The Best Ways to Prevent Age-Related Decreases in Running Performance

by Tom Michaud, DC

It's a depressing fact but shortly after your 30th birthday, you start losing between 0.5 and 1% of your muscle mass each year (1). The rate of muscle loss really accelerates after you turn 50, with nearly 50% of your muscle fibers disappearing between the ages of 50 and 82 (2). To make matters worse, the reduced muscle mass produces even greater decreases in muscle strength, which results in significant reductions in running speed.

The technical name for age-related muscle loss is sarcopenia, which translates from the Greek "poverty of flesh." For unknown reasons, the muscles of the feet and ankles are especially affected by sarcopenia, and this can have a profound effect on running performance. In a 2018 study comparing muscle force production in young and middle-aged runners, Paquette et al. (3) confirm that older runners slow down not because they get weaker in their hips and knees, but because they get weaker in specific muscles of their calves and feet (Fig. 1). In fact, force output in the ankles and feet of older runners was nearly 11% lower than that of their younger peers. The authors suggest that maintaining foot and ankle strength could reduce age-related decreases in running performance.

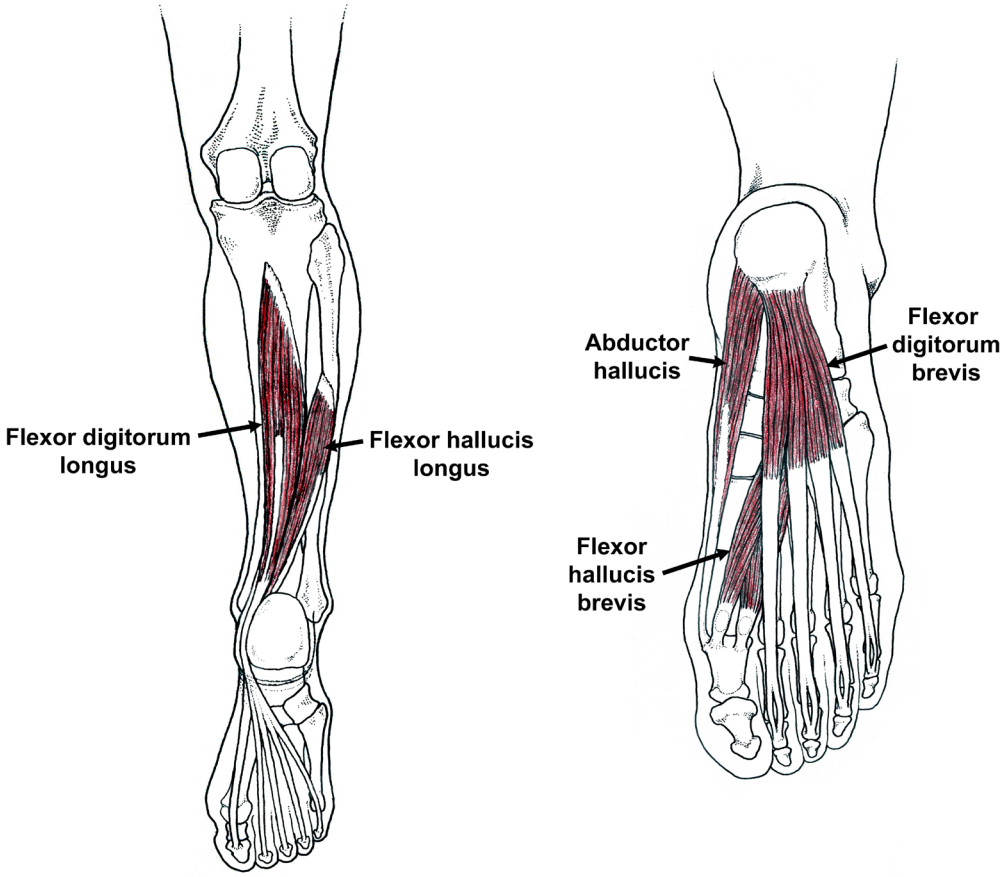

Fig. 1. Muscles of the calves and feet most affected by sarcopenia. Weakness of these muscles is associated with significant reductions in running performance.

