

Effectiveness of Training Programs in Reducing Falls in Older Adults: Systematic Review

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ABSTRACT

Background: With ageing, older adults are faced with decreasing strength and balance and increasing risk for falls. A fall followed by fracture is a factor in mortality and decreased quality of life in older people. However, few systematic review studies have analyzed the effects of training programs in reducing falls in older people.

Aim: This systematic review study aimed to analyze the effects of physical training programs on the risk of falls in older people.

Methods: We used the PRISMA guidelines in conducting the systematic review. The search for eligible studies was performed using four electronic databases (PubMed, BVS Regional Portal, British Library, and Library of Congress).

Results: The results showed a decrease in the risk of falling in 21 studies. Only four studies did not show a reduction in the risk of falling after a training program.

Conclusion: Combined or multicomponent training programs, as well as isolated strength training, could decrease the risk of falling in older people.

Core Tip

Regular and systematic physical exercises can contribute in a comprehensive way to the healthy ageing process by helping increase muscle strength, bone mineral density (hip and spine), and static and dynamic balance, ultimately decreasing the risk of falling. However, controversial results have been observed, with some studies indicating no improvement, especially in the risk of falls in older adults. Thus, the characteristics of the different physical exercise programs must be investigated. Research should discern which types of exercise reduce the risk of falling in the older adults. Thus, this systematic review study aimed to analyse the effects of physical training programs on the risk of falls in older adults.

Introduction

The global projection is that by 2050, the number of older people will increase exponentially, surpassing the number of children under 14 years old [1]. As people age, changes in muscle and bone mass can be observed, as well as reduction in the capacity to produce strength, which impacts the activities of daily living. Thus, regular physical activities can delay marked physiological losses. Falls followed by fractures are recurrent among older adults, attributable to muscle instability and bone fragility [2,3]. Changes

in the sensory and motor systems also become present, and these cause postural instability, which can increase the risk of falling. Falls in older people represent a major public health problem, associated with a worsening quality of life and increased mortality [4]. In Brazil, about one-third of older adults experience at least one fall per year, and the more advanced the age, the greater the risk. Women are affected in greater proportion, as they are more sensitive to changes inherent to ageing, such as hormonal changes,

which increase the incidence of sarcopenia and osteoporosis and make them more susceptible to falling [5].

Another factor associated with the risk of falling is the level of dependency of older adults, which can reach up to 14 times that of those with a high level of independence [6]. Regular and systematic physical exercises can contribute in a comprehensive way to the healthy ageing process by helping increase muscle strength, bone mineral density (hip and spine), and static and dynamic balance, ultimately decreasing the risk of falling [4,7,8].

However, controversial results have been observed, with some studies indicating no improvement, especially in the risk of falls in older adults [9-12]. Thus, the characteristics of the different physical exercise programs must be investigated. Research should discern which types of exercise reduce the risk of falling in the older adults, for example, isolated (strength, aerobic, and balance) or combined (balance/strength, aerobic/balance/strength, aerobic/balance, and aerobic/strength). Thus, this systematic review study aimed to analyse the effects of physical training programs on the risk of falls in older adults.

Materials and Methods

Search Strategy

For the review study, we adhered to the guidelines for systematic reviews (PRISMA) Moher, et al. [13]. The search for eligible studies was carried out using four electronic databases (PubMed, BVS Regional Portal, British Library, and Library of Congress) until October 2019, without language restrictions. The terms used for the search were as follows: the search strategy combined terms covering the topics of population: (resistance training OR strength training) AND (balance training) AND (older OR elderly OR older adults) AND (risk of falling). The search was carried out using combinations of the following terms linked with Boolean operators "AND" (inter-group Boolean operator) and "OR" (intra-group Boolean operator). Duplicate studies were removed. Three independent researchers analyzed titles and abstracts and then selected the articles relevant to the research.

