

Does Long-Distance Running Cause Osteoarthritis?

Tyler Childs Cymet, DO
Vladimir Sinkov, MD

There is a dose-response relationship between physical activity and the reduced risk of some diseases (eg, cardiovascular disease, diabetes mellitus). At a certain “dose,” however, the reduced risk of some diseases may be offset by an increased risk of injury and osteoarthritis. Osteoarthritis can be caused by trauma to, or overuse of, the joints. Sports injuries often occur as a result of dysfunctions in balance or the musculoskeletal system operating in nonneutral mechanics. It is unclear if long-distance running causes the knee and hip joints to deteriorate. The results of animal studies reveal a pattern of increased incidence of arthritis in these joints when there is a history of injury or use in atypical environments (eg, laboratory settings). Human studies show an increase in radiographic evidence of osteoarthritis in endurance sports athletes, but no related increase in symptoms reported. Although there are not currently enough data to give clear recommendations to long-distance runners, it appears that long-distance running does not increase the risk of osteoarthritis of the knees and hips for healthy people who have no other counterindications for this kind of physical activity. Long-distance running might even have a protective effect against joint degeneration. The authors recommend further study.

J Am Osteopath Assoc. 2006;106:342–345
<http://www.jaoa.org/content/vol106/issue6/>

Physical activity is important in maintaining health. Long-distance and marathon running are relatively safe sports.¹ Anecdotally, however, it is felt that “Today’s runners are tomorrow’s cyclists”—not because of a “natural progression” from one sport to the other, but as a result of joint injury.

Is there a causal relationship between running and osteoarthritis? The current data are based on small studies, and their results are often unclear. People engaged in sports

or other physically demanding activities are known to be at an increased risk of osteoarthritis in the joints they use most (eg, knees and hips in soccer players, hands in boxers, lower backs in construction workers). Part of this apparent correlation can be explained by increased risk of joint injury.² It would also seem logical that these groups would be predisposed to osteoarthritis from overuse injuries and not necessarily from trauma.

Osteoarthritis is generally divided into primary osteoarthritis, related to age and genetics, and secondary osteoarthritis, which is associated with a history of any kind of joint injury (eg, trauma, infection, surgery, mineral deposition, autoimmune disorders). Joint trauma can be acute or chronic, and pain intensity can be severe or mild. The trauma may be ligamentous, meniscal, or muscular in origin. Because of nonpathogenic but highly repetitive loading, overuse injuries may be considered a mild, chronic joint trauma. Such use is thought, with time, to deplete the joint of the lubricating glycoproteins, disrupt the collagen network, slowly wear away the cartilage, and cause numerous microfractures in the underlying bones.³

Animal Studies

Researchers conducting animal studies have attempted to simulate long-term stress on weight-bearing joints to determine how such activities might damage the joint. In sheep studies, Radin and colleagues⁴ have shown that 4 hours of walking on a concrete surface resulted in signs of osteoarthritis.

More recent canine studies by Kiviranta et al^{5,6} demonstrated that moderate running improved the joint condition in terms of cartilage thickness and glycosaminoglycan content, whereas more strenuous running reversed those benefits and was detrimental to joint health. The latter finding was further supported in a study of laboratory rats by Pap and colleagues,⁷ in which the animals were subjected to “strenuous running” (30 km within 6 weeks). Researchers found histologic evidence of osteoarthritis in all of the exercised group and none in the resting controls.⁷

The findings of Lapvetelainen et al⁸ differed from those in the previously noted studies, however.⁴⁻⁷ Researchers created mice with heterozygous inactivation of gene coding for type 2 procollagen and subjected them and controls to lifelong voluntary wheel-running exercise. As expected, the exercised knockout mice had more knee osteoarthritis than resting con-

From the Johns Hopkins School of Medicine (Cymet) and Union Memorial Hospital (Sinkov), both in Baltimore, Md.

Address correspondence to: Tyler Cymet, DO, 4915 Deer Park Rd, Owings Mills, MD 21117-4713.

E-mail: tcymet@lifebridgehealth.org

trols. However, running knockout mice had less knee osteoarthritis than sedentary mice. There was no difference in prevalence rates for osteoarthritis between exercised mice and sedentary controls, but increased prevalence of knee osteoarthritis was seen in exercised and control mice with high body weight. Lapvetalainen et al⁸ demonstrated that physical activity does not predispose normal mice to osteoarthritis and might, in fact, protect injured mice from the disease.

