Exercise and knee osteoarthritis: benefit or hazard?

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Abstract

OBJECTIVE To determine whether physical exercise constitutes a benefit or a risk in the development and progression of knee osteoarthritis.

QUALITY OF EVIDENCE MEDLINE, EMBASE, DARE, ACP Journal Club, and Cochrane databases were searched from registry inception to January 2009 using MeSH headings or text words, including *osteoarthritis, arthritis* and *knee* and *exercise, physical training,* and *run.* Reference lists from retrieved articles, citation listings when available, and related articles suggested in PubMed were also evaluated. For individuals without osteoarthritis, strong level II evidence was found (limited by problems with blinding and randomization); for those with pre-existing knee osteoarthritis, robust level I evidence was available.

MAIN MESSAGE Knee osteoarthritis is a major contributor to disability in seniors, and patients have expressed concern that continued exercise might lead to knee symptoms in later years. Studies done on subjects self-selected for exercise and followed for substantial periods of time show no evidence of accelerated development of osteoarthritis, provided injury is avoided. Further, there is good evidence for reduced pain and disability with exercise in this cohort compared with controls. Patients with established osteoarthritis are shown to derive uniform benefit to physical functioning, with reduction of pain and disability, using aerobic, muscle strengthening, aquatic, or physiotherapy-based exercise modalities.

CONCLUSION Provided trauma is avoided, moderate exercise does not lead to acceleration of knee osteoarthritis, whether or not there is evidence of pre-existing disease. In either case there appears to be improved physical functioning and reduction of pain and disability in those who exercise. It is likely that exercise interventions are underused in the management of established knee osteoarthritis symptoms.

Résumé

OBJECTIF Déterminer si l'activité physique constitue un bienfait ou un risque dans le développement et la progression de l'arthrose du genou.

QUALITÉ DES DONNÉES On a effectué une recension dans les bases de données MEDLINE, EMBASE, DARE, ACP Journal Club et Cochrane depuis leur création jusqu'à janvier 2009 à l'aide d'entêtes MeSH ou de mots-de-textes, notamment *osteoarthritis, arthritis* et *knee*, ainsi qu'*exercise, physical training et run.* On a aussi examiné les listes de références des articles sélectionnés, les listes de citations, lorsqu'elles étaient disponibles, et les articles connexes suggérés dans PubMed. Il y avait de solides données probantes de niveau II (limitées en raison de problèmes de double insu et de randomisation) pour les personnes sans arthrose; pour celles qui avaient une arthrose préexistante du genou, on a trouvé de fortes données probantes de niveau I.

MESSAGE PRINCIPAL L'arthrose du genou est un facteur important contribuant à l'incapacité des personnes âgées, et les patients disaient craindre que l'activité continue puisse entraîner des symptômes au genou plus tard dans leur vie. Les études effectuées sur des sujets qui se sont portés volontaires pour faire de l'activité physique et être suivis pendant de longues périodes de temps n'ont présenté aucune manifestation d'un développement accéléré d'arthrose, pourvu que les blessures soient évitées. De plus, de bonnes données probantes étayaient, dans cette cohorte, une réduction de la douleur et de l'incapacité grâce à l'activité physique par rapport aux sujets de contrôle. Il est démontré que les patients ayant une arthrose établie tirent uniformément des bienfaits d'une activité physique, y compris une diminution de la douleur et de l'incapacité, en suivant des programmes d'exercices aérobiques et aquatiques, de renforcement musculaire, ou de physiothérapie.

CONCLUSION Si les traumatismes sont évités, une activité physique modérée n'entraîne pas l'accélération de l'arthrose du genou, qu'il y ait ou non présence démontrée de maladie préexistante. Dans l'un ou l'autre cas, il semble qu'il y ait un meilleur fonctionnement physique et moins de douleur et d'incapacité chez ceux qui sont physiquement actifs. Il semble que les interventions en faveur de l'exercice physique ne soient pas suffisamment utilisées dans la prise en charge des symptômes d'arthrose du genou établie.

Knee osteoarthritis (OA) is seen radiographically in 33% of the population older than 60 years of age,[1] and is responsible for a higher incidence of disability than any other chronic condition. It is as potent a factor as cardiovascular disease in limiting activities of daily living in the elderly.[2] At the same time, seniors, because of advances in disease management, are living longer with the potentially increased burden of chronic diseases, which would otherwise limit lifespan. Any intervention that can improve physical function and minimize the limitations imposed by knee OA in seniors will add quality to the years spent in the latter part of life.

Predictors of mortality tend to gradually change with age. Factors such as socioeconomic status, smoking, and obesity become progressively less influential at the upper extremes of age when physical performance, level of disability, and cognitive performance emerge as the most important determinants.[3] There is evidence that nonagenarians do not live with a higher degree of disability than their younger peers.[4] Their illness events are often delayed until shortly before death and often span a shorter period of time.[5] The first major illness is usually, then, a terminal one. Therefore, maintenance of physical activity and prevention of premature disability are increasingly important for life satisfaction with longevity. It is important to understand the role of exercise in the etiology and natural history of knee OA, one of the most prevalent conditions leading to disability in old age.

The questions posed in this review are as follows:

1. What is the role of exercise in causing knee OA?
2. In the presence of knee OA, what is the effect of exercise on physical function, pain, and disability?

