risk of developing knee OA [36]. This could be one reason why low-impact walking activity has been well tolerated by persons with knee and hip OA.

Third, from a strengthening perspective, sufficient load must be applied to the muscle to result in improvements in strength. Thus, resistance must be great enough to produce an overload to the muscle in order to achieve muscle hypertrophy [37], yet not too excessive to be detrimental to joint tissue. In our clinical opinion, many strengthening activities can be modified so that the exercise is performed in a manner that is optimal for joint tissue. For example, exercises utilizing body or limb weight or resistive bands can effectively overload the muscle and provide an adequate stimulus for strength training while minimizing forces on the joint tissue.

Fourth, persons with knee OA can develop an altered gait pattern, described as "a quadriceps avoidance gait pattern," which reduces the demand for quadriceps muscle function in stance [38]. This type of gait pattern has been implicated in disease progression [39]. For persons with knee OA who demonstrate a quadriceps avoidance movement pattern, developing sufficient strength and control of the knee joint with activity may provide additional active shock absorption at the knee joint and potentially reduce excessive joint loading [39]. Specifically, for persons with either hip or knee OA, attention to gluteal muscle strengthening can reduce aberrant movement of the pelvis or leg in the frontal plane that may increase abnormal loading in the knee joint. Weakness of the hip abductors can result in either a Trendelenburg gait in which the trunk shifts toward the swing leg creating increased varus loading at the knee joint or a compensated Trendelenburg gait where the trunk is shifted over the stance leg resulting in valgus loading to the knee joint [40].

Fifth, if joint malalignment is present, physical activity programs should be developed to ensure proper execution of strengthening exercises and to minimize abnormal joint loading. In addition, external devices such as orthotics or knee braces can be prescribed, although evidence supporting beneficial outcomes of these devices is limited [41,42].

Lastly, from a specificity of training perspective, training in certain functional tasks (e.g., walking) will result in improved walking capacity and may provide superior functional outcomes when compared with training at impairment levels (e.g., muscle strength) [43]. For example, if an individual wants to improve his/her ability to walk long distances, then practicing shorter bouts of walking is likely to lead to better long distance walking.

Additional considerations

In addition to the general and biophysiological considerations discussed above, there are important biomedical considerations that may need to be considered when designing physical activity programs for adults with knee and hip OA. These might include uncontrolled or unstable health conditions (e.g., heart disease, osteoporosis and cancer), current moderate-to-severe pain at rest or with activity in the involved joints or other joints, and balance or functional impairments. The presence of these factors does not necessarily indicate that the individual should not exercise but rather modifications to routine physical activity recommendations may be warranted. For example, if an individual has a history of cardiovascular disease and signs of cardiovascular complications, a referral to a physician would be warranted. Similarly, an elderly woman with knee OA and a history of chronic low back pain for 30 years may have some critical restrictions in strength and flexibility in her spine, hips and ankle, which could increase her risk for subsequent low back pain or knee pain. In addition, she may have osteopenia due to low levels of weightbearing activity during her 30-year history of chronic low back pain. Strengthening exercises indicated for her knee may exacerbate her back pain making the exercise prescription more complex. Thus, her physical activity plan may need to be modified to accommodate her musculoskeletal system.

Similarly, if someone presents with moderate or severe joint or muscle pain, referral to a rheumatologist and physical therapist may be warranted. This is a bit of a paradox: the literature shows that exercise is effective at decreasing pain so why would closer monitoring be warranted? Moderate-to-severe pain with activity at the joint or elsewhere in the body could suggest that there are important musculoskeletal factors that put people at risk for injury or further pain, and may need to be addressed when initiating a physical activity program. Moderate-to-severe pain during exercise could also indicate that the

type of activity is problematic and may need to be modified. On the other hand, mild pain at the joint and/or mild-to-moderate pain at the joint during physical activity that lasts less than 2 h is probably an acceptable response to physical activity [26]. Nonetheless, pain is a complicated phenomenon and if pain is experienced, particularly during exercise, this could indicate that physical therapy or other interventions may be warranted.

Balance impairment and comorbidities are also factors that should be taken into consideration when recommending physical activity programs to persons with knee and hip OA. As with pain, these factors are not a contradiction to exercise but rather indicate that modifications are needed to the physical activity and close monitoring is warranted. We include these factors in this section because balance impairments can lead to falls, injury and activity restriction [44,45], and persons with comorbidities such as poor vision and peripheral neuropathies may need modified exercise programs in order to perform them safely.

