

The Best Ways to Prevent Age-Related Muscle Loss

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Shortly after age 50, the rate at which a person loses muscle mass begins to accelerate (1). Figure 1 is a graphical representation of the average number of quadriceps muscle fibers present in adults aged 18 to 82 (2). Looking at the center of the graph, it is clear that the number of muscle fibers remains stable until around age 50. After that, muscle mass declines rapidly, dropping from 600,000 muscle fibers at age 50 to 320,000 muscle fibers by age 80. The loss of muscle fibers is compounded by even greater losses of strength and power and an increase in fatigability. The resultant weakness produces a downward spiral of frailty that correlates strongly with the development of osteoarthritis, disability, fractures, and reduced lifespan (3).

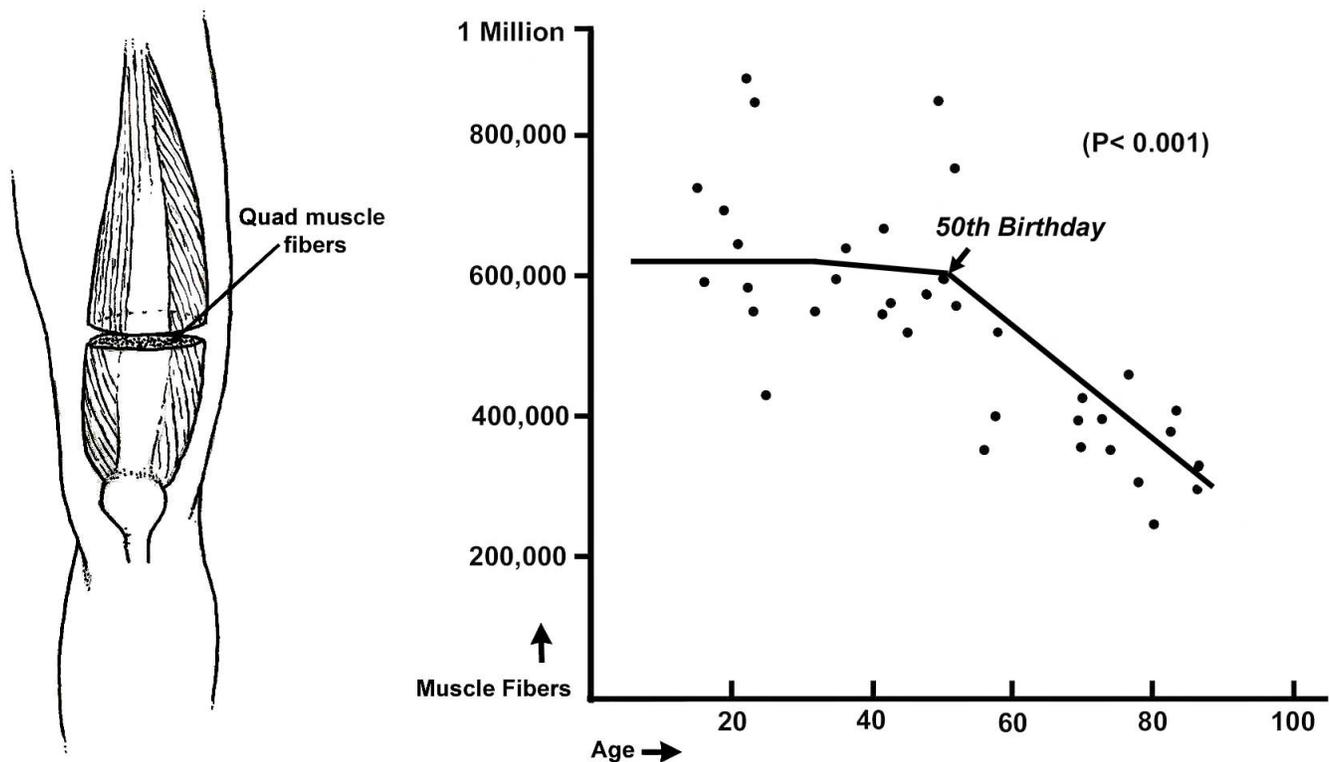


Figure 1. Total number of fibers present in the quadriceps muscles of men between the ages of 18 and 82 years (15).