Eligibility Criteria

Articles that met the following inclusion criteria were selected:

- (1) Original study;
- (2) Providing a description of the training program;
- (3) Having at least one of the following tests as a method of evaluation: Balance Evaluation System Test, Timed Up and Go Test, Six Minute Walk Test, Sit To Stand Test, Falls Efficacy Scale-

Internacional, Posturografia estática BioRescue, Functional Reach Test, and Berg Balance Scale;

- (4) Randomised clinical trials;
- (5) Published in peer-reviewed scientific journals; and
- (6) Studies evaluating the effects of training programs on the risk of falls in older adults.

The exclusion criteria were as follows:

- (1) Review articles;
- (2) Abstracts of unpublished conference papers and studies; and
- (3) No protocol for assessing balance or risk of falling.

According to the inclusion and exclusion criteria, 19 studies were excluded. The studies were evaluated in their entirety by two reviewers. Disagreements were decided by consensus, and when necessary, with the participation of a third reviewer. Eligible study references were also analyzed to identify other relevant studies.

Data Extraction

Independently, the same two reviewers extracted the following data from each selected study: name of the first author, year of publication, research title, age group (years), balance test, type of exercise used in the training program, weekly frequency of the training program, intensity and duration of the training program, training period in months, completion of the study, and periodicals in which the studies were published.

Evaluation of Methodological Quality of Studies

The quality evaluation of the eligible studies was carried out by two independent reviewers, with doubts resolved by consensus, and with the participation of a third reviewer when no consensus could be reached. The Physiotherapy Evidence Database (PEDro) scale was used to assess randomised clinical trials. The instrument consists of 11 items, the first of which is not computed in the final score. Thus, the scale has a score from 0 to 10 [14].

Results

Study Selection

From the electronic databases (PubMed, BVS Regional Portal, British Library, and Library of Congress), 17727 studies were found. After removing the duplicates, 17610 remained. After the selection based on titles and abstracts, 44 complete articles remained. Of these, 25 were selected and used in the present work, as shown in Figure 1.