Although the results of more recent studies conflict with their predecessors, there seems to be a pattern: intrinsic injury or excessive exercise seems to lead to a higher incidence of osteoarthritis, whereas moderate exercise is either noncontributory in joint degeneration or beneficial in decreasing the risk of osteoarthritis in animals.⁹

There are many limitations, however, to making such a general statement or applying this principle to humans. The animals studied varied greatly among these experiments; the anatomy, biomechanics of joint loading, muscle strength, and ability to recover from minor joint injuries varies greatly from sheep and dogs to mice and rats. Furthermore, though some animals were subjected to the same joint loads as they would experience in nature (eg, running), some experimental animals were required to exercise in a laboratory environment to which they were not adapted (eg, walking on concrete).⁴ Finally, the measurements of osteoarthritis varied from gross,¹⁰ to histologic,^{10,11} to biochemical.^{11,12} Even if all of these confounding factors were controlled for, it is still questionable whether the results would be generalizable to humans.

Human Studies

Numerous studies have investigated the association of prolonged running and osteoarthritis of the knee and hip. Unfortunately, the evidence from these studies is conflicting, with some researchers saying that running is not associated with increased prevalence of osteoarthritis,^{3,13-19} while others indicate that running can increase the risk of knee and hip osteoarthritis.²⁰⁻²² All of the studies, however, are retrospective; many have few subjects and fail to separate runners from other athletes^{17,20,21}; or they neglect to stratify the subjects by the amount of running or history of injuries to the lower extremities²¹; and many of the subjects in these studies are either professional athletes or amateurs.²³ In addition, some studies were done in other countries, making it hard to generalize their results to the population in the United States.^{17,18,23} Finally, researchers have used different diagnostic criteria to evaluate the extent of osteoarthritis in subjects.

In a 1973 study, Marti and colleagues²⁰ conducted a retrospective review of men who were former athletes (long-distance runners, $n=27$; bobsleigh riders, $n=9$) or normal, healthy nonathlete controls ($n=23$). Subjects were then reex-

amined 15 years later. Researchers²⁰ found that high-intensity running (ie, 97 km per week) was associated with a significantly higher incidence of radiographic evidence of osteoarthritis of the hip. The limitations of the study included atypically high intensity of running, small sample size, lack of correlation with history of injury to the hip joint, and use of radiographic evidence as the sole measure of osteoarthritis.

A study by Spector and colleagues²¹ in the United Kingdom investigated osteoarthritis in women who were former elite long-distance runners and tennis players. Spector and coauthors²¹ found a twofold to threefold increase in the incidence of radiographic osteoarthritis in the study group even when subjects were controlled for age. The authors²¹ found similar rates of reported knee pain between the former athletes and control subjects, however. This study also had a low number of athletic participants ($n=81$), combined runners and tennis players into one group, and looked at women only. In addition, the study methods assumed that athletes and nonathletes would report pain similarly.

The most recent study implicating running as a cause of osteoarthritis was conducted by Cheng et al.²² The study involved nearly 17,000 patients seen at the Cooper Clinic in Dallas, Tex, from 1970 to 1995. All patients were later contacted by mail and asked to report on physician-diagnosed illnesses and conditions by return survey. Researchers²² found a significantly higher incidence of osteoarthritis in men (aged 20-49 years) who were involved in high levels of physical activity (ie, walking or running more than 20 miles per week). Although this 10-year study had a very large sample size with subjects from a variety of age groups (range, 20-87 years), the study was limited in that the population was demographically uniform (ie, well-educated, non-Hispanic white men of high socioeconomic status) and did not gather data on subjects' occupational activities (eg, kneeling, squatting, carrying heavy loads) or history of physical trauma, and relied solely on self-reported data during follow-up.

In another longitudinal study, Sohn and colleagues¹³ compared 504 former college varsity cross-country runners with a control group of 284 former college swimmers. Subjects were observed for an average period of 25 years. In particular, researchers¹³ noted reports of pain in the hips and knees as well as any history of surgical procedures for relief of that pain (ie, evidence of the presence of osteoarthritis). In the group of college swimmers, no data were gathered on the swimming strokes subjects most commonly used in competition. Sohn and coauthors¹³ found that moderate long-distance running (ie, 25.4 miles per week on average) was not associated with higher incidence of osteoarthritis of the hip or knee. In addition, there was no evidence to suggest that higher weekly averages for distance or more total years running was associated with a higher incidence of osteoarthritis. The study¹³ had a large sample

size, a long average follow-up time, and good measures for incidence of osteoarthritis.