This article has been peer reviewed.
Cet article a fait l'objet d'une révision par des pairs.
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Quality of evidence

MEDLINE, EMBASE, DARE, ACP Journal Club, and Cochrane databases were searched from registry inception to January 2009 using MeSH headings or text words, including *osteoarthritis*, *arthritis* and *knee* and *exercise*, *physical training,* and *run.* Reference lists from retrieved articles, citation listings when available, and related articles suggested in PubMed were also evaluated. As more vigorous forms of exercise interventions are employed in patients without joint symptoms, there was no expectation that there could be adequate randomization or blinding; therefore, level II evidence was deemed acceptable for studies of patients without OA. For studies of patients with established arthritis, only level I evidence that included systematic reviews was selected, as there was outstanding high-level evidence for this cohort. In all cases, the best evidence is presented in this review.

Selection criteria differed for studies of patients with and without established knee OA. Because studies of patients without pre-existing disease were of poorer quality, accepted criteria were much more liberal for this group (**Table 1**). Conclusions drawn for patients without established OA are therefore less reliable than those for patients with existing disease.

Table 1. Study selection criteria

STUDY COHORT	INCLUSION CRITERIA	EXCLUSION CRITERIA
No previous OA	Adult Land- or water-based exercise Diagnosis by x-ray examination or clinical findings or both Changes in x-ray findings or self-reported change in pain, disability, or physical function with exercise	Level III evidence or lower
Established OA	Adult Land- or water-based exercise Diagnosis by clinical findings, with or without x-ray Self-reported change in pain, disability, or physical function with exercise	Level II evidence or lower Level I evidence other than systematic reviews or meta-analyses

OA—osteoarthritis

Levels of evidence

Level I: At least one properly conducted randomized controlled trial, systematic review, or meta-analysis
Level II: Other comparison trials, non-randomized, cohort, case-control, or epidemiologic studies, and preferably more than one study
Level III: Expert opinion or consensus statements

Definition and diagnosis of knee OA

Although the onset of knee OA probably involves the entire joint, loss of hyaline cartilage seems to be the signature event. The presence of inflammation is inconsistent, and is not clearly causative. Diagnosis is both clinical and radiological (**Box 1**); however, clinical features form the basis of diagnosis, with x-ray investigations being helpful to confirm diagnosis and exclude other possible conditions.

There is considerable discordance between joint symptoms and x-ray findings in knee OA.[1,6-8] Patients with radiographic evidence of OA were found to have knee pain between 15% and 81% of the time in a recent systematic review.[8] Imaging techniques are also important. Patellofemoral views can improve the likelihood of predicting the cause of knee pain from 10% to 50%.[9] Conventional weight-bearing anterior-posterior views done for patients who have acute pain often overestimate joint space narrowing, as pain obliges the patient to maintain the joint in slight flexion.[10] On the other hand, early painful OA might not necessarily be accompanied by radiographic changes. This can happen for several reasons:

- Pain fibres are not present in cartilage, so pain might not be perceived until the periosteum, joint capsule, peripheral meniscus, or synovium become stimulated.
- Comorbidities, such as surrounding muscle weakness and loss of proprioception, can both be the cause and the result of OA. Subsequent disturbed joint function results in pain.[1]

Clearly there is substantial evidence that, in the absence of a clinical correlation, x-ray findings have little relevance in understanding the cause of knee pain.

Box 1. Features of knee OA

Clinical
- Onset after age 40; usually progressive
- Asymmetrical, but might be bilateral
- Pain with weight bearing and morning stiffness (usually < 30 min)
- Crepitus or reduced flexion (advanced)
- Tenderness on patellar pressure or over joint space
- Bone enlargement or deformity (advanced)
- Absence of heat or inflammation
- Occasional effusion containing a WBC count < 2000/mm^3, with normal viscosity

Radiographic
- Joint space narrowing—tibiofemoral or patellofemoral
- Subchondral sclerosis
- Marginal osteophytes
- Subchondral cysts

OA—osteoarthritis, WBC—white blood cell.

Etiology

Various proposed causes of and risk factors for knee OA are summarized in **Table 2.**[11-25] For the purposes of this review, factors related to the risks and benefits of exercise are considered. The first consideration with respect to exercise is whether "wear and tear" resulting from repetitive use of articular cartilage is the primary driver for degenerative change. If this were the case, exercise would lead to progressive OA. According to the evidence presented here, this does not seem to be the case. Alternatively, Schrier, in a systematic review,[24] has proposed that muscle dysfunction and weakness resulting from injury, inadequate rehabilitation, overuse, and inactivity is the primary driver for OA. In normal knees, the muscles absorb most of the forces presented to the joint. Articular cartilage does not absorb the remaining force, but redistributes it to bone. Abnormal force distribution on cartilage caused by injury, malalignment, meniscectomy, or muscle dysfunction eventually leads to cartilage damage; loss of this redistribution leads to protective bony sclerosis. The hardened bone, being less resilient, leads to further cartilage damage, facilitating osteoarthritic change.

It seems possible that a normal joint, experiencing normal forces, is well-protected when subjected to even vigorous exercise, particularly if there is opportunity for adaptation and regeneration through incremental muscle training and injury avoidance. Trained marathon runners have been found to have normal post-race magnetic resonance imaging findings, while beginner runners show abnormalities after the same distance.[26] In contrast, abnormal forces on the joint resulting from trauma,[27] poor proprioception,[20] joint misalignment,[22] or muscle dysfunction and weakness[24] might provoke osteoarthritic changes after exercise.

