



# The Power of Eccentrics for the

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**EXECUTIVE SUMMARY:** A review of the research supporting eccentric training in older populations to achieve multiple benefits, including decreased risk for falls.

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ACCORDING TO THE ADMINISTRATION ON AGING, THE older population (persons 65 years or older) numbered 39.6 million in 2009, or 12.9% of the U.S. population. By 2030, this number is expected to grow to 72.1 million—more than 19% of the U.S. population. As humans age, the body loses muscle mass (sarcopenia) and strength, which affects balance and coordination, ultimately increasing the risk of falls. On average, by the age of 80, one-half of the skeletal muscle mass has been lost.<sup>1</sup> Approximately one-third of all older adults fall each year, making falls the leading cause of injury in this population. Falls, especially while negotiating stairs, are also the most common cause of nonfatal injuries and hospital admissions for trauma. A large proportion of the elderly at highest risk for falls are exer-

cise intolerant because of illness and age-related cardiac and respiratory impairments. Therefore, an easily tolerated training method must be employed to achieve success in fall prevention.

Literature related to strength training for the elderly reviews isometric, isotonic, and isokinetic resistance exercises. Within the realm of dynamic exercise (isotonics and isokinetics), both concentric and eccentric muscle contractions occur. Concentric contractions involve shortening of skeletal muscle when placed under load, such as when lifting a weight to perform a biceps curl. Here, the force generated by the muscle must be sufficient to overcome the resistance, which in this case is the weight. Conversely, to control the lowering of that weight, a lengthening or eccentric contraction occurs. The muscle lengthens as it works against the force of the weight.<sup>2</sup>

Work occurs as a result of the contraction of skeletal muscle. In concentric muscle action, the force generated to overcome resistance results in work. This type of contraction also requires significant energy expenditure. Eccentric muscle action, when weight exceeds the force developed by the muscle, is referred



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to as “negative work” because the muscle is absorbing energy in this loaded position. This mechanical energy is converted into heat or elastic recoil. Heat results if the muscle is being used as a shock absorber, and elastic recoil results if the muscle is acting like a spring.<sup>3</sup> Force production in skeletal muscle is highest during eccentric work; therefore, eccentric training produces greater strength gains and muscle hypertrophy.<sup>4</sup> Negative work requires muscles to contract with little demand for energy, often resulting in less effort from the person performing the movement. For these reasons, eccentric training is very well suited to the exercise-intolerant elderly (LaStayo et al., 2003).

Additional benefits gained from applying eccentric training as a treatment and prevention tool for the geriatric population include positive outcomes for those suffering from osteopenia, sarcopenia, and muscle tendon injuries, which encompass a large portion of elderly individuals. Bone mass is affected by

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a muscle's force and its load to the bone structure. Osteopenia, which is often thought of as the beginning of osteoporosis, occurs when bone density is lower than normal levels. The ability to achieve high muscle loading, coupled with low required energy output, makes eccentric training an essential rehabilitation tool for osteopenia in the aging population.

Eccentric exercise also has the ability to counteract sarcopenia through continued training. Sarcopenia, the degenerative loss of skeletal muscle mass and strength associated with aging, causes weakness and frailty in the elderly and is often a primary trigger for falls. Eccentric training offers a unique benefit in combating age-related sarcopenia, as it provides greater overloads to the muscle through low-impact movement.<sup>4</sup>

Additionally, the elderly are prone to muscle tendon injuries that may occur from trying to break a fall. Performing the various knee movements needed for walking and using stairs also contribute to these types of injuries. The addition of eccentric exercise to a muscle tendon rehabilitation program can improve muscles' ability to absorb more energy before deteriorating. According to a 2003 study from LaStayo and colleagues, research shows that "increased stiffness in tendons, greater force at failure, and an improved ability to absorb energy at the musculotendinous junction all result following eccentric exercise training."

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Critics of eccentric training for the geriatric population cite the fact that eccentric exercise in extreme forms can cause muscle damage, transient muscle soreness, joint stiffness, and a reduction in joint range of motion. To prevent these possible effects, it is important to monitor the intensity of eccentric movement among elderly patients. Careful, objective assessment and administration of optimal resistance force and duration are critical to a successful eccentric exercise-training plan. LaStayo and colleagues confirm that old human muscle responds to eccentric loading with low levels of soreness and little if any myofibrillar disruption, especially in the quadriceps muscle.<sup>6</sup>

Traditionally, eccentric training has been accomplished in various ways. These include increasing the duration of the eccentric contraction compared with the concentric contraction (4 seconds for eccentric versus 1 second concentrically), adding weight, or providing increased manual load during the eccentric portion of the repetition in free weight or body weight exercises. Another method is plyometric training, where a rapid eccentric load is immediately followed by a forceful concentric contraction. This can be accomplished by throwing a ball against a rebounder, catching it, and throwing it again for the upper extremities. For lower extremities, stepping off a 12-inch or higher platform, landing on both legs, and then immediately jumping up as high as possible delivers eccentrics via plyometrics. LaStayo et al. describe the use of an eccentric ergometer powered by a motor that drives the pedals in a backward rotation. This provides a safe, closed chain exercise. Recent technology has offered another option: a platform that rotates in a reverse elliptical pattern, which forces the lower body to absorb the kinetic energy from of the platform. Clearly, some of these options are more suitable than others for the older population.

Using the best method and technology is key to delivering the benefits of eccentrics safely to the aging, across the spectrum from active to less active.

In a 2003 study, LaStayo and colleagues found that by including eccentric exercise in geriatric training programs, elderly patients increased the size and strength of their quadriceps, improved their balance and stair descent abilities, and had their risk of a fall reduced from high to low within 12 weeks of treatment.<sup>5</sup> Additionally, this research showed that after 3 weeks of gradual and progressive increases in eccentric training, muscle soreness was essentially absent in the elderly patients. This approach also significantly minimized muscle injury, while both muscle size and strength increased.

In summary, research indicates that the benefits of eccentric resistance training are significant for the aging population. The proven strengthening benefits of this modality are very real for prevention, conditioning, and rehabilitation. Adding lower extremity eccentric exercise to treatment and training programs provides efficient, effective, and measurable strengthening to the elderly population, ranging from the active to the exercise intolerant. This is a powerful tool for increased stability and mobility, resulting in reduced fall risk and increased confidence and quality of life. Therapists and researchers are increasingly leveraging safe, proven methods and technologies to provide optimal

eccentric strengthening to older clients, achieving impressive clinical outcomes. ■

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