



Mini-Review

Best-Practice Exercise Interventions to Prevent Falls in Older Adults

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Abstract

Globally, falls are a major public health problem that can cause morbidity, including fracture and disability, and mortality in older people. Exercise therapy is widely recommended, and it is frequently regarded as the gold-standard strategy for preventing falls in both community-dwelling and institutionalized older people. This review synthesizes published findings on feasible, low-technology, low-cost equipment, and easy-to-follow effective fall prevention interventions in healthy older adults. According to the evidence presented in this review, home-based balance and strengthening training programs utilizing low-cost equipment such as foam balance pads, steps, dumbbells, and elastic bands are more cost-effective and feasible exercises for fall prevention in older adults who do not have cognitive impairments. The Otago program, Lifestyle Approach to reducing Falls through Exercise (LiFE) program, and Ossébo exercise program are some of the best-known examples. Physiotherapists will benefit from this updated review, which rates different simple fall prevention programs used worldwide for both community-dwelling and institutionalized older adults.

Keywords: Feasible; Cost-effectiveness; Exercise; Falls prevention; Older adults

Introduction

A fall is defined as an event that results in a person coming to rest inadvertently on the ground, floor, or other lower level (1). According to estimates by WHO, 684 000 fatal falls occur each year, making them the second most common cause of unintentional injury death, after injuries from road traffic accidents (1). More than 80% of fall-related fatalities occur in low-and middle-income nations, with 60% of these deaths in the Western Pacific and Southeast Asia (1). Falls are a major health concern among older adults, with an estimated one-third of adults over the age of 60 experiencing at least one fall annually (2). In the United States of America, 20–30% of older people who fall suffer moderate to severe injuries such as bruises, hip fractures, or head trauma (1).

Sri Lanka is one of the rapidly ageing societies in South Asia. The latest Sri Lanka Population and Housing Census (SLPHC) reports that the share of the elderly population over 60 years old in 2032 will be 19.9 percent (3). Information on falls among the elderly is limited in Sri Lanka as well as other

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developing countries (4). A study of older people in Colombo reported that, 25.8% of community-dwelling older people had experienced falls in one year (4).

Previous studies have identified multiple intrinsic and extrinsic risk factors for falling in older adults (5-10). Intrinsic risk factors include age-related or disease-induced physiologic and perceptual/cognitive impairments (e.g., muscle weakness, balance deficits, and gait instabilities), whereas extrinsic risk factors include the use of multiple medications, improper use of assistive devices, poor footwear, history of falls, and environmental hazards (e.g., dim lighting or slippery surfaces) (5-10).

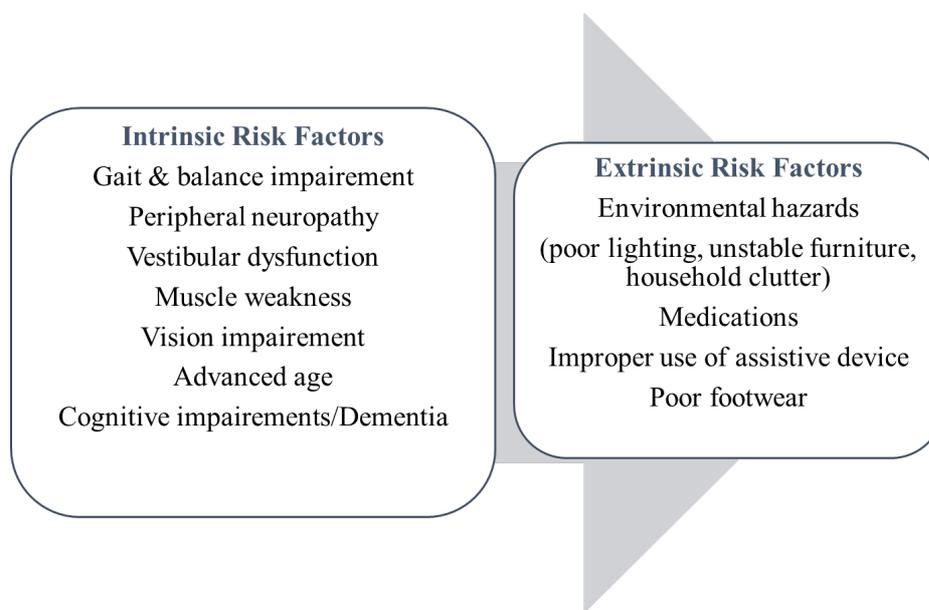


Figure 1. The multiple intrinsic and extrinsic risk factors for falling in older adults.