One possible mechanism for the accelerated rate of muscle loss in the foot and ankle compared to the rest of the body is that the genes responsible for repairing muscle were programed during the late Paleolithic period (50,000 years ago), when constant activity led to continual repair and remodeling of our muscles. Booth et al. (4) claim that because the genetic code for muscle remodeling was hard-wired into our system when we were physically active hunter-gatherers, in order to stimulate repair, we must duplicate the stress present when the muscle repair genes were first made. Without excessive stress, muscle remodeling would not occur. Supporting the belief that our genes were designed for activity is the fact that modern hunter-gatherers develop age-related reductions in muscle strength at a much slower rate than similar-aged sedentary populations (5).

The most logical explanation for accelerated muscle wasting in the feet and ankles compared to the rest of the body relates to the regular use of protective shoe gear. Because our stone-aged ancestors were barefoot from birth, the constant irritation from stepping on stones and other sharp objects stressed and strengthened the toe and arch muscles, which were constantly active as they pushed the toes down with excessive force to redistribute pressure along the bottom of the foot (Fig. 2).

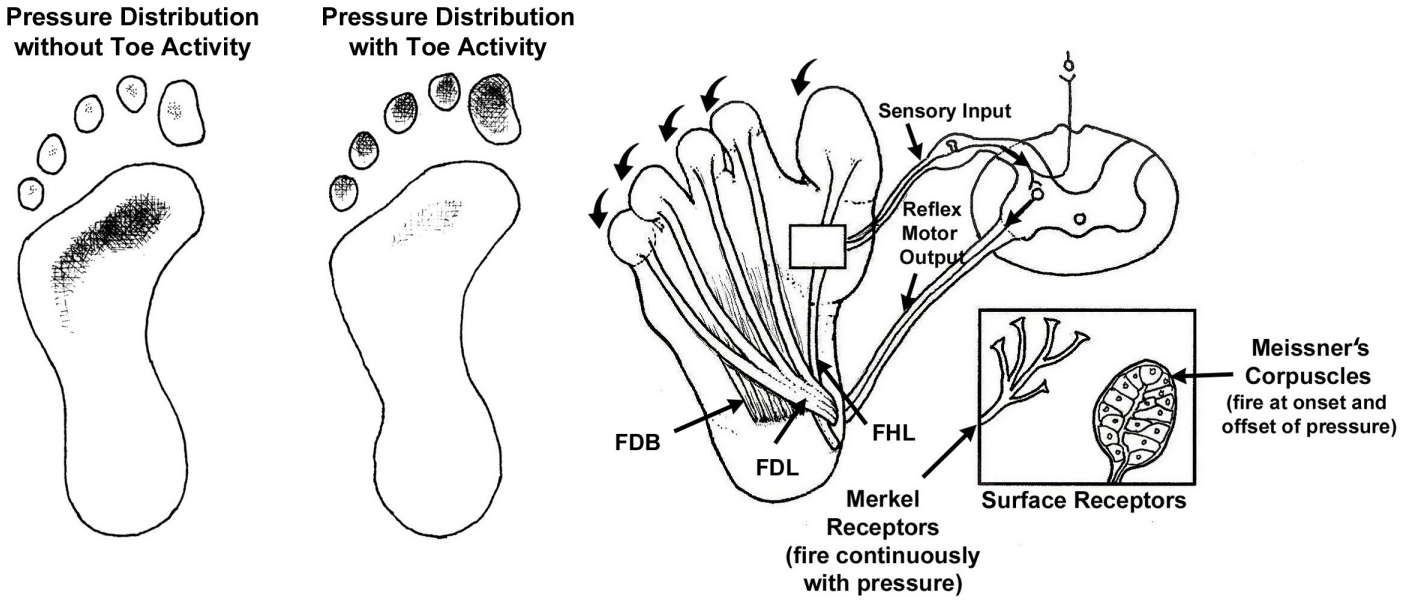

Fig. 2. Special receptors in the skin beneath the bottom of our feet (Merkel receptors and Meissner's corpuscles) create a reflex in which painful stimulation (such as stepping on a stone) produces an immediate reflex forcing our toe muscles to push down with more force. Downward pressure from the toes (**arrows**) produces a redistribution of pressure away from the central forefoot into the tips of the toes (images on the left). **FDB**: flexor digitorum brevis, **FDL**: flexor digitorum longus, **FHL**: flexor hallucis longus.

The clear differences in force output between our late Paleolithic feet and modern feet is evident by comparing skeletal remains from 100,000 years ago and now (Fig. 3). Notice how compared to the modern foot, our ancestors had significantly wider toe bones. According to Trinkaus and Shang (6), changes in the shape of our toes occurred rapidly, approximately 30,000 years ago. These authors claim that because the decreased bone width occurred only in the toes, not in any other bones of the body, the only plausible explanation was that the thinner toes resulted from the introduction of shoes. Without the need to push down to distribute pressure away from uncomfortable objects, toe stress was significantly reduced, resulting in a gradual wasting away of the toe bones themselves.