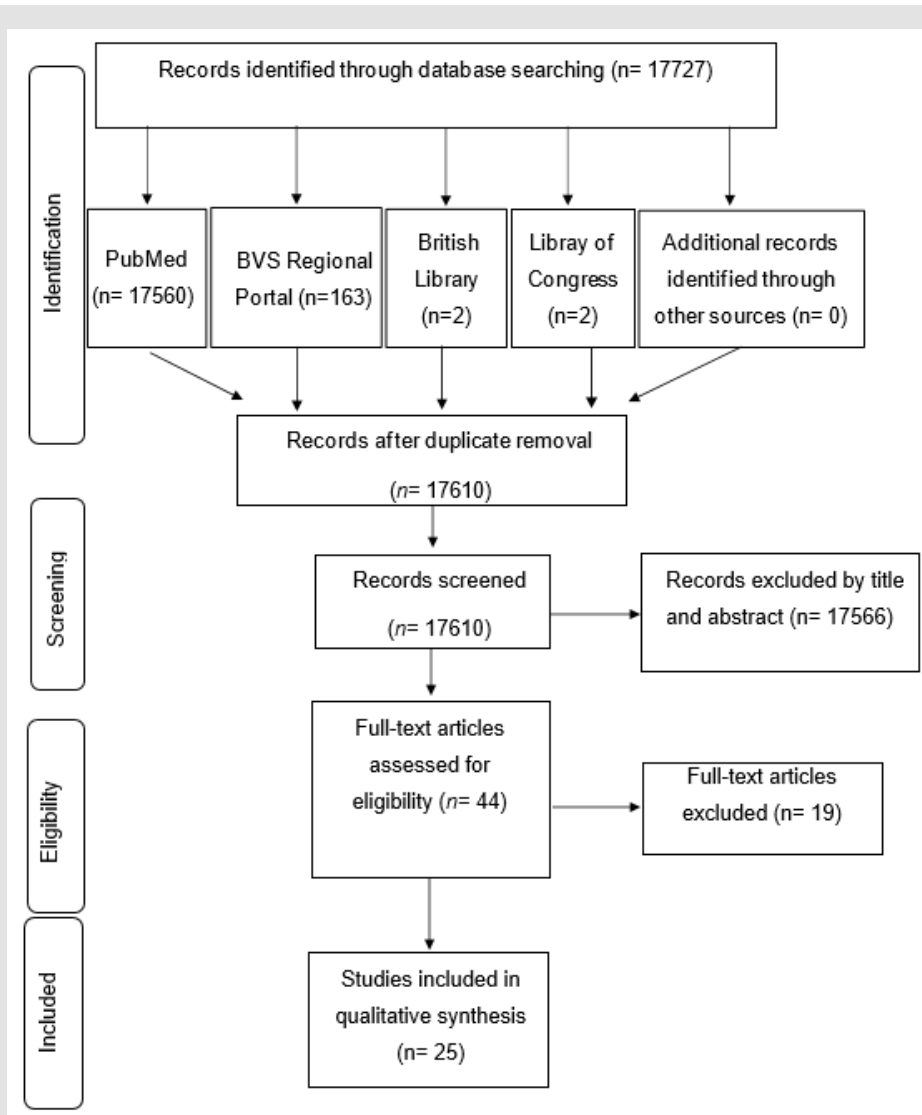


Figure 1: Organization of articles reviewing the effects of training programs on the risk of falls in the elderly. PRISMA 2009 flow diagram. Adapted from Moher, et al. [13].

Study Characteristics

Table 1 presents the general characteristics and results of studies that analyzed the effects of training programs on the risk of falls in older adults. The analyzed studies were published between 2008 and 2019, including a total of 2229 people. The studies were conducted in Australia [15], Brazil [4,10,16-18], Canada [19], China [20], Finland [21], Germany [22], Hungary [23], India [24], Iran [25], Japan [11], Portugal [7,26], Republic of Korea [27], Spain [12,28], Switzerland [29], and the United States [9,30-33]. Eight studies were identified as using a combination of balance and strength exercises [4,16,17,19,21,22,24,29]; three studies using a combination of aerobic exercises, balance, and strength [7,9,28]; six studies using strength exercises [15,20,25,27,30,33]; one

study using a combination of aerobic and strength exercises [10]; one study using aerobic exercises [12]; four studies using balance exercises [11,23,31,32]; and two studies using balance and strength exercises separately [18,26]. A reduction in the risk of falling was observed in 21 studies [4,7,15-33]. In four studies, training programs did not show a reduction in the risk of falling [9-12]. To evaluate the risk of falling in the older population, 16 studies used the Timed Up and Go Test [4,7,9,11,12,15-22,25,26,29]. Some studies opted for other tests to assess the risk of falling, such as the Balance Evaluation System Test [28], Six Minute Walk Test [30,33], Sit-to-Stand [10], Falls Efficacy Scale-Internacional [31], Posturografia estática BioRescue [27], Functional Reach Test [24], and Berg Balance Scale [23,32].

Table 1: Results of studies of training programs' effects (n= 25) on the risk of falls in older adults.