In general, aging induces a gradual decline in physical and mental health (7). The decline of lower extremity muscle power and strength, balance/postural control, and walking ability are recognized characteristics that become progressively more impaired with aging, increasing the risk of falls among the elderly (6). Recent studies of fall prevention programs have shown that interventions targeting balance improvement (11-13), dual-task (14), and multifactorial interventions by adding cognitive training components (9, 15, 16) are effective at reducing the risk of falls and fall injuries among older adults over 65 years (17) and beneficial even in those aged more than 80 years (18).

The majority of the published studies were carried out at universities, using equipment and spaces which will often be unavailable to or unfeasible to use with the general population (19). For example, computerized balance training has been shown to improve performance in clinical tests of mobility and gait speed. In addition, cognitive-motor training programs are considered promising strategies for improving physical function in older people with the use of computer-based technology ideal for such interventions (20, 21).

Consequently, it is essential to establish efficient, simple, safe, low-cost, and easy-to-administer fall prevention programs nationwide to reduce the risk of falls (7, 19, 22-24). However, just a few studies have investigated fall prevention programs utilizing inexpensive, low-tech equipment. It was observed from previous studies that the community frequently accepts less complicated training programs and older adults adhere to the exercises more frequently (18,26,27). Therefore, this mini review highlights the feasible, effective exercise programs for fall prevention in older adults without cognitive impairment that can be used in low and middle-income countries where resources are limited. Healthcare professionals involved in managing geriatric patients might benefit from this updated review on exercise strategies to lower the risk of falling.

Methods

Original research articles were searched using relevant keywords in PubMed, Google scholar and Hinari using MeSH terms. Searches were limited to English-language articles published between 2010 and 2022. The selected articles were then examined thoroughly to gain insight into exercise interventions in terms of feasible, low technology, low-cost equipment, and easy to follow effective fall prevention interventions in older adults without cognitive impairments. The relevant findings are included in the mini review.

Results and Discussion

After screening, 15 articles were selected for inclusion in this review. The selected articles were reviewed, and relevant findings were incorporated into the mini review. Only randomized controlled trials (RCTs) were selected for this mini review. Randomized controlled trials are the “gold standard” for evaluating treatment outcomes, providing information on the “efficacy” of treatments and designed to test a therapeutic hypothesis under optimal settings in the absence of confounding factors (28).

Fifteen randomized controlled trials, with interventions of feasible, low technology, low-cost equipment, and easy-to-follow effective fall prevention interventions met the described criteria. Participants included community-dwelling and institutionalized ambulatory adults over the age of 60, the elderly with falls in the previous year, and cognitively intact seniors. In addition, comorbidities such as severe cognitive problems (for example, dementia), neurological conditions such as stroke and Parkinson's disease, osteoporosis or osteoporotic fractures, severe cardiovascular disease, vestibular or visual impairment, and severe medical conditions such as aortic aneurysm, malignant arrhythmias, critical aortic stenosis, and active hernias were all identified in the studies that were included in the review (5, 6, 10, 12, 16-18, 23, 25-27, 29-31).

Many effective exercise interventions were found with balance training (5, 6, 10-12, 18, 26, 27, 29-35), strengthening programs (3, 15, 16, 21, 27, 33), and endurance training (11, 27, 31, 32), and have proven their effectiveness in improving physical fitness and reducing the falls in the elderly in the community. Studies included in the analysis of simple fall prevention exercise programs are presented in Table S1.

Balance training

Balance training was found to be the most effective component of falls prevention programs compared with other modes of training, such as strength or flexibility exercises (36, 37). Balance is the process of maintaining the center of mass over the base of support in static and dynamic tasks (5, 36, 37). Static balance has been defined as the capability to control postural sway during steady standing, whereas dynamic balance has been defined as the ability to anticipate and react to changes in body movement (5). As a result, most programs to prevent falls include balance-training exercises in which both challenge the center of mass in static and dynamic activities. Sitting on a balance ball, single-leg standing, semi tandem or tandem stance, tandem walking, walking sideways, turning in a circle, and square and stair stepping are examples of such static and dynamic balance exercises (5, 6, 12, 22, 30, 31).

