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How to help runners steer clear of injury

Assess risk factors, then work to address modifiable ones, such as wearing the right running shoes and building up slowly. Don't let overweight or OA dampen enthusiasm.

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PRACTICE RECOMMENDATIONS

› *Counsel runners to cross-train, replace shoes regularly, and use shoes with moderate-to-high (8-12 mm) heel-to-toe drop.* (C)

› *Don't discourage running for exercise, as long as it is tolerated, in patients who have osteoarthritis.* (C)

› *Encourage moderation in running distance and intensity, especially in novice runners.* (C)

Strength of recommendation (SOR)

(A) Good-quality patient-oriented evidence

(B) Inconsistent or limited-quality patient-oriented evidence

(C) Consensus, usual practice, opinion, disease-oriented evidence, case series

Approximately 60 million people in the United States run for exercise at least once a calendar year, with approximately 11 million of them running > 100 days a year.[1,2] Running is an affordable, convenient, and efficient form of exercise, whose benefits include a decrease in the risk of all-cause early mortality, cancer, and diabetes; an improved lipid profile; and better mental health.[3]

However, running is also the cause of a significant percentage of exercise-associated injuries: More than 60% of runners report overuse injury annually.[4] Given the high incidence of running-related injury, an important component of primary care is accurately diagnosing and managing such injuries and counseling patients about how to prevent them.

This article reviews risk factors for running-related injury and summarizes evidence-based recommendations for prevention.

CASE ▶

During a health maintenance examination, Clara K, a 47-year-old woman who is obese (body mass index [BMI], 34) and has bilateral knee osteoarthritis (OA), inquires about establishing a weight-loss strategy. Ms. K is interested in starting an exercise regimen involving running but is worried about provoking a flare of OA pain.

Risk factors for running injuries

Several risk factors—some modifiable, others nonmodifiable—are associated with running-related injury (**TABLE 1**[4-16]). In addition, research suggests that other variables once thought to be risk factors, such as running surface and the Q-angle (described later), are not associated with running-related injury.

Modifiable risk factors

Changes in a training regimen or type of training. Many runners escalate training regimens as their fitness improves.

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Increasing mileage and changing the type of training (such as introducing hills or interval training) are independent risk factors for sustaining injury.[5]

The traditional recommendation has been for a runner to slowly increase or modify training with a 10% weekly increase in mileage or intensity.[17] However, a randomized controlled trial failed to show a lower incidence of injury among amateur runners who adopted a graded exercise program.[18] Regardless: It is still prudent to recommend a gradual increase in activity, such as taking ≥ 1 day off between running workouts or starting with a walking or jogging program, especially when there is a history of injury.[19]

Excessive mileage. Many runners aspire to complete high-mileage runs. There is low-quality evidence demonstrating that high-mileage running, especially > 40 miles per week, is associated with increased risk of running-related injury.[5] Injuries that occur with higher mileage are more often those of the hip and hamstring.[5] A study noted that running ≤ 25 miles a week was protective against calf injury.[6]

Overall, there is little evidence to show that high-mileage running is associated with increased risk of running-related injury. However, this is still a risk factor that you should address with patients who have a running program—especially novices and those who ramp up mileage quickly.

Type of surface. Access to running surfaces—concrete, pavement, trails, treadmills, and athletic tracks—varies by time of day and season. Softer surfaces include treadmill, tracks, and trails; harder surfaces include asphalt and concrete.

There are limited data linking running surface with risk of injury.[7] A study did not find an association between peak impact force based on running surface[8]; the authors hypothesized that runners compensate for a harder surface by making kinematic adjustments to minimize impact. With no strong evidence to link running-related injury to a particular running surface, patients should not be restricted to a softer running surface unless they notice a difference in comfort, because it is likely that they can compensate for a harder surface by adapting their gait.

Patients can therefore be counseled to run locally on sidewalks and neighborhood streets—if safe to do so—instead of obtaining a gym membership or driving to run on a trail. Such reassurance can increase a patient's access to running and reduce barriers to exercise.