Nº	Author(s)	Title	Age (y)	Method of Evaluation	Training Program (Protocol)				Conclusion Regarding Risk of Falls	Journal
					Type of Exercise	Weekly Frequency	Intensity and Duration	Period in Week		
1	Teixeira et al. [4]	Progressive load training for the quadriceps muscle associated with proprioception exercises for the prevention of falls in postmenopausal women with osteoporosis: a randomized controlled trial	55 - 75	TUG	Combination of balance and strength exercises	-	moderate-to high-intensity 60 min	4,5	Reduced the risk of falling	Osteoporos Int
2	Sousa et al. [7]	Combined exercise is more effective than aerobic exercise in the improvement of fall risk factors: a randomized controlled trial in community-dwelling older men	65 - 79	TUG	Combination of aerobic exercises and balance	3	moderate-to high-intensity 60 min	8	Reduced the risk of falling	Clinical Rehabilitation
3	Cancela et al. [9]	Effects of Three Different Chair-Based Exercise Programs on People Older Than 80 Years	>80	TUG	Aerobic exercises, Balance, and Strength exercises	3	Low- to moderate-intensity 60 min	3	Did not reduce the risk of falling	Rejuvenation Research
4	Ansai et al. [10]	Effects of two physical exercise protocols on physical performance related to falls in the oldest old: A randomized controlled trial	>80	Sit-to- stand	Combination of aerobic and strength exercises	3	moderate-to high-intensity 60 min	4	Did not reduce the risk of falling	Geriatrics Gerontology
5	Hiyamizu et al. [11]	Effects of dual task balance training on dual task performance in elderly people: a randomized controlled trial	>65	TUG	Balance exercises	2	Low- to moderate-intensity 60 min	12	Did not reduce the risk of falling	Sage Journals - Clinical Rehabilitation
6	Varela et al. [12]	Effects of two different intensities of aerobic exercise on elderly people with mild cognitive impairment: a randomized pilot study	>79	TUG	Aerobic exercises	3	Low- to moderate-intensity 60 min	12	Did not reduce the risk of falling	Sage Journals - Clinical Rehabilitation
7	Daly et al. [15]	Effectiveness of dual-task functional power training for preventing falls in older people: study protocol for a cluster randomised controlled trial	>64	TUG	Strength exercises	2	moderate-to high-intensity 45-60 min	18	Reduced the risk of falling	BMC Research

8	Bohrer et al. [16]	Multicomponent training program with high-speed movement execution of ankle muscles reduce risk of falls in older adults	>69	TUG	Combination of balance and strength exercises	3	Low- to moderate-intensity 45 min	3	Reduced the risk of falling	Rejuvenation Reserarch
9	Pirauá et al. [17]	Effect of 24 week strength training on unstable surfaces on mobility, balance, and concern about falling in older adults	>68	TUG	Combination of balance and strength exercises	3	Moderate intensity 60min	3	Reduced the risk of falling	Scandinavian Journal of medicine e Science in Sports
10	Alfieri et al. [18]	Functional mobility and balance in community- dwelling elderly submitted to multisensory versus strength exercises	60 - 75	TUG	Balance and strength exercises separately	2	moderate- to high-intensity 60min	3	Reduced the risk of falling	Clin Interv Aging
11	Liu- Ambrose et al. [19]	Otago Home-Based Strength and Balance Retraining Improves Executive Functioning in Older Fallers: A Randomized Controlled Trial	>70	TUG	Combination of balance and strength exercises	-	Low- to moderate-intensity 60min	12	Reduced the risk of falling	Journal of the American geriatrics society
12	Yamada et al. [20]	Effect of resistance training on physical performance and fear of falling in elderly with different levels of physical well-being	>65	TUG	Strength exercises	2	moderate- to high-intensity 60 min	50	Reduced the risk of falling	Oxford Journal - Age and Ageing
13	Aartolahti et al. [21]	Long-term strength and balance training in prevention of decline in muscle strength and mobility in older adults	>76	TUG	Combination of balance and strength exercises	1	Moderate intensity 75min	27	Reduced the risk of falling	Aging Clinical and Experimental Research
14	Lacroix et al. [22]	Effects of a Supervised versus an Unsupervised Combined Balance and Strength Training Program on Balance and Muscle Power in Healthy Older Adults: A Randomized Controlled Trial	65-80	TUG	Combination of balance and strength exercises	3	moderate- to high-intensity 60 min	3	Reduced the risk of falling	Gerontology
15	Miko et al. [23]	Effectiveness of balance training programme in reducing the frequency of falling in established osteoporotic women: A randomized controlled trial	>65	Berg Balance Scale	Balance exercises	3	Low- to moderate-intensity 30 min	56	Reduced the risk of falling	Sage Journals - Clinical Rehabilitation
16	Joshua et al. [24]	Effectiveness of Progressive Resistance Strength Training Versus Traditional Balance Exercise in Improving Balance Among the Elderly - A Randomised Controlled Trial	>65	Functional reach test	Balance, strength and combination of balance and strength exercises	4	Low- to moderate-intensity 30 min	24	Reduced the risk of falling	Journal of Clinical & Diagnostic Research