To understand the biomechanical effects of being barefoot from birth, researchers from Belgium measured pressure beneath the forefeet in modern humans who grew up barefoot, and in people who grew up wearing shoes (7). Besides having forefeet that are 16% wider, lifelong barefoot populations have significantly less pressure centered directly beneath the middle of the forefeet.

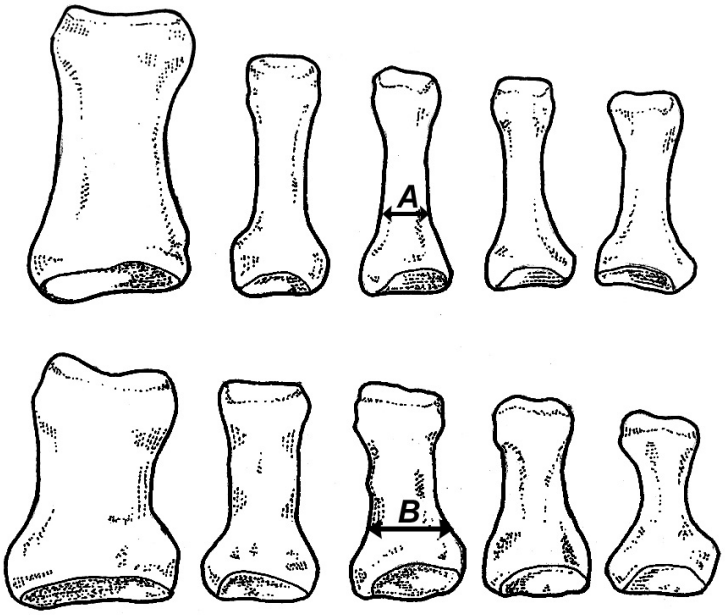

Fig. 3. Compare the width of the toe bones from the early (bottom row) and late (top row) Paleolithic era. Trinkaus and Shang (6) claim that the decreased strain on the toes associated with regular shoe use produced bony remodeling with a gradual narrowing of the toe bones (compare **A** and **B**).

These authors prove that when barefoot from birth, overactive toe muscles produce a redistribution of pressure away from the forefoot into the tips of the toes (as in Fig. 2). This research is consistent with a comparative study of ancient and modern human skeletal remains that confirmed the development of bunions and forefoot arthritis correlated exactly with the initial use of shoes (8).

All of this research proves that about 30,000 years ago, the routine use of protective shoe gear led to a rapid weakening of our toe and arch muscles, which our DNA hasn't had time to adapt to. Without duplicating the stresses present when we were barefoot, our modern-day underutilized toe and arch muscles are unable to adequately stimulate muscle repair and are subject to accelerated age-related muscle wasting. This is the only logical explanation as to why runners develop decreased force output in their feet and ankles and not in the knees or hips. Apparently, protecting our feet with shoes created a mismatch between our stone-aged genes, which stimulate muscle repair when a certain threshold of force is reached, and our modern lifestyle, where shoes and sneakers significantly limit force output by the toe and arch muscles.

While running barefoot has been proven to strengthen our toes and arches, unless you are barefoot from birth, your narrow forefeet and weak toes are likely to be injured when attempting to run sans sneakers. To evaluate the risks and rewards associated with barefoot running, researchers from Brigham Young University had runners complete a 10-week running program wearing either conventional running shoes, or the Vibram 5-finger minimalist shoes designed to duplicate barefoot running (9). Repeat MRIs performed at the beginning and end of the 10-week training revealed that while only one out of 17 runners wearing conventional running shoes showed signs of bone injury, 10 out of 19 runners wearing the minimalist shoes developed a bone injury. The 10-fold increased rate of bone injury present in the minimalist shoes occurred in spite of the fact that the runners training in traditional shoes actually ran more miles per week. In a 2012 analysis of 10 experienced runners transitioning to minimalist shoes, Salzler et al. (10) report that within 3 months of switching from conventional running shoes, the runners suffered total of 8 metatarsal stress fractures, one fractured heel, and one ruptured plantar fascia. Subsequent studies have confirmed that the shin and calf muscles of runners wearing minimalist shoes are particularly prone to being injured (11).