On the other hand, people with radiological evidence of knee or hip OA, who have little to no pain, who have engaged in physical activity programs effectively in the past and who are in good health are probably able to initiate a routine physical activity program with little guidance and health professional oversight. If, however, an individual has difficulty becoming physically active or he/she experiences pain or functional difficulties while exercising, a referral to a healthcare provider may be warranted.

People with OA can & should exercise: but why don't they?

The majority of people with OA do not meet the physical activity guidelines of 150 min per week of moderate activity, with research showing estimates as high as 75% of people not meeting recommended levels [46]. If the benefits are so clear, why are so many people inactive? This could be explained by several factors. First, it could be that until the past decade physical inactivity was viewed by many healthcare providers and adults with OA as part of disease treatment. This is compounded in cultures that are becoming increasingly physically inactive as jobs become more sedentary and physical activities are replaced by computer and electronic activities. Second, messages regarding the benefits of physical activity for persons with OA may not be reaching individuals with the condition. Physical activity prescription is rarely part of routine clinical care for persons with OA and public health messages are geared towards people who are motivated and who can engage in physical activity programs without any complications.

On the other hand, it might be that our model is oversimplified. In many instances, clinicians and healthcare providers assume that people can change their activity and embark on a potentially complicated physical activity program on their own. The following scenario describes why this assumption may be incorrect. Mrs X is seen in a rheumatology clinic by a healthcare provider. The provider ascertains that Mrs X is physically inactive and encourages Mrs X to begin aerobic and strength training. Mrs X, who is 70 years old, has lived with her arthritis for 15 years. She tried walking and strengthening programs in the past but was unsuccessful in developing a regular exercise program. Her failure could have been due to specific joint problems with exercise that resulted in more pain, lack of an ability to manage her lifestyle when more activity was added or an inability to manage competing factors for her time. Regardless of the reason, she developed negative beliefs towards exercising – exercising is painful and she is not able to do the activity. Mrs X then returns to her longstanding state of physical inactivity and is sedentary. Thus, Mrs X has a significant history regarding physical activity that she needs to work with and overcome before she becomes active. This task is even more complex because with time Mrs X's disease progresses and Mrs X's musculoskeletal system changes. Thus, activity that was once easily accomplished might become very difficult, and she now struggles with her current challenges with physical activity and her past experiences of failure. Acquiring new physical activity behaviors – particularly for persons who are sedentary – is very challenging.

While there is substantial research in the field of health promotion and many recent advances in the field over the past several years, it remains challenging to intervene on sedentary behaviors in the context of the clinical setting. The literature on physical activity behavior change, while showing some small effects on changing behavior, continues to show limited impact, particularly in sustained change [47]. There is, however, evidence supporting the notion that older adults value health recommendations by physicians [48], and that physicians are able to promote physical activity in the context of routine clinical care [48]. In addition, goal setting, self-efficacy enhancement and social support

are intervention approaches with some evidence supporting initiation and adherence to physical activity programs [49,50]. A full review for each of these factors is beyond the focus of this article but interested readers may pursue additional information in other excellent reviews [47,49,50].

Although continued research is needed in developing and testing physical activity promotion strategies, healthcare professionals do have a unique opportunity to promote physical activity to their patients. Simple, easy screening questions pertaining to current exercise behavior (e.g., what activities are you doing for exercise? How many minutes during the week do you do moderate-intensity exercise?), past exercise behavior, in particular related to past exercise attempts with pain (e.g., have you exercised in the past? Did you have joint pain?) and plans for future activity (e.g., would you like to start an exercise program?) may help motivate patients to initiate programs.

Limitations

There are several limitations to our review. First, the literature search, while extensive, was not exhaustive. We did not perform a systematic review of any of the ideas presented in this review, in large part because there are several recent well-conducted meta-analyses on the outcomes of physical activity programs for people with knee and hip OA, which is the most robust evidence-based aspect of this review. Second, we did not include articles that were non-English, nor did we specifically search

Executive summary

Physical activity for persons with osteoarthritis: what does the evidence show?