17	Motalebi et al. [25]	Effect of low-cost resistance training on lower-limb strength and balance in institutionalized seniors	>64	TUG	Strength exercises	2	Low- to moderate-intensity 50 min	3	Reduced the risk of falling	Experimental Aging Research
18	Marques et al. [26]	Multicomponent Training Program with Weight-Bearing Exercises Elicits Favorable Bone Density, Muscle Strength, and Balance Adaptations in Older Women	>68	TUG	Balance and strength exercises separately	2	Low- to moderate-intensity 60 min	32	Reduced the risk of falling	Calcified Tissue International
19	Lee et al. [27]	Balance Improvement by Strength Training for the Elderly	>69	Posturografia estática BioRescue	Strength exercises	2	moderate- to high-intensity 60 min	12	Reduced the risk of falling	Journal of Physical Therapy
20	Seco et al. [28]	A long-term physical activity training program increases strength and flexibility and improves balance in older adults.	>65	Balance Evaluation Systems Test	Combination of aerobic exercises, balance, and strength exercises	3	Low- to moderate-intensity 50-55 min	9	Reduced the risk of falling	Rehabilitation Nursing Journal
21	Gschwind et al. [29]	A best practice falls prevention exercise program to improve balance, strength/ power, and psychosocial health in older adults: study protocol for a randomized controlled trial	65 - 80	TUG	Combination of balance and strength exercises	3	Low- to moderate-intensity 30 min	3	Reduced the risk of falling	BMC Geriatrics
22	LaStayo et al. [30]	Eccentric versus traditional resistance exercise for older adult fallers in the community: a randomized trial within a multi-component fall reduction program	>65	6MW	Strength exercises	3	moderate- to high-intensity 60 min	3	Reduced the risk of falling	BMC Geriatrics
23	Halvarsson et al. [31]	Long-term effects of new progressive group balance training for elderly people with increased risk of falling - a randomized controlled trial	>80	Falls Efficacy Scale-Internacional	Balance exercises	3	Low- to moderate-intensity 60 min	12	Reduced the risk of falling	Sage Journals - Clinical Rehabilitation
24	Jacobson et al. [32]	Independent static balance training contributes to increased stability and functional capacity in community-dwelling elderly people: a randomized controlled trial	>80	Berg Balance Scale	Balance exercises	3	Low- to moderate-intensity 60 min	12	Reduced the risk of falling	Sage Journals - Clinical Rehabilitation
25	Sparrow et al. [33]	Increases in Muscle Strength and Balance Using a Resistance Training Program Administered Via a Telecommunications System in Older Adults	50 - 94	6MW	Strength exercises	3	moderate- to high-intensity 60	12	Reduced the risk of falling	Oxford Journals

Quality Assessment of Studies

The studies evaluated by the PEDro scale presented an average score of 8.6 points. One study scored 6 points [12], seven studies

scored 7 points [4,11,16,27,28,31,32], eight studies scored 8 points [9,10,19,21,23,24,29,30], one study scored 9 points [25], and eight studies scored 10 points [7,15,17,18,20,22,26,33] (Table 2).

Table 2: Assessment Study Quality Using the PEDro Scale for Randomized Clinical Trials.