What is the role of exercise in causing knee OA?

A 60-year-old man has been running 30 km/wk for 35 years. He has no history of noteworthy illness and has never had a sports- or running-related injury. He has been told that he is wearing out his knees and that he will get arthritis if he continues to run, but he wishes to remain active as he gets older. He asks your advice.

Evidence for the influence of exercise on knee OA onset is all level II, owing to problems with compliance and blinding in imposing this type of intervention. Studies are observational and are done on self-selected populations. There is no externally imposed intervention. These studies do, however, provide an opportunity to evaluate quite vigorous levels of exercise, and many of them are of prospective cohorts followed for very long periods of time.

While presence of knee OA is often the end point in these studies, there is generally a poor correlation between x-ray findings and symptoms. A diagnosis of knee OA is really only a surrogate for lower extremity pain and disability, which are major components of reduced quality of life in seniors. The process advances with age equally in those who exercise and those who do not.[28] The best prospective cohort studies[12,29-35] show no increase in rate of progression of knee OA in individuals who exercise compared with those who do not. Many of these populations are followed for long periods of time (**Table 3**[12,13,17,21,22, 27-44]). Only one cohort study[17] shows increased OA in individuals who exercise, and only in those with a history of "heavy physical activity." More important, there is convincing evidence—as well as lack of dissenting opinion—that increased levels of exercise lower the incidence of musculoskeletal disability, reduce pain, and increase functional capacity.[28,31,37] In fact, Stanford University's runners' study[28] shows that after 21 years all-cause morbidity is further delayed toward the end of life and that, so far, mortality is also being delayed in runners compared with controls.

Studies of lesser quality, usually case-control studies or cross-sectional surveys, have been conducted, which show similar results with high levels of exercise.[36,40,42] Some of these suggest that athletes competing at high levels of activity when they are young are increasingly susceptible to OA later in life.[13,44] Elite athletes have shown increased knee OA in some studies.[27,39,41,43] Some authors cite trauma as a risk factor.[21,22,27] Certain sports, such as soccer and wrestling, increase the risk.[35] Genu varum was associated with knee OA in one paper.[22] Occupational stresses, such as repetitive kneeling and

Table 2. Risk factors for and possible causes of knee OA

RISK FACTOR	CONTRIBUTION
Older age	Incidence increases with age
Female sex	Greater prevalence of OA in women[11]
Obesity	Higher incidence of OA among obese patients[11-14]
Osteoporosis	Associated with higher incidence and slower progression of OA[15]
Occupation	Higher incidence of OA with repetitive squatting, kneeling, and bending[16-19]
Sports activities	Increased risk of OA with high-impact contact, torsional loads, and overuse[11,19-21]
Previous trauma	Increase in OA shown in athletes postinjury[11,22,23]
Muscle weakness or dysfunction	Increases in OA with inactivity, poor training, and injury[23,24]
Proprioceptive deficit	Increases OA with age, comorbid illness, and ACL injury[25]
Genetic factors	Neither preventable or modifiable—variable expression[16]

ACL—anterior cruciate ligament, OA—osteoarthritis.

Table 3. Studies on exercise as a possible cause of knee OA, in order of quality of evidence

STUDY	STUDY TYPE	N (FOLLOW-UP, %)	DURATION	ACTIVITY	OUTCOME ON KNEE OA	COMMENTS
Framingham offspring (Felson et al[29])	Cohort	1705 (75)	9 y	Recalled level of activity	No increase in OA; obesity did not increase OA risk	History, examination, and x-ray findings Ongoing data collection reduced recall bias Reported patellofemoral disease Injury reported
Framingham (McAlindon et al[17])	Cohort	473 (99)	9 y	Recalled level of activity	Increased incidence with heavy physical activity	History, examination, and x-ray findings Ongoing data collection reduced recall bias Injury reported
Chingford (Hart et al[12])	Cohort	1003	4 y	Walking, jogging, or sports	No increased risk with greater activity levels	X-ray findings and reported pain evaluation Women only Self-reported exercise
Stanford University (Fries et al,[28] Chakravarty et al,[30] Wang et al,[31] Lane et al,[32] Lane et al[33])	Cohort	113 (87)	18 y	Running	No increase in OA; reduced disability; marked divergence in morbidities of all types compared with controls Careful evaluation of x-ray findings and symptoms	Careful evaluation of function and disability Runners were self-selected Very specific for runners of high education and socioeconomic status
Panush et al[34,35]	Cohort	35 (100)	8 y	Running	No increase in OA	Diagnosis by symptoms and x-ray findings
Cooper Clinic (Cheng et al[13])	Case control	16961	17 y	Recalled level of activity	Increase for young men exercising >20 h/wk; increase for obese women and obese young men	No record of injury Diagnosis of OA given to patient by another physician Level of exercise by subjective recall No evaluation of function Subjects all of high socioeconomic status
Sohn and Micheli[36]	Case control	791	2-55 y	Running, swimming	Runners had no increase in lower extremity pain or arthritis surgery compared with swimmers	Compared hip or knee pain in runners and swimmers Arthritis diagnosed only by history of knee or hip surgery
Lane et al[37]	Case control	863	NA	Running	Runners showed less muscle and joint disability and increased functional capacity	Study of lower extremity disability related to knees but not specific to knee OA
Framingham (Hannan et al[38])	Case control	1404	NA	Level of activity	No increase in OA with increased level of activity	History, examination, and x-ray findings Data collection reduced recall bias Injury reported
Spector et al[39]	Case control	1058	NA	Elite tennis players, runners	Increased OA in elite athletes, but no increase in symptoms	Women only Diagnosis based on x-ray findings only
Schmitt et al[40]	Case control	40	NA	Elite marathon runners	No increase in OA	Good clinical and x-ray definition of OA
Kujala et al[41]	Case control	2448	NA	Elite athletes	Athletes had slightly higher risk of hospital admission	Hospital admission for any sign of OA Examination of records only Control group was incomplete
Sutton et al[27]	Case control	1080	NA	Recalled level of exercise	Increased risk only with injury	Diagnosis and level of exercise self-reported
Kujala et al[21]	Cross sectional	117	NA	Sports	Increased OA in soccer players and weight lifters; increased risk with obesity, injury, and work history of heavy lifting	Diagnosis based on recorded history, physical and x-ray findings Men only
Konradsen et al[42]	Cross sectional	30	NA	Running	No increase in OA	Diagnosis based on clinical and x-ray findings

