

Resistance Training for Fall Prevention: A Narrative Review of the Literature

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ABSTRACT

Background: Falls are the leading cause of fatal and nonfatal injuries for adults 65 years of age and older. Decreased lower extremity strength, lack of proprioceptive input (coordination), and instability are the main causes of falls in older adults.

Methods: Peer-reviewed articles were accessed from PubMed using search terms Fall Prevention Exercise AND Resistance Training. Articles featuring interventions other than resistance training were excluded.

Discussion: Identifying physical performance deficits is the first step in constructing a quality program to reduce the rate of falls in older adults. Lower body progressive resistance training has demonstrated an ability to reduce fall risk and should be a central component of any fall prevention exercise intervention.

Conclusion: This literature review demonstrates the current effectiveness of strength training for fall prevention. The American College of Sports Medicine guidelines are an effective starting point for preventing falls due to poor leg strength and physical capability.

INTRODUCTION

According to the Centers for Disease Control (CDC), falls are the leading cause of fatal and nonfatal injuries for adults 65 years of age and older every year.¹ Every fourteen seconds, an older adult is seen in an emergency department for a fall-related injury.² In 2017, 2.8 million older adults were treated in emergency departments for injuries from falls, and more than 800,000 of these patients were hospitalized as a result of their injuries. The price of fall-related injuries totaled nearly 31 billion dollars in medical costs and lost wages.¹ The most common forms of injury in older adults are fractures, sprains, contusions, and head trauma.³ Additionally, falls in older adults are the third leading cause of chronic disability, making fall prevention an important public health concern.⁴ While not entirely avoidable, fall risk can be vastly decreased with proper education and training.

Many factors contribute to the likelihood of sustaining a fall-related injury. Decreased lower extremity strength, lack of proprioceptive input (coordination), and instability are the main causes of falls in older adults.¹

According to the CDC, leg strength is the most important factor related to falls.¹ Leg strength often decreases significantly with age, but it does not have to. The current American College of Sports Medicine (ACSM) guideline suggests any person over the age of 65 should be able to leg press between 1.04 (females) and 1.49 (males) percent of their body weight to meet the "average" criteria. These numbers rise to 1.32 and 1.73 percent to reach the "well above average" standing.⁵ Increasing leg strength is the foundation of fall prevention; it builds both bone and muscle density while improving all aspects of balance and stability.¹

Proprioception is the body's ability to sense where it is in space; to sense movement, action, and location.⁶ Proprioceptors in and around the joint send information to the brain about the joint's position. Dysfunctional ankle and foot mechanics can result in altered proprioception which can lead to balance and stability deficits.

Stability of the lower extremity is achieved through strength and proprioception resulting in effective and efficient movement. If the legs are strong and the joints move well, the final step is targeting specific areas of weakness for rehabilitation. Gait training and specific muscle activation exercises like short foot exercises have been shown to decrease the risk of falls and improve balance and coordination and should be considered when designing a fall prevention program.⁷

METHODS

Peer-reviewed articles were accessed from PubMed from the years 2015 through 2020 using the search terms “Fall Prevention Exercise AND Resistance Training”. A total of 61 articles were returned with these search terms. Following our initial results, exclusion criteria eliminated 49 articles that featured interventions other than resistance training, and allowed for a review of 12 articles.

DISCUSSION

As the number of age-related falls increases, so does the need for alternative approaches for fall prevention therapy. It has been predicted that nearly one-third of the elderly population will sustain a fall in their lifetime, with many resulting in injury or death.⁸ Additionally, the likelihood of a second fall doubles after the first.¹ However, the most recent literature from the CDC suggests that many of these falls may be avoidable with preventative measures such as balance and leg strength training.¹ Attributes such as strength, power, endurance, or functional mobility have all been proposed as factors when considering fall prevention.⁹

Fall-related injuries can often be traced back to physical performance deficits.¹⁰ Identifying such deficits is the first step in constructing a quality program to reduce the rate of falls in older adults. Balance (both static and dynamic) and functional mobility, gait speed, and leg strength have consistently demonstrated themselves as factors in elderly falls.¹¹ However, leg strength continuously appears as the apex of priorities.¹ One study notes that muscular strength decreased by as much as 5% per year with advancing age, increasing the importance of developing and maintaining essential strength.⁵

In addition to strength loss, it is also common to experience decreased rate of force development (RFD), the efficiency of movement and gate due to age-related loss of Type II skeletal muscle fiber.¹² Maximal strength training at 85% or more of an individual’s 1 rep max has been shown to directly increase these attributes as it increases both the size and quantity of Type II muscle fibers.^{12, 13}

Adults who used aerobic activity as their sole means of exercise demonstrated decreased isometric muscle strength with an even higher rate of concentric strength loss.⁵ This information provides us an avenue for developing an intelligent, evidence-based program with which the elderly population can thrive.