Items	Eligibility Criteria *	Random Allocation	Concealed Allocation	Similar at Baseline	Blinding Subjects	Blinding Therapists	Blinding Assessors	Adequate Follow-up	Intention to Treat Analysis	Between-Group Statistical Comparison	Point Estimate/ Measure of Variability	Score Total
Teixeira et al. [4]	Y	Y		Y	Y			Y	Y	Y	Y	07-Oct
Sousa et al. [7]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10-Oct
Cancela et al. [9]	Y	Y		Y	Y		Y	Y	Y	Y	Y	08-Oct
Ansai et al. [10]	Y	Y		Y	Y		Y	Y	Y	Y	Y	08-Oct
Hiyamizu et al. [11]	Y	Y	Y	Y	Y				Y	Y	Y	07-Oct
Varela et al. [12]	Y			Y	Y			Y	Y	Y	Y	06-Oct
Daly et al. [15]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10-Oct
Bohrer et al. [16]	Y	Y		Y	Y		Y		Y	Y	Y	07-Oct
Pirauá et al. [17]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10-Oct
Alfieri et al. [18]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10-Oct
Liu-Ambrose et al. [19]	Y	Y		Y	Y		Y	Y	Y	Y	Y	08-Oct
Yamada et al. [20]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10-Oct
Aartolahti et al. [21]	Y	Y		Y	Y		Y	Y	Y	Y	Y	08-Oct
Lacroix et al. [22]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10-Oct
Miko et al. [23]	Y	Y	Y	Y	Y			Y	Y	Y	Y	08-Oct
Joshua et al. [24]	Y	Y	Y	Y	Y			Y	Y	Y	Y	08-Oct
Motalebi et al. [25]	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	09-Oct
Marques et al. [26]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10-Oct
Lee et al. [27]	Y	Y	Y		Y			Y	Y	Y	Y	07-Oct
Seco et al. [28]	Y	Y		Y	Y		Y		Y	Y	Y	07-Oct
Gschwind et al. [29]	Y	Y		Y	Y		y	Y	Y	Y	Y	08-Oct
LaStayo et al. [30]	Y	Y		Y	Y		Y	Y	Y	Y	Y	08-Oct
Halvarsson et al. [31]	Y	Y	Y	Y				Y	Y	Y	Y	07-Oct

Jacobson et al. [32]	Y	Y	Y	Y	Y				Y	Y	Y	07-Oct
Sparrow et al. [33]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10-Oct

Y: Contemplated item.

*Item 1 does not contribute to the total score.

Discussion

This systematic review analyzed the effects of training programs on the risk of falling in older adults. We mainly aimed to elucidate whether the risk of falling is positively affected by isolated or combined training programs, and thus contribute to the prevention of falls and reduction in the risk of mortality. Regular exercise influenced total daily physical activity and possibly induced chronic physiological adaptations. We observed that all studies that combined strength training programs with balance exercises reduced the risk of falling [4,16-19,21,22,24,26,29]. The same was seen in isolated strength training programs [15,20,24,25,27,30,33]. According to studies by Wolfson, et al. [34], Lord, et al. [35], and Howe, et al. [36], the findings of this review can in part be attributed to improvements in neuromuscular coordination by and “training specificity” of the programs applied in the studies cited here. However, positive effects on muscle mass, strength, composition, power, and torque production, as well as changes in the mechanical properties of the tendon, must be observed to explain the significant reduction in the risk of falling [37,38]. Balance training, as well as the evaluation of this variable, is considered an essential component of fall prevention programs [39].

The loss of balance is directly related to decreases in muscle mass, strength, and proprioception. According to Teixeira, et al. [4], a strength training program for the quadriceps combined with proprioception training can decrease the risk of falling in postmenopausal women, in addition to increasing strength and static and dynamic balance. Therefore, proprioception and strength exercises are of great importance in reducing the risk of falling in older adults. Sousa, et al. [7] found a decrease in the risk of falling after the aerobic and balance training program. The risk of falling also decreases when the strength protocol integrates aerobic and balance training [28]. However, Cancela, et al. [9] observed no decrease in the risk of falling after a strength, aerobic, and balance training program. Ansai, et al. [10], who used an aerobic and strength training program, likewise found no decrease. Both studies used samples of older adults over 80 years old. This age group has less organic adaptation, and the studies justified, in a respective way, the differences attributable to the short period of intention, application of light physical activity in a sitting position, and failure to monitor falls daily.