Rather than risking injury by trying to strengthen your feet with barefoot running, a safer way to maintain arch and toe strength is to run in conventional running shoes and strengthen the toes with specific exercises designed

to target the long and short toe flexors. In addition to preventing age-related decreases in running speeds, toe strengthening exercises have been proven to improve jump height, increase horizontal jump distance, and improve sprint performance (12-14). The importance of toe strength is made clear by evaluating foot x-rays of the world's fastest runners: these athletes have toes that are nearly 1 cm longer than regular runners, which provides the toe muscles a longer lever arm for generating force during push-off (15) (Fig. 4). While we can't make our modern-day structurally weak and narrow toes become longer or wider, we can make them significantly stronger.

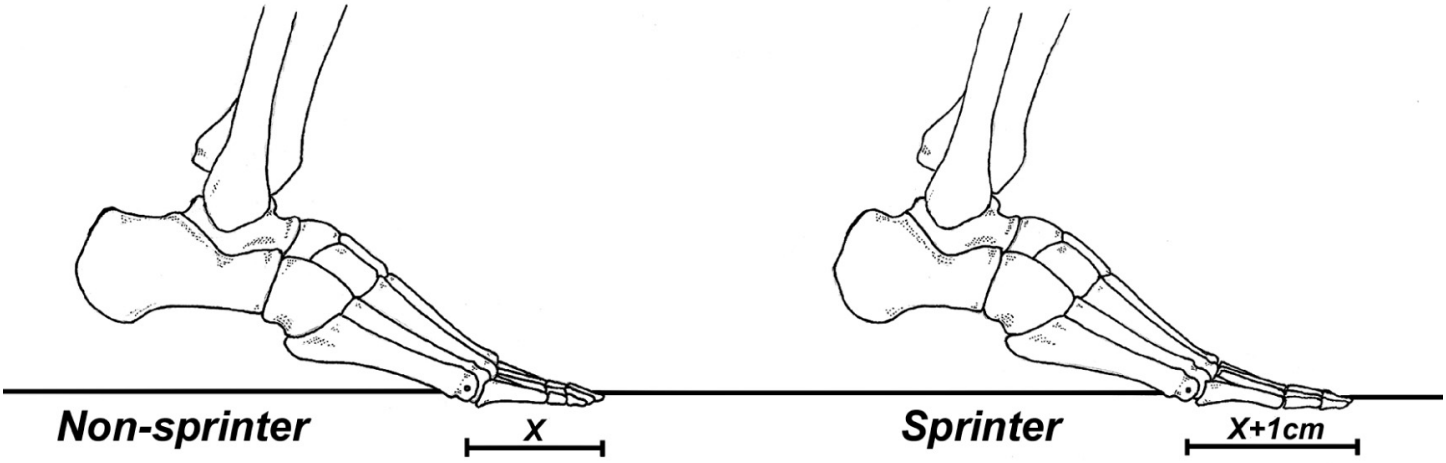

Fig. 4. The toes of sprinters are one centimeter longer than the toes of non-sprinters. Long toes allow for faster running times by providing the toe muscles with longer lever arms to generate force during propulsion.

My favorite way to strengthen the long and short toe muscles is with the ToePro exercise platform. This platform has an elevated support built beneath the toes, which forces you to recruit your toe muscles while they are in a stretched position. As demonstrated by Goldmann et al. (14), exercising your toes while they are in lengthened positions produces 4-times the strength gains associated with conventional exercises, such as elastic band exercises and marble pickups. Just 6 weeks of performing isometric toe exercises with the toes stretched resulted in significant increases in horizontal jump distance (14). This compares to six months of training with elastic bands and marble pickups, which resulted in no appreciable increase in the ability to bear weight beneath the toes (16). Apparently, because strength gains are angle specific, in order to be effective, the toe muscles must be exercised in the upward positions that they are used while running. To produce the best functional outcomes, the toe muscles should be exercised through ranges that match their real-life movement patterns.

The ToePro exercise platform also has a 10° negative side tilt, which forces you to use the peroneal muscles (Fig. 5). In addition to protecting the heel from injury (17), the peroneal muscles have also been proven to play an important role in running fast. In an interesting analysis of muscle activity as athletes transition from slow to fast running, Reber et al. (18) show that peroneus brevis has a linear increase in activity as running speed is increased. The authors emphasize the importance of strengthening this often overlooked muscle in order to optimize sprint performance. While our hunter gatherer ancestors routinely used their peroneal muscles while traversing uneven terrain, running sneakers maintain the forefoot and rearfoot in the same transverse plane, greatly underutilizing the peroneal muscles.