These factors can be used as a checklist or starting point from which to develop a quality fall-prevention program. However, where does one begin when starting a fall prevention program? While the literature shows that progressive exercise is a critical element of program design, the non-exercise professional may still find it challenging to navigate these patients since many falls can be considered multifactorial.¹ Another challenge often posed with progressive training is the lack of ease with which it can be applied to older frail patients.¹⁴

Lower body progressive resistance training (PRT) has demonstrated its ability to reduce fall risk.¹⁵ This approach should be considered a central component of any fall prevention exercise intervention.¹⁴

Reduced activity and fear of falling have also been shown to lead to deconditioning, muscle atrophy, and weakness.¹⁶ Such fear-avoidance behaviors can result in a vicious cycle of movement avoidance due to fear of falling which can be prevented via proper patient education. Fortunately, many of the current guidelines support the idea that progressive resistance training, even when performed in a minimalist setting, can provide lasting results.¹

Progressive exercise training programs do not need to be complex. These programs can be used as a stand-alone exercise in settings such as in-home or community dwellings and have considerable benefit in fall prevention.¹⁵ In fact, individuals with a greater number of strength training sessions per week had 75% reduced odds of falling as opposed to those with fewer sessions, and progressive resistance exercise three days a week for ten weeks significantly improved the results of all muscle strength tests.¹⁵

Balance training can also be considered a significant factor in fall prevention; however, the exact mechanism of balance training resulting in fewer falls remains unclear. Firstly, balance capability can be considered multifactorial. Many elderly individuals suffer cognitive decline during the aging process, which has been acknowledged as a component in loss of balance.¹⁷ Secondly, it becomes difficult to delineate the exact role of balance training, as quality balance training also results in improved leg strength and motor control.¹¹ This does not diminish its importance, though, because the most common reported reason for falls was the loss of balance.¹⁵ Many falls in older people result from the inability to generate lower limb power to produce rapid, explosive movement to step quickly when the balance is lost. The risk of falling is also increased when attempting to “dual-task,” talking while walking, negotiating traffic or obstacles.¹⁸ A study demonstrated that balance, when coupled with free weight-based training, could effectively improve balance, strength, and power at lower loads than machine-based training.¹⁹

Intelligent balance training depends dramatically on the efficient muscle functioning of the foot. Specifically, the ability to functionally integrate the dynamics of the medial longitudinal arch and supportive intrinsic foot muscles is essential as they have demonstrated crucial roles in many lower extremity injuries. Recently the literature has shown the short foot exercises to be more effective than traditional toe-curling exercises for targeting the intrinsic foot muscles.⁷ This allows the clinician to strengthen the foot while supporting the medial arch actively.

Fall Prevention Exercise Program

Using the information synthesized from this review, the authors propose a 4-phase fall prevention program. This program, presented in **Table 1**, begins with unloaded prone, supine, and side-lying exercises targeted at the feet, leg, and hip muscles.⁴ The exercises then progress through varying neural developmental positions such as quadruped, kneeling, and standing over the course of four phases.

The reader will notice the timeline of each phase is unspecified. As a beginning intervention, many individuals will likely progress at different rates. The structure of this program will allow everyone to progress at their own rate.

Finally, the number of sets and reps are a suggestion. Some individuals will see better results in progressing the exercise volume before trying new positions, while others will benefit from new exercises more frequently.

Phase 1	Sets / Reps	Phase 2	Sets / Reps
Short Foot	1 set 10 Sec Holds	Standing Short Foot	2 sets 10 Sec Holds
Sit to Stands	1 set 8 -15 reps	BW squats	2 sets 8 -15 reps
Leg curls	1 set 8-15 reps	Glute Bridge w/ ABductor stim	2 sets 8-15 reps
Hip Extensions	1 set 8 -15 reps	Glute Bridge w/ ADductor stim	2 sets 8 -15 reps
Clam Shells	1 set 8-15 reps	Single Leg Stance / March	2 sets 8-15 reps
Adductor Ball Squeezes	1 set 20 second holds	Farmers Carry	2 sets 20 second holds
Phase 3	Sets / Reps	Phase 4	Sets / Reps
Cork Skrew to Agility step	3 sets 10 Sec Holds	Speed Ladder	4 sets 10 Sec Holds
Goblet Squat	3 sets 8 -15 reps	Reverse Sled Drags	4 sets 8 -15 reps
Deadlift	3 sets 8-15 reps	SLDL	4 sets 8-15 reps
Unilateral Carries	3 sets 8 -15 reps	Sled Push	4 sets 8 -15 reps
Bird Dog	3 sets 8-15 reps	Unilateral Carries	4 sets 8-15 reps
Tall Kneeling Heartbeats /	3 sets 20 second holds	Half Kneeling Heartbeats / Halos	4 sets 20 second holds

Table 1

CONCLUSION

Falls are a significant healthcare issue in all populations because of the associated risk of injury. With proper training, falls can be reduced by taking a multimodal approach. Rehabilitation professionals including physical therapists, chiropractors, and physiatrists can assist with evaluation and management. This literature review demonstrates the current effectiveness of strength training for fall prevention. Numerous papers suggest the benefit of multimodal exercise. The ACSM guidelines and the exercise program described in this paper are an effective starting point for preventing falls due to poor leg strength and physical capability.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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