Age-related muscle loss is referred to as sarcopenia, which is Greek for “poverty of flesh.” Unfortunately, the prevalence of sarcopenia is increasing with each generation; the number of elderly individuals who are frail is expected to double within the next 40 years (4). One theory for the growing prevalence of sarcopenia posits that the genes responsible for repairing damaged muscles were programmed during the late Paleolithic period, when constant activity led to continual repair and remodeling of muscles (5). Our current, more sedentary lifestyle does not match our evolutionarily programmed Paleolithic genes. Supporting the belief that human genes were designed for activity is the fact that modern hunter-gatherers develop sarcopenia at much slower rates than similar-aged sedentary populations (5).

While research confirms that regular exercise can reduce the speed of muscle wasting, there is a surprising amount of controversy regarding what type of exercise is best-suited for maintaining muscle mass. According to the American College of Sports Medicine, the only way to effectively build muscle is to perform multiple sets of 8 to 12 repetitions using heavy weights (6). The theory is that the muscle must be pushed to the limit of its capacity to stimulate muscle repair.

The problem with using heavy weights is that as a person ages and muscle fibers begin to disappear, the vanishing muscle fibers are replaced with fat and scar tissue, which significantly weakens muscles and tendons (7). As a result, heavy resistance exercise increases the likelihood of a muscle tear, which explains why so few seniors are consistent with strength-training programs.

Fortunately, recent research has proven this theory wrong: exercising with light weights, when done properly, is very effective at stimulating muscle repair (3). To understand how light weights can increase muscle remodeling, it is first necessary to understand how muscles work. Basically, all muscles are made of small cells, or myofibers, which are classified as either slow-twitch (type I) or fast-twitch (type IIB) fibers. Slow-twitch fibers are designed to produce low levels of force for long periods of time. Slow-twitch muscles use oxygen for energy and therefore require a lot of capillaries to supply them with oxygen-rich blood. Slow-twitch muscle fibers are the body's preferred fibers when running marathons. Conversely, fast-twitch fibers function without oxygen and produce large amounts of force in very short periods of time. Fast-twitch muscle fibers are essential for success in sprinting and weightlifting. Because fast-twitch muscle fibers function without oxygen, they have limited need of a blood supply.

The central nervous system selectively recruits either slow- or fast-twitch muscle fibers depending on the activity being performed. When exercising with light weights, the body chooses the same small percentage of the available slow-twitch muscle fibers over and over again. These slow-twitch muscle fibers generate adequate amounts of force and rarely fatigue, making them the body's "go to" muscles for almost all daily activities. When lifting a heavy weight, however, the slow-twitch fibers are initially activated, but when they are unable to generate adequate force, the body begins to recruit fast-twitch fibers. The heavier the weight, the more fast-twitch muscle fibers are recruited.

The forced recruitment of fast-twitch muscle fibers is the key to preventing age-related muscle loss because stimulation of fast-twitch muscle fibers causes specialized satellite cells to repair and rebuild muscle fibers (8) (Figure 2). Satellite cells are considered the stem cells of muscles because they have the ability to differentiate into myoblasts, the precursor repair cells that are responsible for muscle growth, remodeling, and repair (9). Until recently, it was believed the recruitment of fast-twitch muscle fibers with subsequent satellite cell activation could only occur by lifting heavy weights. This is why the American College of Sports Medicine continues to recommend heavy-resistance exercise for strength training (6).