Kujala and colleagues^{17,18} have conducted many studies on the effects of running on the human musculoskeletal system. In one of their articles, Kujala et al¹⁷ described the incidence of knee osteoarthritis in former athletes in various sports. Runners were not found to have an increased incidence of knee osteoarthritis. However, the study¹⁷ had few participants (N=117; long-distance runners, n=28) and included only professional male athletes from Finland.

In another study, Kujala and coauthors¹⁸ compared men who were master orienteering runners with matched non-smoking control subjects. Even though researchers found a higher incidence of knee osteoarthritis in the runners (17% vs 10.6%; $P=.025$), they attributed this difference to a higher likelihood of knee injuries in the athletes and to referral bias.

One of the most well-known American studies on running and osteoarthritis was published by Lane and coinvestigators¹⁶ in 1993. These researchers looked at a large population of members of the 50-Plus Runners' Association and, after a careful selection process, narrowed down their sample to 33 matched pairs of long-term long-distance runners and nonrunning controls living in Stanford, Calif. All 66 subjects underwent a rheumatologic examination, completed annual questionnaires, and received radiographs of their joints during the 5-year study period. The study¹⁶ showed no difference in the incidence of osteoarthritis in runners and nonrunners. The limitations of this study included a small sample size and a limited follow-up time. However, in a subsequent study, Lane and colleagues¹⁹ reported that at 9-year follow-up, the results were the same; there was no difference in the incidence and progression of knee and hip osteoarthritis in runners and nonrunners.

Fries and coauthors³ studied 451 members of a runners' club and 330 community controls aged 50 to 72 years, observing these 781 subjects during an 8-year study period. The runners had lower mortality rates and a lower incidence of musculoskeletal disabilities and osteoarthritis. The study, however, looked at overall disability rather than osteoarthritis in particular.³

Advising Patients

Most acute injuries in runners are from overuse.²⁴ In addition, running while injured seems to promote poor body mechanics, functioning as a major contributor to chronic injuries.²⁵

A 1-mile run may require anywhere from 1000 to 1500 strides, depending on the body mechanics of the runner. In long-term, repetitive strain, the body responds by increasing water and proteoglycan content in the joint fluid while periarticular ligaments and supporting muscles undergo adaptive hypertrophy.

In properly trained athletes (ie, those who have increased exercise intensity and duration gradually), localized pain or

problems with performing to their regular expectations often precede injury to a specific joint. Medical advice to a runner should take into account the individual's running style and ability, as well as body size. The greater the body mass index, often the greater the radiographic evidence of osteoarthritis noted in the joints.²⁴

Apophyseal injuries are a greater risk for athletes aged between 16 and 25 years.²⁶ Physicians should carefully consider patient age, size, and biomechanics when providing advice to long-distance runners.

The rate-limiting step in long-distance running is energy related, with glycogen ready in the muscle for sustained exercise instead of supporting swelling or bone and joint dysfunction.²⁷

Conclusion

Although the existing evidence on whether long-term long-distance running causes osteoarthritis is currently insufficient for researchers to draw unequivocal conclusions, the preponderance of data seems to indicate that moderate levels of running do not increase the risk of osteoarthritis of the knees and hips for healthy people and that this activity might even have a protective effect. A history of injury—from overuse or acute trauma as a result of running, excessive running, intrinsic anatomical instability in the joints, or a high body mass index—can accelerate the onset of osteoarthritis and cause disability, however. It is important that people considering a new exercise regimen seek a physical evaluation by a sports medicine physician and that they learn proper training methods so that they may prevent joint injury.

The risks of running as noted should be weighed against the tremendous benefits of this activity to the other body systems. Running has been shown to decrease the risk of cardiovascular disease,²⁸ diabetes mellitus,²⁸ and depression.²⁹ This kind of physical activity has also been shown to help with weight control, to improve bone density, and to decrease mortality.³⁰

To better understand the effects of running on the human musculoskeletal system, more studies are needed. Such studies would ideally follow cohorts of runners and controls prospectively using validated diagnostic criteria³¹ and would use a large sample size. Subjects at various levels of running should be included, with controls for confounding factors such as sex, body weight, history of injury to the lower extremities, family history of osteoarthritis, and occupational risks.³²

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