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Table 3 *continued from page 874*

Roos et al[43]	Cross sectional	858	NA	Soccer	Increased OA in elite athletes only	No symptoms reported X-ray diagnosis only
Szoeke et al[44]	Cross sectional	224	NA	Recalled level of exercise	Increased risk with obesity and in those very active in youth	Women only Exercise self-reported Diagnosis based on x-ray findings only
McDermott and Freyne[22]	Cross sectional	20	NA	Running	Strong association of OA with trauma and genu varum	Men only

Questionnaire, physical examination, and x-ray findings
NA—not applicable, OA—osteoarthritis.

stair climbing, can increase risk.[19] Surprisingly, marathon running does not seem to induce changes in joints or increase the risk of OA in most studies.[40,45,46] A large case-control study comparing swimmers with runners was unable to show a difference in lower-extremity pain or arthritis surgery associated with either accumulated mileage or number of years spent running.[36]

To summarize this literature:

- The best evidence suggests that exercise, at least at moderate levels, does not accelerate development of knee OA. Running seems to be particularly safe.
- There might be increased risk of OA with competitive sports participation, particularly early in life, and with competition at an elite level; however, the presence of OA does not lead to increased disability.
- Risk of OA might be increased in the presence of obesity, trauma, occupational stress, and alignment problems of the lower extremities.
- There is evidence for reduction in lower-extremity disability and all-cause disability in self-selected runners compared with controls.
- There is some evidence for prolongation of lifespan in self-selected runners.

Case resolution

This man can be reassured that, as a self-selected runner, he will not develop accelerated knee OA as a result of his activity, and that his risk of disability might even be minimized as he ages because of his level of exercise. Although there is no evidence that a physician-imposed recommendation for the same level of activity in a sedentary person would be risk free, it is reassuring to note that activity at a moderate level with avoidance of extreme sports and trauma does not seem to increase the risk of knee OA. Knee x-ray scans would not be helpful for this man, as changes do not predict future appearance of clinical symptoms.

In the presence of knee OA, what is the effect of exercise on physical function, pain, and disability?

A 55-year-old woman has been experiencing increasing knee pain with physical activity for the past several years. She has been told by her physician that she presents early stages of knee arthritis on x-ray scans, and she occasionally uses over-the-counter anti-inflammatory medications for relief. She is slightly overweight and finds that she cannot lose weight by dieting. She is sedentary and is afraid to start exercising as an aid to weight loss because she is afraid that this will make her knee arthritis worse as she becomes older. She asks your advice.

Review of the literature addressing the effects of exercise on established symptomatic knee OA yields numerous good-quality level I studies in the form of Cochrane reviews and systematic reviews (**Table 4**[47-55]). There is, in fact, a systematic review evaluating available systematic reviews.[50] Blinding is still a problem in some of the more vigorous interventions. There are also small problems with randomization, intention-to-treat analysis, compliance, and heterogeneity in the evaluation of these studies; however, all included studies are randomized controlled trials.

Interventions examined include progressive resistance training,[49] quadriceps strengthening,[52] aquatic exercise,[47] land-based exercise,[48] walking,[53] intensity of life activities,[51] aerobic training,[52] and all physical modalities.[50] Long-term effects of exercise interventions have been evaluated.[54] Factors influencing prognosis for OA progression have also been identified.[55] The following conclusions can be drawn from this literature:

- These studies pertain only to the effects of interventions on symptoms and degree of disability in patients previously diagnosed with knee OA. No clinical or x-ray evaluations were done.
- The levels of exercise intervention were generally low or moderate.
- There is demonstrated benefit for sedentary people, provided progressive structured activity is provided.[51]
- There is little correlation between severity of OA symptoms at onset of activity and degree of benefit.[55]
- here is probably an advantage of dynamic over static activity.[51]
- Obesity is a prevalent comorbidity. Studies varied as to whether obese subjects benefited from exercise interventions,[55] but the most inclusive study suggested benefit.[50] Body fat reduction by exercise and diet, rather than weight reduction alone, was effective in reducing OA symptoms in a small controlled study.[56] Therefore, it is suggested that weight loss need not be

a prerequisite for OA improvement in overweight individuals. None of the exercise modalities demonstrated any harm in obese subjects.