Some researchers have reported improvement in older adults' balance following such balance training programs (10, 38). To improve balance therefore, it seems rational to add sensory training to conventional balance exercises, often referred to as “multisensory exercises” (10). In addition, a study by Alfieri et al., (2010) on functional mobility and balance in community-dwelling elderly who submitted to multisensory exercises showed that there was significant control of balance and dynamic activities. Nematollahi et al., (2016) showed that four weeks balance training of conventional, multi-sensory, and dual-task exercises would be equally effective in improving balance in older adults. Furthermore, any of the three modes of exercises can be performed in various ways, such as in its simplest form without compromising the other sensory systems (i.e., conventional exercise), with closed eyes on a foam mat

(i.e., Multisensory exercise), or by adding a cognitive function such as counting backward (i.e., dual-task exercise) (10).

Several exercise interventions could be more effective, less expensive, motivating, and specially designed for preventing falls, including Square Stepping Exercise (SSE) (5, 22). Square Stepping Exercise is a program that consists of performing multiple steps in several directions on a thin carpet divided into 25x25cm squares (22). Square Stepping Exercises can be conducted either outdoors or indoors. Consequently, this is a perfect substitute for one-way outdoor walking, which has less benefit for preventing falls, but this exercise program will be more unsafe for older people (22). Square Stepping Exercise is an alternative intervention that includes physical exercises that is apparently more effective than walking for enhancing balance and lowering fall risk factors (22). Additionally, it is advised as a health promotion exercise in older people and has been shown that SSE could be applied easily, inexpensively, and in groups (22). Conventional balance exercises, which include training strength, endurance, maximizing flexibility, and postural control, have been proven effective in improving functional ability and reducing the risk of falls in the community and institutionalized elderly people (5, 39). However, Carlos-Vivas et al., 2020 reported that SSE is effective for falls prevention and is cost-effective compared to conventional treatment (usual care). This would pose an economic savings opportunity for the health system. Therefore, as this is a low-cost healthcare technology, where levels of difficulty can easily be standardized, its implementation in both public and private sectors would not pose any problems. (22)

The Ossébo exercise program is considered a balance-training program that aims to increase awareness of fall risks, introduce strategies to reduce fall injuries through behavioral changes, and improve postural stability (30). It contains joint flexibility exercises, balance exercises (for example, knee bends, tandem stance, backward walking, sit-to-stand), reaction time exercises (for example, playing in a group with a ball), coordination exercises (for example, side leg swings, front leg swings), muscle strength exercises critical for posture and balance (for example, hip abductor, knee extensor, ankle plantar-flexors), and internal sense of spatial orientation (senses of position and movement of limbs and trunk) (30). El-Khoury et al. reported that the Ossébo exercise program makes it feasible to put into place a large-scale, long-term exercise program that is safe and effective in reducing injurious falls, in women aged 75-85 at risk of falling.

Strength and Endurance

Previous studies have shown that exercises targeting lower limb and core muscles can increase kinesthetic coordination and awareness along with musculoskeletal strength (25, 28). Muscle strength is described as the maximal force that a muscle can produce against a given resistance, whereas muscle power is the product of force and speed (5). Therefore, muscle strength is likely to be more important for preventing falls than muscle power (5). Theoretically, preventing falls requires enhancing lower extremity muscle power, body balance, and walking ability (5). In this regard, a variety of exercise modalities, such as strength training and/or resistance training, have been shown to be useful in improving balance in elderly people (5).

Numerous exercise programs aimed at preventing falls by improving balance and lower limb muscle strength have been conducted in the community and institutions. Among them, the vast majority of studies using the Otago program focused on reducing falls. (11, 16, 31, 34). The Otago program is a set of simple exercises that can be performed at home (30). Home-based exercise programs could be suitable for such a long-term condition, have fewer adverse events, and are appropriate for the elderly (18). This simple exercise also affects the quality of life (QoL) in both physical and mental health dimensions (18). Furthermore, the Otago Exercise Program requires relatively low supervision and material costs. Hence, the Otago exercise protocol can be used in daily clinical practice (31). The 'Otago exercise program' (OEP) is a strength, balance retraining, walking, and aerobic exercise program designed to prevent falls in the community and institutionalized elderly people. (11, 16, 31). Otago

exercises were first developed and tested at the University of Otago in New Zealand (14, 29). Various studies using the Otago exercise program reported significantly reduced falling rates. (18, 32). For example, a study by Nancy N. Patel & Shweta Pachpute in 2015 reported that the Otago had been shown to reduce falls by 35% among high-risk individuals.