To use the ToePro exercise platform, place the tips of your toes into the center of the front crest (A) while shifting your weight to the outside of your feet; i.e., keep your arches raised. Now, raise your heels while pressing down firmly with your toes, gradually shifting weight from your outer to your inner forefoot (Bv). When raising your

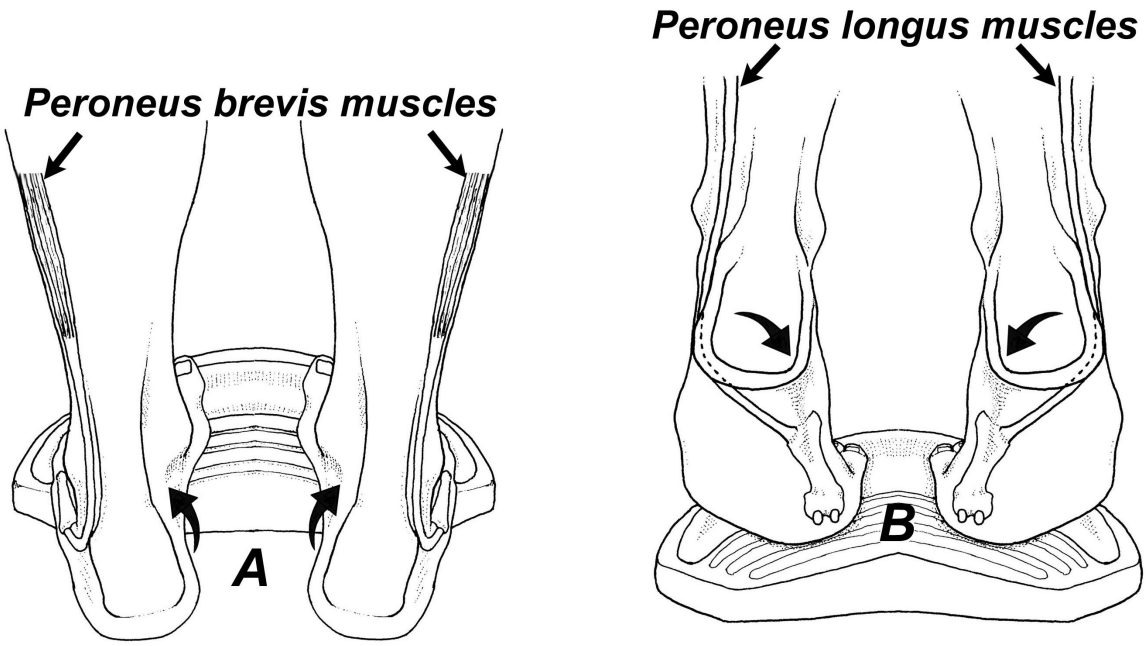

Fig. 5. The downward side tilt of the ToePro Platform forces you to recruit the peroneal muscles, which are important for injury prevention and performance enhancement.

heels, focus on driving your inner forefoot and toes firmly into the foam and hold this position for a few seconds. Try to build up to doing 4 sets of 25 repetitions moving at a moderate pace: spend 1-second going up and 2-seconds going down. The first set of this exercise is performed with your knees straight. Subsequent sets are performed with the knees slightly bent, which better isolates the leg and arch muscles. It is important that you spend less than 30 seconds resting between each set. Short rest periods between sets have been proven to accelerate muscle repair and remodeling (15). Finish the exercise by holding your heels 1-inch off the ground for up to 60 seconds. Prolonged isometric contractions performed with muscles in their lengthened positions have also been proven to accelerate muscle repair (16). Try to balance with hands close to but not touching the wall for the final 60 seconds.

Start to finish, this program takes about 6 minutes to complete and should be performed 5 times each week. Because your body adapts to a specific workout, vary sets and repetitions, and alternate 12-week cycles. Perform some of the sets quickly and some slowly. If you're up for a challenge, try performing 4 sets of 80 light-resistance repetitions, as this protocol has been proven strengthen tendons in high-level athletes (17). Maintaining tendon resiliency is especially important as we age since tendons store and return energy, which greatly improves running efficiency. With a minimal investment of time and energy, you can delay age-related reductions in strength and performance by forcing your stone-aged genes into repairing and remodeling your toe and arch muscles the way your ancestors did 100,000 years ago.

The ToePro is available online at www.HumanLocomotion.org.

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