CONTINUED

IMAGE: JOE GORMAN/GETTY IMAGES

TABLE 1

Real (and refuted) risk factors for running-related injury: How to help patients reduce their risk[4-16]

Risk factor	Magnitude of risk	Recommendation to reduce risk
Arch height	Pes planus and pes cavus can be associated with increased risk of injury[5,7,11-13]	Consider prescribing or recommending an orthosis to reduce pain, although this does not necessarily reduce the risk of injury
Sex	Female runners—particularly those who are underweight and meet criteria for the female athlete triad—are at slightly higher risk of running-related injury, including bone stress injury[4,14]	Complete a risk assessment for female runners (as for all runners) and evaluate them for the female athlete triad
Changes in training	Changes in the training regimen are associated with increased risk of running-related injury[5]	Recommend that any increase in activity that the patient is planning be gradual; consider recommending a day off between runs to allow for recovery—especially when a runner has had a previous injury
Mileage	Higher mileage can be associated with increased risk of injury[5,6]	Recommend (especially to novices) running < 40 miles per week (ideally, < 25 miles per week) to decrease risk of injury
Surface	There is no association between running surface and injury or impact force[7,8]	No recommendations for reducing risk Advise patients that they can run on any surface they find comfortable or convenient
Body mass index	Patients with a higher body mass index might have a slightly higher risk of running-related injury[4,9,10]	No recommendations for reducing risk Given the potential benefit of exercise, patients should not be discouraged from running—the slight increase in risk of injury notwithstanding
Osteoarthritis	There is no strong evidence that osteoarthritis progresses with, or is exacerbated by, running[15,16]	No recommendations for reducing risk Patients with osteoarthritis who want to run can be encouraged to do so, as long as they find that running is comfortable

BMI. Elevated BMI increases joint contact forces, which might increase risk of pain and injury.[20] Results of studies investigating the link between BMI and running injury are mixed; some report that, in regard to bone stress injury, overweight BMI (> 25) is a risk factor for male runners and underweight BMI (< 18.5) is a risk factor for female runners.[4,6] An observational study concluded that, among half-marathon and marathon runners, there was no significant increase in race-related injury, based on BMI.[9] However, another study showed a higher rate of running-related injury in novice runners who had a higher BMI.[10] A prospective cohort study found that runners with a higher BMI reported increased knee stiffness, which can place a runner at higher risk of overuse injury.[4]

Although these results conflict, there is consistency in the finding that obese novice runners are likely at increased risk of running-related injury; it is reasonable, therefore, for you to discuss strategies to reduce the risk of other modifiable factors, especially among obese novice runners. Patients with a higher BMI should not be discouraged from running, because exercise in combination with healthy eating habits is essential to decrease the myriad adverse health outcomes associated with obesity.

Female runners with a lower BMI, especially in the presence of other components of the female athlete triad (inadequate nutrition, amenorrhea, and low bone density), should be counseled about their increased risk of bone stress injury.[21] Notably, a study of female US Navy recruits randomized to receive a trial of dietary supplementation of

vitamin D plus calcium, or placebo, showed a 21% lower incidence of bone stress injury in the active-treatment group.[22] To mitigate risk of injury associated with low BMI and the female athlete triad, therefore, a multidisciplinary approach of nutrition intervention, dietary optimization of vitamin D and calcium, and, possibly, activity modification should be implemented when appropriate.

Running gait. A study using 2-dimensional gait analysis to visualize biomechanical running patterns in injured and noninjured runners found that, in regard to mechanical variables, running-related injury was most strongly associated with contralateral pelvic drop.[23] Gait retraining can be employed to help decrease contralateral pelvic drop.[24] In addition, pelvic drop is often a result of weak gluteal muscles, and can be improved by doing strengthening exercises at home or with physical therapy.

Longer stride is also associated with running-related injury.[25] A study showed improvement in patellofemoral pain by having runners increase stride rate by 10%, which reduces stride length to a significant degree.[25,26] These improvements were maintained at 1-month and 3-month follow-up, and required only 1 gait retraining session.

Gait analysis is not feasible in most primary care clinics. Instead, patients who run and (1) in whom pain persists despite more traditional treatments and (2) who have had recurring injury should be referred to a gait lab for analysis, usually by a physical therapist.