- Most of the benefits of exercise were measured for a short term.[47,48,53] Long-term benefit was not demonstrated unless repeated "booster sessions" were provided.[54]
- Exercise interventions all had small to moderate beneficial effects on pain. There were no dissenting studies.
- All exercise interventions, with the exception of progressive resistance training, had a small to moderate beneficial effect on disability.

Table 4. Studies of exercise in patients with known knee OA

STUDY	STUDY TYPE	INTERVENTION	OUTCOME IN KNEE OA	COMMENTS
Bartels et al,[47] 2007	Cochrane review	Aquatic exercise	Pain—large reduction; function—small to moderate benefit; quality of life—small to moderate benefit	Combined hip and knee study 800 participants Lack of many high-quality studies Short-term follow-up of outcomes
Fransen and McConnell,[48] 2008	Cochrane review	Land-based exercise	Pain—small reduction; physical function—small benefit	Generally good-quality evidence 3616 participants Outcomes sensitive to degree of supervision of exercise Short-term follow-up Improvement similar to effect of NSAIDs
Latham et al,[49] 2008	Cochrane review	Progressive resistance training	Pain—small reduction; functional limitation—moderate benefit; disability—no effect	Problems with control matching and intention-to-treat analysis 3783 participants More increase in strength than aerobic capacity Adverse effects poorly reported
Jamtvedt et al,[50] 2007	Systematic review of systematic reviews	All physical therapies	Good-quality evidence that exercise and weight reduction improve both pain scores and physical function	Range of modalities studied 9 systematic reviews of 49 trials of exercise therapy Weight-reduction trials included behaviour therapy and 1 good systematic review containing 4 trials
Vignon,[51] 2006	Systematic review	Activities of living, sports, exercise habits, occupational activities	Pain—good evidence for structured activity in sedentary participants; benefit of dynamic over static exercise; trauma and obesity contribute more risk than sports; exercise at a pain-free level is safe	Wider ranging modalities lead to increased heterogeneity
Roddy et al,[52] 2005	Systematic review	Aerobic exercise, quadriceps strengthening	Pain—4 exercise and 11 strengthening studies showed improvement; disability—2 exercise and 10 of 11 strengthening studies showed improvement; limited evidence for no difference between exercise or strengthening; adherence to intervention a major predictor of success	Small number of exercise studies Interventions lasted between 8 wk and 2 y
Petrella,[53] 2000	Systematic review	Walking	Pain—small to moderate benefit; disability—small benefit; global assessment—moderate to large perceived benefit	All short-term outcomes in studies lasted less than 8 wk
Pisters et al,[54] 2007	Systematic review	Long-term (> 6 mo) follow-up of exercise therapy	Pain—no evidence for improvement; disability—no evidence for improvement; booster sessions provided longer term improvement	Studies included both hip and knee OA
Belo et al,[55] 2007	Systematic review	Prognostic factors for knee OA prevention	Evidence for definite association between serum hyaluronic acid levels and generalized OA; limited association with running; conflicting association with obesity; unrelated to baseline OA, knee pain, sex, quadriceps strength, injury, and sports participation	Reviewed studies selected for interventions influencing progression—exercise considered to be one of these interventions

NSAID—nonsteroidal anti-inflammatory drug, OA—osteoarthritis.

- The benefits of land-based exercises can be similar to the relief obtained from nonsteroidal anti-inflammatory drugs.[48] Generally, nonpharmacologic approaches to OA treatment are as effective as pharmacologic approaches.[57]
- There is no indication that low to moderate exercise intervention causes increased pain or disability in knee OA.

Guidelines from the American College of Rheumatology[58] and the European League Against Rheumatism,[59] although generated in 2000, are consistent in recommending aerobic exercise, muscle strengthening, and preservation of joint mobility as central components of the nonpharmacologic approach to the treatment of knee OA. The 2007 recommendations of the Osteoarthritis Research Society International[57] are more inclusive of the current literature and again stress the value of exercise, whether water-based, aerobic, muscle strengthening, or physiotherapy-based. Further, these guidelines stress that there are no statistical differences in the benefits derived from pharmacologic and nonpharmacologic modalities in the treatment of knee OA.[57] Despite these findings, DeHaan et al,[60] in a Canadian study at a teaching clinic, were rarely able to find documentation of the use of nonpharmacologic therapy. However, based on the evidence, judicious use of exercise is a compelling modality in the treatment of knee OA, and this intervention incurs little risk.

Case resolution

This woman can be reassured that gradually increasing exercise to a moderate level as a means of losing weight is unlikely to make her knee symptoms worse. She can also be told that there is a possibility that exercise can improve her knee symptoms as well. A plan for continuing long-term exercise will be important to both facilitate and maintain her weight loss and possibly reduce her knee symptoms. It is reasonable to suggest that, even if she achieves minimal weight loss, continued exercise will minimize both pain and disability. If she chooses land-based exercise, she might expect improvement in symptoms and disability similar to benefits obtained from nonsteroidal anti-inflammatory drugs, without the side effects. She might consider stopping the medication or switching to acetaminophen.

Conclusion

Individuals without knee OA who opt to exercise will not have increased progression of joint degeneration as a result of their increased physical activity; indeed, they can expect reductions in knee pain and all-cause disability as the years progress. Vigorous sports and activity leading to trauma should be avoided. Externally imposed recommendations for exercise will not necessarily produce the same results, as these studies have not yet been done.