Luckily, muscles can be "tricked" into recruiting fast-twitch fibers (and hence, stimulate satellite cell activity) by fatiguing the slow-twitch fibers with multiple sets of light-resistance repetitions performed with very short rest periods (10). Although the exact mechanism is unclear, it is theorized that frequent repetitions performed without rest causes an increase in intramuscular pressure, which in turn reduces oxygen levels in the muscle (10). Because slow-twitch muscle fibers require oxygen to function properly, lower oxygen levels force a shift from slow-twitch to fast-twitch muscle fibers despite the fact that only light resistance is being used. Regardless of how it is accomplished, the recruitment of fast-twitch muscle fibers stimulates satellite cells to rebuild and repair muscles.

To prove light resistance can build muscle mass, researchers from McMaster University measured the rate of muscle protein synthesis before and after young subjects completed a conventional heavy-resistance exercise program (performed at 90% of full effort) or a less intense protocol in which subjects performed four sets of 24 repetitions to volitional fatigue (approximately one third of full effort) (11). Surprisingly, the authors noted significantly more muscle fiber production in the lower resistance group. The only drawback to this study was that the researchers evaluated athletic 21-year-old males, who tend to build muscle mass easily.

To evaluate the ability of light-resistance versus heavy-resistance protocols to increase muscle mass in senior citizens, researchers from Belgium (12) measured muscle volume with a CT scanner before and after a group of older

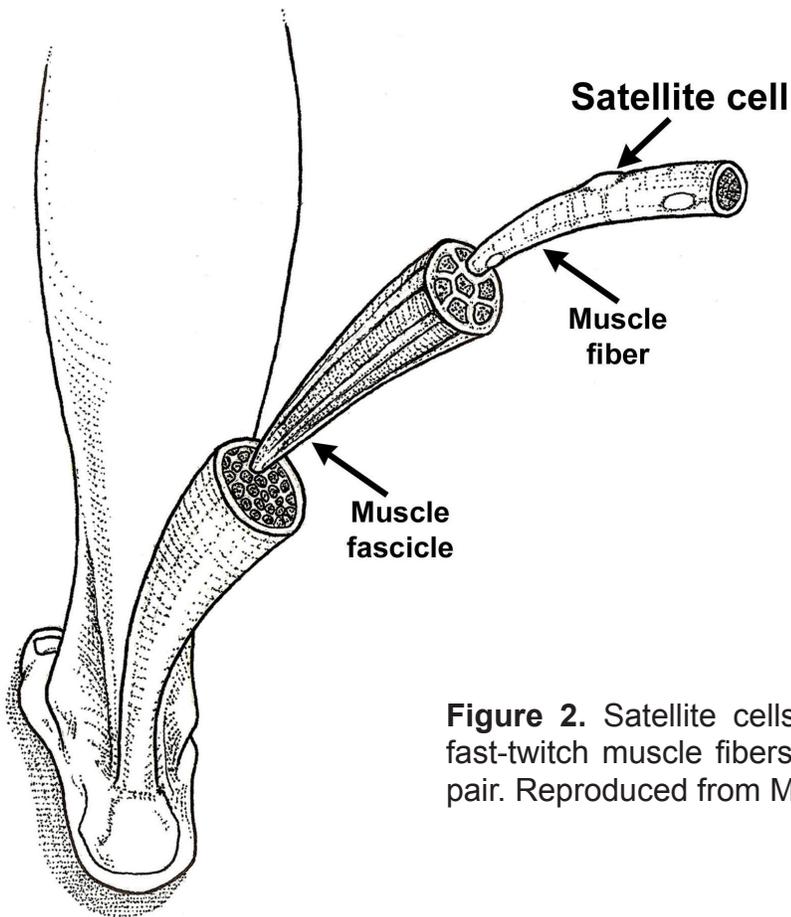


Figure 2. Satellite cells surround muscle fibers (especially fast-twitch muscle fibers) and are responsible for muscle repair. Reproduced from Michaud (18).

adults completed a 12-week training program (the average participant age was 70 years old). The heavy-resistance program included the usual two sets of 10 to 15 repetitions performed at near full effort. In the light-resistance program, the seniors were instructed to complete a fatiguing protocol of 60 light-resistance repetitions, followed, without rest, with one set of 12 repetitions performed slowly and with slightly higher resistance (approximately 40% of full effort performed at a moderate pace of one second up and two seconds down). At the end of 12 weeks, follow-up CT scans confirmed both the heavy- and light-resistance groups had increased muscle mass by an equal amount. The authors stated that prior to publishing their paper in 2013, virtually no studies had been performed using high-repetition protocols.