Nonmodifiable risk factors

Arch height. A high arch (pes cavus) is associated with increased risk of running-related injury, including bone stress injury, Achilles tendinopathy, plantar fasciitis, and patellofemoral pain syndrome.[5] The mechanism of injury is thought to be increased forefoot loading forces.[1]

A review article showed that patients with pes cavus have reduced pain when using an orthosis, although there is no associated decrease in the risk of injury.[5] To the contrary, a prospective study concluded that arch height was unrelated to increased risk of running-related injury.[7]

Evidence regarding flat feet (pes planus) and risk of injury is also mixed. Some studies show that pes planus is not associated with increased risk of injury in athletes.[12] A cross-sectional study in older patients showed those with pes planus morphology had a higher rate of knee pain and wearing away of medial compartment cartilage.[13] Because this study comprised only older adults, it is not generalizable to runners—nor can conclusions be drawn about causation, given the cross-sectional nature of the study.

Although a foot orthosis can correct mechanical differences caused by pes planus morphology, there is not enough evidence to conclude that correction results in a lower rate of injury. In sum, data are mixed with regard to arch height as a risk factor for running-related injury.

Patients with pes planus or pes cavus should not be discouraged from running, however. If they experience pain with running, they might benefit from a trial of arch support inserts; or consider referral to an orthotist for evaluation for a custom orthosis.

Sex. Based on a prospective cohort study, female runners have a slightly higher rate of running injury than male counterparts.[4] Similarly, a study showed that female military members generally had a higher incidence of stress fractures than male military members—specifically, femoral shaft and neck stress fractures.[14] Runners who fall in the spectrum of the female athlete triad, as described earlier, are particularly vulnerable to bone stress injury. It is reasonable, therefore, to review risk factors for injury with female runners (as it is with all runners), especially those who have sustained a prior running-related injury.

Increased Q-angle (an obsolete risk factor). The Q-angle is approximated by drawing a line from the anterior superior iliac spine to the patella and a second line from the patella to the tibial tubercle. In males, a normal Q-angle is 14°; in females, 17° (SD = 4.5°). The Q-angle can be obtained by goniometric or radiographic measurement.

An increased Q-angle had been considered an intrinsic risk factor for running injury but has not been shown to be associated with

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High-mileage running, especially > 40 miles per week, is associated with increased risk of injury, most often of the hip and hamstring.

increased risk of running-related injury or patellofemoral pain syndrome.[27,28] Because the Q-angle is not a clinically relevant tool in assessing risk of injury, do not routinely measure it or include it in risk-factor counseling.

OA. Based on a systematic review of observational studies, data are inconclusive with regard to whether running contributes to, or is protective against, knee OA.[15] In a large cohort study, running (1) was protective against development of hip OA and (2) decreased the risk of requiring hip replacement.[29] This finding was supported by animal-model research that concluded that it is inactivity that results in thinning of articular cartilage.[29] In addition, a systematic review of randomized controlled trials concluded that knee joint-loading exercises are not harmful to articular cartilage (this is low-quality evidence, however).[16]

Given that there are no high-quality studies suggesting that running contributes to or exacerbates OA, patients with OA can be counseled to start or continue running as tolerated because the health benefit of running likely outweighs risk. Patients with preexisting moderate-to-severe OA might report knee and hip pain that is already exacerbated by certain activities; if a high-impact activity, such as running, makes that pain worse, exercise counseling that you provide can be tailored to include lower-impact alternatives, such as swimming, cycling, or an elliptical workout.

CASE ▶

In response to Ms. K's interest in beginning an exercise regimen that includes running, you perform a complete routine pre-participation evaluation and appropriate cardiac screening. You discuss risk factors for running injury, focusing on modifiable risk factors.

Ms. K is perimenopausal but reports a history of regular menstrual cycles. She eats a relatively well-balanced diet. You advise that her BMI should not restrict her from incorporating running into her fitness regimen. Also, you reassure her that she should not restrict running based on a diagnosis of OA; instead, you advise her to monitor her symptoms and reconsider her program if running makes her knee pain worse.