EDITOR'S KEY POINTS

- With more people living longer, maintenance of physical activity and prevention of premature disability are increasingly important for quality of life with longevity. It is important to understand the role of exercise in the etiology and natural history of knee osteoarthritis (OA), one of the most prevalent conditions leading to disability in old age.
- Studies show that individuals without knee OA who opt to exercise will not have increased progression of joint degeneration as a result of the excercise; indeed, they can expect reductions in knee pain and all-cause disability as the years progress. Vigorous sports and activity leading to trauma should be avoided.
- There is outstanding evidence for the benefit of exercise therapy in knee OA. Those with knee OA who do moderate exercise can expect reduction in knee pain and disability for the duration of their intervention. A long-term exercise program is unlikely to be harmful, but interventions of a longer duration have not been adequately studied.

POINTS DE REPÈRE DU RÉDACTEUR

- Avec le vieillissement de la population, le maintien de l'activité physique et la prévention d'une incapacité prématurée revêtent une importance grandissante pour la qualité de vie à long terme. Il est important de comprendre le rôle de l'activité physique dans l'étiologie et l'évolution naturelle de l'arthrose du genou, l'un des problèmes les plus fréquents entraînant l'incapacité chez les personnes âgées.
- Des études démontrent que les personnes qui n'ont pas d'arthrose du genou et choisissent de faire de l'activité physique n'auront pas de progression plus rapide de la dégénérescence de l'articulation à cause de l'activité; de fait, ils peuvent s'attendre à avoir moins de douleurs au genou et d'incapacité toutes causes confondues avec les années. Les sports et activités plus intenses causant des blessures devraient être évités.
- Des données probantes très convaincantes démontrent les bienfaits d'une thérapie au moyen de l'activité physique dans les cas d'arthrose du genou. Ceux qui en sont affectés et font de l'activité physique modérée peuvent s'attendre à des douleurs et une incapacité réduites à long terme. Il est improbable qu'un programme d'activité physique à long terme soit dommageable, mais les interventions d'une plus longue durée n'ont pas suffisamment fait l'objet d'études.

Persons with knee OA who exercise to a moderate level can expect reduction in both knee pain and disability for the duration of their intervention. A long-term

exercise program is unlikely to be harmful, but interventions of a longer duration have not been adequately studied. There is outstanding evidence for the benefit of exercise therapy in knee OA and some indication that it is underused as a treatment modality.

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Competing interests
None declared