- There are a number of well-conducted randomized controlled trials and several systematic reviews to guide evidence-based clinical recommendations regarding physical activity and exercise.
  - People with knee and hip osteoarthritis (OA) experience decreased pain and improved function with low-impact aerobic activity (e.g., walking) and strength training.
  - There is a large heterogeneity in type, duration, intensity and frequency of exercise, and sample selection among the studies, which limits our ability to identify specific types of exercises that may be matched to specific types of pathology and disease factors.
  - Many questions remain regarding the effects of aquatic exercise but the limited evidence does seem to support aquatics for hip OA, at least over the short term.
  - The literature examining the effects of physical activity specifically among persons with hip OA is limited.

OA & physical activity: general considerations

- From a biophysiological perspective articular cartilage needs moderate intermittent loading to remain healthy.
  - Excessive loading is often detrimental to the joint cartilage.
  - Moderate levels of exercise have been shown to increase the glycoaminoglycan component of articular cartilage in persons at high risk of developing knee OA.
  - Sufficient load must be applied to the muscle during strengthening exercises to result in improvements in strength.
- Low-impact aerobic and strengthening activities are currently the activities of choice for persons with OA.
  - At the onset of physical activity programs these activities may need to be performed at low intensity and for short durations and progressed as tolerated.
  - General soreness in muscles after an activity is acceptable.
  - Joint pain during or after exercise lasting longer than 2 h could indicate detrimental forces to the joint.
  - The mode (type), duration (length of time), intensity (amount of effort) and frequency of the activity may need to be altered or decreased to allow the person to engage in the activity without joint problems.
  - Biomechanical issues that can be addressed to reduce excessive joint loading should be considered; people should be encouraged to wear supportive shoes, and pursue bracing and/or orthotic inserts when warranted.
- Strengthening exercises can be performed by persons with OA without increasing their symptoms.
  - The quadriceps and gluteal muscles should be targeted in this patient population.

OA & physical activity: additional considerations

- Many people with OA can safely engage in physical activity but some may require close monitoring.
- Factors that may warrant modifications to or monitoring of physical activity programs are:
  - Uncontrolled or unstable health conditions (e.g., heart disease, osteoporosis and cancer)
  - Current moderate-to-severe pain in involved joints or other joints at rest or with activity
  - Joint malalignment
  - Balance or functional impairments

People with OA can & should exercise: but why don't they?

- Physical inactivity is high among persons with knee and hip OA.
- The 'exercise prescription' model for people with OA may be oversimplified and we may need a more dynamic and multifactorial model.
- Changing physical activity behavior among people who are sedentary remains challenging.

for articles that were not published. Inclusion of both of these factors could change the data upon which we drew our conclusions for this paper. Third, we did not critically review the literature in terms of outcomes pertaining to 'physical activity' versus 'exercise' programs. Examining outcomes based on these two intervention types could yield different results and is indeed an important aspect of future research in the field. The heterogeneity of intervention programs in this field is substantial, as is noted by several systematic reviews [3,4,6–11,13,14].

Conclusion

Physical activity is now recognized as a cornerstone of knee and hip OA disease management. Low-intensity aerobic (e.g., walking) and strengthening activities are recommended with beneficial effects noted including reduced pain and increased function. Several well-conducted randomized controlled trials and systematic reviews support the beneficial effect of physical activity among persons with hip and knee OA; however, because of the heterogeneity in these studies, the optimal physical activity program is not known. Furthermore, study samples are highly variable and it is not clear whether persons with the full continuum of pathology (mild-to-severe OA) are able to tolerate the same physical activity guidelines.

People with knee and hip OA may have complex musculoskeletal impairments (e.g., foot structural malalignment, hip and spine musculature strength, and flexibility deficits) and modification of physical activity may be warranted. There is a paucity of research that identifies which musculoskeletal or health conditions warrant closer monitoring of physical activity among persons with OA. Persons with foot, ankle, knee, hip or back impairments (e.g., pain, strength deficits and functional limitations) may need close monitoring and intervention by a healthcare professional.

Future perspective

Over the next 5–10 years, we anticipate further delineation of the type of physical activity or exercise matched with the structural presentation of pathology. Increased clarity may, for example, identify that persons with varus thrust or varus malalignment may benefit from a different exercise approach than persons with minimal malalignment. We anticipate a better understanding of the role that proximal and distal structure and strength may have on dynamic movement of the knee and hip, and ultimately functional performance of individuals. Lastly, we anticipate advances in the area of physical activity promotion for persons with knee and hip OA, in particular in the use of primary care models in promoting physical activity hopefully tailored to the needs of the individual from biophysiological and behavioral perspectives.

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