At this point, Ms. K is ready to run. She tells you that, based on your guidance, she feels more comfortable and safe starting a running program.

Preventing injury

After reviewing risk factors for running-related injury with patients, encourage other evidence-based methods of reducing that risk.

Shoes

The running shoe industry offers a variety of running shoes, from minimalist shoes to cushioned stability shoes that vary based on the amount of cushioning, level of motion control, and amount of heel-to-toe drop. With so many options, new runners might wonder which shoes can reduce their risk of injury and how they should select a pair.

Stability. A characteristic of running shoes promoted by the industry is their stability: ie, their motion control. Stability shoes are marketed to runners who overpronate and therefore limit motion to prevent overpronation. The benefit of stability shoes, or stability insoles, is unclear.[30] A randomized controlled trial showed that, in runners who overpronate, motion-control shoes reduced their risk of injury.[31] However, another study assessed whether shoes that had been "prescribed" based on foot morphology and stride reduced the risk of injury (compared to neutral, cushioned shoes) and found no change in the incidence of soft-tissue injury.[32] Given no strong evidence to suggest otherwise, runners can be advised to buy shoes based on comfort rather than on foot morphology or running stride.

Heel-to-toe drop. Another component of shoe variability is heel-to-toe drop (the height difference between heel and forefoot). A study suggests that moderate-to-high (8-12 mm) heel-to-toe drop is associated with a reduced risk of running injury.[33] Barefoot running shoes, which, typically, have no heel-to-toe drop, are associated with increased risk of injury—specifically, foot stress fracture (especially in runners who are even moderately overweight).[34,35]

Shoe age and shoe wear can be modified to reduce injury. There is evidence that

TABLE 2

Keep patients running safely with this running shoe guidance

Variable	Comment	Recommendation
Age	Cushioning in running shoes decreases with age	Consider replacing shoes every 12 mo
Wear	Approximately 50% of cushioning is lost by 300-500 miles of wear, which can lead to increased risk of running-related injury	Replace shoes after 300-500 miles of running
Heel-to-toe drop	Low to no heel-to-toe drop is associated with increased risk of injury in regular runners	Recommend running shoes that have a moderate-to-high (8-12 mm) heel-to-toe drop Advise against minimalist or so-called barefoot running shoes, especially in overweight patients
Stability and motion control	Certain running shoes are intended to prevent or correct overpronation during running stride	Evidence is inconsistent that motion-control shoes decrease the risk of running-related injury Runners should try several pairs of shoes and wear the pair that feels most comfortable

running shoes lose approximately 50% of cushioning after 300 to 500 miles of use.[36] Another study found that rotating running shoes—ideally, different types or brands—can lead to fewer running-related injuries.[37]

In general, patients can be counseled to use shoes that feel comfortable, as long as they replace them regularly (**TABLE 2**). Runners can also consider alternating pairs of different running shoes between runs. Overweight runners should avoid minimally cushioned and low heel-to-toe drop running shoes.

Cross-training

Cross-training exercises for runners include cycling, an elliptical workout, swimming, and weightlifting. Incorporating cross-training can be protective against running injury because cross-training requires different movement patterns, prevents overuse, and equalizes muscle imbalances that occur with running.[7] In addition, replacing running with a cross-training activity can decrease weekly running time and mileage, which can further reduce risk of running-related injury.[7] Runners—especially higher-mileage runners—should be encouraged to incorporate cross-training into their workout regimen to decrease their risk of injury.

Stretching. The authors of a Cochrane review concluded that there is no significant reduction in injury associated with hamstring or gastrocnemius stretching.[32] A small randomized, controlled, crossover study concluded that participants subjectively felt their performance was better when warm-ups included stretching.[38] This perceived improvement in performance was similar between groups who completed dynamic or static stretching. However, no difference was noted in flexibility or objective performance between groups who stretched or did not stretch before activity.

Although there is no supporting evidence that stretching reduces the risk of injury, stretching is a low-risk intervention. Because stretching might provide subjective benefit to runners, you need not discourage patients from including this activity in their running program. JFP

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There is no reason to counsel runners to run on a softer running surface, unless they find that doing so is more comfortable.

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