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References

1. Felson DT. An update on the pathogenesis and etiology of osteoarthritis. *Radiol Clin North Am* 2004;42(1):1-9, v.
2. Guccione AA, Felson DT, Anderson JJ, Anthony JM, Zhang Y, Wilson PW, et al. The effects of specific medical conditions on the functional limitations of elders in the Framingham Study. *Am J Public Health* 1994;84(3):351-8.
3. Nybo H, Petersen HC, Gaist D, Jeune B, Andersen K, McGue M, et al. Predictors of mortality in 2,249 nonagenarians—the Danish 1905-Cohort Survey. *J Am Geriatr Soc* 2003;51(10):1365-73.
4. Christensen K, McGue M, Petersen I, Jeune B, Vaupel JW. Exceptional longevity does not result in excessive levels of disability. *Proc Natl Acad Sci U S A* 2008;105(36):13274-9. Epub 2008 Aug 18.
5. Fries JF. Physical activity, the compression of morbidity, and the health of the elderly. *J R Soc Med* 1996;89(2):64-8.
6. Szebenyi B, Hollander AP, Dieppe P, Quilty B, Duddy J, Clarke S, et al. Associations between pain, function, and radiographic features in osteoarthritis of the knee. *Arthritis Rheum* 2006;54(1):230-5.
7. Hannan MT, Felson DT, Pincus T. Analysis of the discordance between radiographic changes and knee pain in osteoarthritis of the knee. *J Rheumatol* 2000;27(6):1513-7.
8. Bedson J, Croft PR. The discordance between clinical and radiographic knee osteoarthritis: a systematic search and summary of the literature. *BMC Musculoskel Disord* 2008;9:116. Available from: **www.biomedcentral.com/1471-2474/9/116.** Accessed 2009 Jul 24.
9. Felson DT, McAlindon TE, Anderson JJ, Naimark A, Weissman BW, Aliabadi P, et al. Defining radiographic osteoarthritis for the whole knee. *Osteoarthritis Cartilage* 1997;5(4):241-50.
10. Mazzuca SA, Brandt KD, Lane KA, Katz BP. Knee pain reduces joint space width in conventional standing anteroposterior radiographs of osteoarthritic knees. *Arthritis Rheum* 2002;46(5):1223-7.
11. Jordan JM, Luta G, Renner JB, Linder GF, Dragomir A, Hochberg MC, et al. Self-reported functional status in osteoarthritis of the knee in a rural southern community: the role of sociodemographic factors, obesity, and knee pain. *Arthritis Care Res* 1996;9(4):273-8.
12. Hart DJ, Doyle DV, Spector TD. Incidence and risk factors for radiographic knee osteoarthritis in middle-aged women: the Chingford Study. *Arthritis Rheum* 1999;42(1):17-24.
13. Cheng Y, Macera CA, Davis DR, Ainsworth BE, Troped PJ, Blair SN. Physical activity and self-reported, physician-diagnosed osteoarthritis: is physical activity a risk factor? *J Clin Epidemiol* 2000;53(3):315-22.
14. Cooper C, Snow S, McAlindon TE, Kellingray S, Stuart D, Coggon D, et al. Risk factors for the incidence and progression of radiographic knee osteoarthritis. *Arthritis Rheum* 2000;43(5):995-1000.
15. Zhang Y, Hannan MT, Chaisson CE, McAlindon TE, Evans SR, Aliabadi P, et al. Bone mineral density and risk of incident and progressive radiographic knee osteoarthritis in women: the Framingham Study. *J Rheumatol* 2000;27(4):1032-7.
16. Kalunian KC. Risk factors for and possible causes of osteoarthritis. *UpToDate* [serial on the Internet]. Available from: **www.uptodate.com/patients/content/topic.do?topicKey=~MoRo6jZJ3hjA3E.** Accessed 2009 Jul 24.
17. McAlindon TE, Wilson PW, Aliabadi P, Weissman B, Felson DT. Level of physical activity and the risk of radiographic and symptomatic knee osteoarthritis in the elderly: the Framingham Study. *Am J Med* 1999;106(2):151-7.
18. Cymet TC, Sinkov V. Does long-distance running cause osteoarthritis? *J Am Osteopath Assoc* 2006;106(6):342-5.
19. Buckwalter JA, Lane NE. Does participation in sports cause osteoarthritis? *Iowa Orthop J* 1997;17:80-9.
20. Felson DT, Lawrence RC, Dieppe PA, Hirsch R, Helmick CG, Jordan JM, et al. Osteoarthritis: new insights. Part 1: the disease and its risk factors. *Ann Intern Med* 2000;133(8):635-46.
21. Kujala UM, Kettunen J, Paananen H, Aalto T, Battié MC, Impivaara O, et al. Knee osteoarthritis in former runners, soccer players, weight lifters, and shooters. *Arthritis Rheum* 1995;38(4):539-46.
22. McDermott M, Freyne P. Osteoarthritis in runners with knee pain. *Br J Sports Med* 1983;17(2):84-7.
23. Van Gent RN, Siem D, van Middelkoop M, van Os AG, Bierma-Zeinstra SM, Koes BW. Incidence and determinants of lower extremity running injuries in long distance runners: a systematic review. *Br J Sports Med* 2007;41(8):469-80.
24. Shrier I. Muscle dysfunction versus wear and tear as a cause of exercise related osteoarthritis: an epidemiological update. *Br J Sports Med* 2004;38(5):526-35.
25. Sharma L, Pai YC. Impaired proprioception and osteoarthritis. *Curr Opin Rheumatol* 1997;9(3):253-8.
26. Hohmann E, Wörtler K, Imhoff A. Osteoarthritis from long-distance running? [Article in German]. *Sportverletz Sportschaden* 2005;19(2):89-93.
27. Sutton AJ, Muir KR, Mockett S, Fentem P. A case-control study to investigate the relation between low and moderate levels of physical activity and osteoarthritis of the knee using data collected as part of the Allied Dunbar National Fitness Survey. *Ann Rheum Dis* 2001;60(8):756-64.
28. Fries JF, Singh G, Morfeld D, Hubert HB, Lane NE, Brown BW Jr. Running and the development of disability with age. *Ann Intern Med* 1994;121(7):502-9.
29. Felson DT, Niu J, Clancy M, Sack B, Aliabadi P, Zhang Y. Effect of recreational physical activities on the development of knee osteoarthritis in older adults of different weights: the Framingham Study. *Arthritis Rheum* 2007;57(1):6-12.
30. Chakravarty EF, Hubert HB, Lingala VB, Zatarain E, Fries JF. Long distance running and knee osteoarthritis. A prospective study. *Am J Prev Med* 2008;35(2):133-8. Epub 2008 Jun 12.
31. Wang BW, Ramey DR, Schettler JD, Hubert HB, Fries JF. Postponed development of disability in elderly runners: a 13-year longitudinal study. *Arch Intern Med* 2002;162(20):2285-94.