Multicomponent exercise programs specifically including strength and power, endurance, and balance training (28) are beneficial. In this regard, the Otago program has been identified as one of the most effective multi-component programs (40). Furthermore, the study by Alhambra-Borrás, Durá-Ferrandis and Ferrando-García in 2019 reported that the multicomponent program offers a modified format of the Otago program, including evidence-based improvements. Based on the study, the modified format of the Otago program, which comprises evidence-based modifications, has proven to be both potentially useful and less expensive than traditional usual care. Moreover, a multi-component exercise program based on the Otago exercise program has reduced the risk of falling by 45.4% (34).

The Lifestyle approach to reducing Falls through Exercise (LiFE) program is another simple exercise program found in the literature. The LiFE program involves embedding balance and lower limb strength training in habitual daily routines. LIFE is the first home-based, lifestyle-integrated balance and strengthening exercise program developed explicitly for fall prevention (26, 41). The LiFE program includes simple and feasible four balance strategies and seven strength strategies. Clemson et al., in 2010 reported that the LiFE program included simple and feasible exercises and concluded that the LIFE program effectively reduces recurrent falls. Previous studies have shown that the LiFE program can enhance and preserve the functional capacity of community-dwelling elders with their dynamic balance and lower-limb strength within six months (26, 41).

Maritz and Silbernagel, 2016 conducted a study that aimed to find the impact of calf strengthening exercises along with balance training on functional mobility, strength, and balance in older adults. They used a balance training program that included calf muscle strengthening. The results showed significant improvements in calf muscle strength, functional performance, and balance, as well as a significant improvement in balance confidence. Furthermore, this study identifies the significance of unilateral calf muscle strength in falls risk among older adult patients performing unilateral heel-rise exercises when screening for and implementing falls prevention programs. According to Yamashita et al. (2012), the chair-rising exercise may function the quadriceps and gluteus medius muscles and improve joint movement of the lower extremities, possibly improving body balance in subjects with locomotive disorders. It is also convenient and well-tolerated (6).

A variety of exercises involving gait, balance, coordination, functional tasks, and strength-training have used low-cost equipment such as ankle weights, dumbbells, stepping training using a yoga mat, different types of balls, soft cushions (27), foam rubber pad (12), the elastic band (23), balance boards (29), and stability discs (29). Exercise programs should be simple, easily instituted, and provided at low cost if they are part of a public health program to be introduced widely in the community, and simpler training programs may thus be accepted within the community. Elastic resistance training (ERT) is suitable for seniors because it is low-cost, simple, lightweight, portable, and flexible (23). Motalebi et al., 2018 examined the effect of a group-based resistance-training program among institutionalized seniors. The findings show that a simple and affordable resistance-training program can enhance lower-limb muscle strength and dynamic balance of institutionalized older adults. Furthermore, previous studies (42, 43) have reported that elastic resistance exercises benefit seniors. Instead of using weight machines, using an elastic band allows you to keep up the exercise routine for a very long time (23).

Some findings suggest that walking exercise has been speculated to play a role in improving walking ability and thereby preventing falls (6, 44). However, Carlos-Vivas et al., 2020 have stated that SSE is an effective intervention that combines physical activities and is apparently more effective than walking for improving balance and helping to lower fall risk factors. However, because walking can induce more trips, walking should not be recommended for older adults who are susceptible to falling or frailty (44).

Finally, various recommendations for improving balance to reduce falls and improve function have included fully supervised clinical or home activities such as balancing, and strength; endurance exercises such as walking have been shown to be effective in improving stability as well as being cost-effective.

Conclusions

Exercise is commonly accepted as a primary means of fall prevention among older adults. The review indicates that home-based balance and strengthening training programs utilizing low-cost equipment such as bands, dumbbells, and elastic bands, the Otago program, Lifestyle Approach to reducing Falls through Exercise (LiFE) program, and the Ossébo exercise program, are more cost-effective and feasible exercises for fall prevention in older adults. Future research efforts are now required to identify exercise interventions in terms of low technology, low-cost equipment, and easy-to-follow programs for older adults with cognitive impairments.

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