No reduction in the risk of falling was also found in Varela, et al. [12], who used isolated aerobic training in older adults with mild cognitive impairment. According to Xu, et al. [40], aerobic

activities can improve balance and generates a positive effect on the proprioception of older adults, given that aerobic exercises decrease gait instability and can decrease degenerative processes in the nervous and muscular systems. As such, aerobic exercises can contribute to decreasing the risk of falls in older adults [41]. In studies that used isolated balance exercises, Jacobson, et al.[32], Halvarsson, et al. [31], and Miko, et al. [23] reported a decrease in the risk of falling. However, these results were not observed in Hiyamizu, et al. [11]. A plausible explanation regarding the divergent results is the lack of non-standardized protocols in the experiments. According to Thomas, et al. [42], training programs that offer an approach that includes resistance exercises, aerobic components, and proprioception work can improve balance and reduce the risk of falling in older adults. Falls are multifactorial events that may be related to intrinsic and extrinsic factors. The incidence of falls increases each year in the older population worldwide, with a positive relation between age and the increase in cases of falls.

Older adults can have several complications after a fall, such as fractures and head injuries; indeed, falls account for 11% of the mortality rate in this population [43-45]. Thus, increased mortality in older adults is related to physical inactivity [46]. Moreover, Thomas, et al. [42] reported that low-intensity exercises improve the balance of older adults and contribute to decreasing the risk of falling; adherence to moderate- to high-intensity training programs is less attractive, leading to lower adherence, especially in older adults. Based on the studies above, and in recognition of the importance and relevance of reducing falling risk for maintaining the quality of life and decreasing falls-related mortality in the older population, we propose that strength and aerobic training programs with proprioception exercises be recommended when and included in designing interventions. The strengths of this systematic review are that it was based on reliable results and full-text studies and it included high-quality papers. Meanwhile, the main limitation of this study is the lack of standardized assessment instruments for the risk of falling. Nonetheless, the instruments were validated and reliable, and thus, we chose to include all instruments.

Conclusion

This systematic review analyzed the effects of training programs on the risk of falls in older adults. Combined or multicomponent training programs, as well as isolated strength training, could decrease the risk of falling in older people. Further studies should standardize the protocols of training programs and assessment

instruments, to enable further analysis of the aspects that brings better benefits: whether it is the training program, the modality to be worked on, or the modulation of the variables in the training.

Implications for Practice

The findings, based on the studies analyzed, demonstrated the importance and relevance of physical training programs for decreasing the risk of falling in people and older adults. Therefore, strength and aerobic training programs are recommended, along with balance exercises, for older adults.

Author Contributions

Silva A designed the research; Andrade G, Nascimento J, Ribeiro A and Barbosa C performed the research; Silva A, Silva J and Oliveira J analyzed the data; Silva A, Oliveira J wrote the paper; Silva A, Pertille A, Silva J and Oliveira J supervised the paper; all authors read and approved the final manuscript.

PRISMA 2009 Checklist

The authors have read the PRISMA 2009 Checklist, and the manuscript was prepared and revised according to the PRISMA 2009 Checklist.