32. Lane NE, Michel B, Bjorkengren A, Oehlert J, Shi H, Bloch DA, et al. The risk of osteoarthritis with running and aging: a 5-year longitudinal study. *J Rheumatol* 1993;20(3):461-8.
33. Lane NE, Oehlert JW, Bloch DA, Fries JF. The relationship of running to osteoarthritis of the knee and hip and bone mineral density of the lumbar spine: a 9 year longitudinal study. *J Rheumatol* 1998;25(2):334-41.
34. Panush RS, Schmidt C, Caldwell JR, Edwards NL, Longley S, Yonker R, et al. Is running associated with degenerative joint disease? *JAMA* 1986;255(9):1152-4.
35. Panush RS, Hanson CS, Caldwell JR, Longley S, Stork J, Thoburn R. Is running associated with osteoarthritis? An eight-year follow-up study. *J Clin Rheumatol* 1995;1(1):35-9.
36. Sohn RS, Micheli LJ. The effect of running on the pathogenesis of osteoarthritis of the hips and knees. *Clin Orthop Relat Res* 1985;(198):106-9.
37. Lane NE, Bloch DA, Wood PD, Fries JF. Aging, long-distance running, and the development of musculoskeletal disability. A controlled study. *Am J Med* 1987;82(4):772-80.
38. Hannan MT, Felson DT, Anderson JJ, Naimark A. Habitual physical activity is not associated with knee osteoarthritis: the Framingham Study. *J Rheumatol* 1993;20(4):704-9.
39. Spector TD, Harris PA, Hart DJ, Cicuttini FM, Nandra D, Etherington J, et al. Risk of osteoarthritis associated with long-term weight-bearing sports: a radiologic survey of the hips and knees in female ex-athletes and population controls. *Arthritis Rheum* 1996;39(6):988-95.
40. Schmitt H, Rohs C, Schneider S, Clarius M. Is competitive running associated with osteoarthritis of the hip or the knee? [Article in German]. *Orthopade* 2006;35(10):1087-92.
41. Kujala UM, Kaprio J, Sarna S. Osteoarthritis of weight bearing joints of lower limbs in former elite male athletes. *BMJ* 1994;308(6923):231-4. Erratum in: *BMJ* 1994;308(6932):819.
42. Konradsen L, Hansen EM, Sondergaard L. Long distance running and osteoarthritis. *Am J Sports Med* 1990;18(4):379-81.
43. Roos H, Lindberg H, Gärdsell P, Lohmander LS, Wingstrand H. The prevalence of gonarthrosis and its relation to meniscectomy in former soccer players. *Am J Sports Med* 1994;22(2):219-22.
44. Szoeke CE, Cicuttini FM, Guthrie JR, Clark MS, Dennerstein L. Factors affecting the prevalence of osteoarthritis in healthy middle-aged women: data from the longitudinal Melbourne Women's Midlife Health Project. *Bone* 2006;39(5):1149-55. Epub 2006 Jul 17.
45. Hohmann E, Wörtler K, Imhoff AB. MR imaging of the hip and knee before and after marathon running. *Am J Sports Med* 2004;32(1):55-9.
46. Schueller-Weidekamm C, Schueller G, Uffmann M, Bader TR. Does marathon running cause acute lesions of the knee? Evaluation with magnetic resonance imaging. *Eur Radiol* 2006;16(10):2179-85. Epub 2006 Mar 10.
47. Bartels EM, Lund H, Hagen KB, Dagfinrud H, Christensen R, Danneskiold-Samsøe B. Aquatic exercise for the treatment of knee osteoarthritis. *Cochrane Database Syst Rev* 2007;(4):CD005523.
48. Fransen M, McConnell S. Exercise for osteoarthritis of the knee. *Cochrane Database Syst Rev* 2008;(4):CD004376.
49. Latham N, Anderson C, Bennett D, Stretton C. Progressive resistance strength training for physical disability in older people. *Cochrane Database Syst Rev* 2003;(2):CD002759.
50. Jamtvedt G, Dahm KT, Christle A, Moe RH, Haavardsholm E, Holm I, et al. Physical therapy interventions for patients with osteoarthritis of the knee: an overview of systematic reviews. *Phys Ther* 2008;88(1):123-36. Epub 2007 Nov 6.
51. Vignon E, Valat JP, Rossignol M, Avouac B, Rozenberg S, Thoumie P, et al. Osteoarthritis of the knee and hip and activity: a systematic international review and synthesis (OASIS). *Joint Bone Spine* 2006;73(4):442-55. Epub 2006 May 6.
52. Roddy E, Zhang W, Doherty M. Aerobic walking or strengthening exercise for osteoarthritis of the knee? A systematic review. *Ann Rheum Dis* 2005;64(4):544-8.
53. Petrella RJ. Is exercise effective treatment for osteoarthritis of the knee? *Br J Sports Med* 2000;34(5):326-31.
54. Pisters MF, Veenhof C, van Meeteren LU, Ostelo RW, de Bakker DH, Schellevis FG, et al. Long-term effectiveness of exercise therapy in patients with osteoarthritis of the hip or knee: a systematic review. *Arthritis Rheum* 2007;57(7):1245-53.
55. Belo JN, Berger MY, Riejman M, Koes BW, Bierma-Zeinstra SM. Prognostic factors of progression of osteoarthritis of the knee: a systematic review of observational studies. *Arthritis Rheum* 2007;57(1):13-26.
56. Toda Y, Toda T, Takemura S, Wada T, Morimoto T, Ogawa R. Change in body fat, but not body weight or metabolic correlates of obesity, is related to symptomatic relief of obese patients with knee osteoarthritis after a weight control program. *J Rheumatol* 1998;25(11):2181-6.
57. Zhang W, Moskowitz RW, Nuki G, Abramson S, Altman RD, Arden N, et al. OARSI recommendations for the management of hip and knee osteoarthritis, part II: OARSI evidence-based, expert consensus guidelines. *Osteoarthritis Cartilage* 2008;16(2):137-62.
58. American College of Rheumatology Subcommittee on Osteoarthritis Guidelines. Recommendations for the medical management of osteoarthritis of the hip and knee: 2000 update. *Arthritis Rheum* 2000;43(9):1905-15.
59. Pendleton A, Arden N, Dougados M, Doherty M, Bannwarth B, Bijlsma JW, et al. EULAR recommendations for the management of knee osteoarthritis: report of a task force of the Standing Committee for International Clinical Studies Including Therapeutic Trials (ESCISIT). *Ann Rheum Dis* 2000;59(12):936-44.
60. DeHaan MN, Guzman J, Bayley MT, Bell MJ. Knee osteoarthritis clinical practice guidelines—how are we doing? *J Rheumatol* 2007;34(10):2099-105. Epub 2007 Aug 15.