More recent research shows it is possible to build muscle mass using light resistance provided by body weight alone (3). In this 2018 study, researchers from Japan had 88 men and women aged 70 years or older participate in a weight-training program in which they performed two sets of 10 to 14 repetitions daily for 12 weeks. The subjects used body weight alone and performed the movements very slowly (four seconds up and four seconds down). At the end of the 12-week training program, in addition to significant increases in muscle mass, participants also had decreased hip and waist circumference and decreased abdominal fat. The authors claim their success was related to the total time the muscles were contracting during their protocol. Even though the loads were light, the four-second up and four-second down time resulted in a total of 1,344 seconds of muscle contraction time per week (12 repetitions x 8 seconds x 2 sets x 7 times per week). The authors suggest the long total contraction time is what creates muscle mass, not the amount of resistance. This study is remarkable because the participants had no prior experience with weight training, the exercises were performed at home (taking less than 15 minutes each day), and at the end of the study, only two of the 88 people involved dropped out.

The most important component of all of these exercise protocols is that light weight is repeatedly lifted until the involved muscle is fatigued. In some situations, the involved muscles fatigued after one set of 60 repetitions performed at about 15% of full effort. In other situations, the involved muscles fatigued after 24 repetitions performed at about 30% of full effort. Regardless of which fatigue protocol is chosen, the rest periods between sets should be

short (less than 30 seconds), as this may increase the number of muscle fibers recruited in subsequent sets (10). The more muscle fibers recruited with each set, the more satellite cells work to stimulate remodeling. Apparently, long rests between sets allow for the restoration of blood flow, which restores circulation and allows the body to go back to using slow-twitch muscle fibers. A growing body of research suggests that muscle hypertrophy can occur with loads as low as 15% of full effort as long as the total contraction time is prolonged (13-15).

Increased muscle remodeling with prolonged contraction times explains why isometric contractions are so effective at building muscle mass (16). For unknown reasons, muscle remodeling occurs more quickly when muscles are isometrically contracted in their lengthened positions. To prove this, Australian researchers had subjects perform a series of five-second isometric contractions with their muscles either stretched or shortened (17). After six weeks of training, muscle volume was measured using MRI. The authors noted that the muscles which were isometrically contracted in their lengthened positions had significantly more mass. It is possible that stretched muscles are under greater physiological stress, which has been proven to increase protein synthesis.

The latest research on muscle function proves that it is easy to build muscle mass as long as muscles are contracted for extended periods of time. However, the amount of rest between sets must be kept to 30 seconds or less in order to limit the restoration of blood flow.

Simple Workout Routine to Maintain Muscle Mass

The following routine, which can be applied to any specific muscle group, takes about five minutes to complete and should be performed two to three times per week. Because the body adapts to specific exercise protocols, vary sets and repetitions on 12-week cycles. Some of the set should be performed quickly and some slowly. Hold some positions isometrically for five to 10 seconds.

- Warm up with one set of 60 repetitions. This will increase muscle pressure and force a shift to fast-twitch muscle fibers.
- Perform three sets of 24 repetitions to fatigue with less than 30 seconds rest between each set.
- Finish with one 60-second isometric contraction with the muscle held in a stretched position.

For a more challenging workout, perform four sets of 80 light-resistance repetitions. This protocol has been proven to strengthen tendons in high-level athletes (14). The most important factor is to begin strength training early in life because it is not possible to increase the total number of muscle fibers in the body; it is only possible to maintain existing muscle fibers.

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