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References

- (2018) Instituto Brasileiro de Geografia e Estatísticas (IBGE) - Estatísticas Sociais. Em 2018, expectativa de vida era de 76,3 anos. Rio de Janeiro: Agência IBGE Notícias.
- Matsudo SM, Matsudo VKR, Barros Neto TL (2001) Atividade física e envelhecimento: aspectos epidemiológicos. *Rev Bras Med Esporte* 7(1): 2-13.
- Fujita K, Kaburagi H, Nimura A, Miyamoto T, Wakabayashi Y, et al. (2019) Lower grip strength and dynamic body balance in women with distal radial fractures. *Osteoporos Int* 30(5): 949-956.
- Teixeira LE, Silva KN, Imoto AM, Teixeira TJ, Kayo AH, et al. (2010) Progressive load training for the quadriceps muscle associated with proprioception exercises for the prevention of falls in postmenopausal women with osteoporosis: a randomized controlled trial. *Osteoporos Int* 21(4): 589-596.
- Oliveira Rjd, Lima RM, Gentil P, Simões HG, Ávila WRdM, et al. (2008) Respostas hormonais agudas a diferentes intensidades de exercícios resistidos em mulheres idosas. *Rev Bras Med Esporte* 14(4): 367-371.
- Gasparotto LPR, Falsarella GR, Coimbra AMV (2014) As quedas no cenário da velhice: conceitos básicos e atualidades da pesquisa em saúde. *Rev Bras Geriatr Gerontol* 17(1): 201-209.
- Sousa N, Mendes R, Silva A, Oliveira J (2017) Combined exercise is more effective than aerobic exercise in the improvement of fall risk factors: a randomized controlled trial in community-dwelling older men. *Clin Rehabil* 31(4): 478-486.
- Zhao R, Zhao M, Xu Z (2015) The effects of differing resistance training modes on the preservation of bone mineral density in postmenopausal women: a meta-analysis. *Osteoporos Int* 26(5): 1605-1618.
- Cancela Carral JM, Pallin E, Orbegozo A, Ayan Perez C (2017) Effects of Three Different Chair-Based Exercise Programs on People Older Than 80 Years. *Rejuvenation Res* 20(5): 411-419.
- Ansai JH, Aurichio TR, Goncalves R, Rebelatto JR (2016) Effects of two physical exercise protocols on physical performance related to falls in the oldest old: A randomized controlled trial. *Geriatr Gerontol Int* 16(4): 492-499.
- Hiyamizu M, Morioka S, Shomoto K, Shimada T (2012) Effects of dual task balance training on dual task performance in elderly people: a randomized controlled trial. *Clin Rehabil* 26(1): 58-67.
- Varela S, Ayan C, Cancela JM, Martin V (2012) Effects of two different intensities of aerobic exercise on elderly people with mild cognitive impairment: a randomized pilot study. *Clin Rehabil* 26(5): 442-450.
- Moher D, Liberati A, Tetzlaff J, Altman DG, Group P (2009) Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 6(7): e1000097.
- Maher CG, Sherrington C, Herbert RD, Moseley AM, Elkins M (2003) Reliability of the PEDro scale for rating quality of randomized controlled trials. *Phys Ther* 83(8): 713-721.
- Daly RM, Duckham RL, Tait JL, Rantalainen T, Nowson CA, et al. (2015) Effectiveness of dual-task functional power training for preventing falls in older people: study protocol for a cluster randomised controlled trial. *Trials* 16: 120.
- Bohrer RCD, Pereira G, Beck JK, Lodovico A, Rodacki ALF (2019) Multicomponent Training Program with High-Speed Movement Execution of Ankle Muscles Reduces Risk of Falls in Older Adults. *Rejuvenation Res* 22(1): 43-50.
- Piraua ALT, Cavalcante BR, de Oliveira VMA, Beltrao NB, de Amorim Batista G, et al. (2019) Effect of 24-week strength training on unstable surfaces on mobility, balance, and concern about falling in older adults. *Scand J Med Sci Sports* 29(11): 1805-1812.
- Alfieri FM, Riberto M, Gatz LS, Ribeiro CP, Lopes JA, et al. (2010) Functional mobility and balance in community-dwelling elderly submitted to multisensory versus strength exercises. *Clin Interv Aging* 5: 181-185.
- Liu Ambrose T, Donaldson MG, Ahamed Y, Graf P, Cook WL, et al. (2008) Otago home-based strength and balance retraining improves executive functioning in older fallers: a randomized controlled trial. *J Am Geriatr Soc* 56(10): 1821-1830.
- Yamada M, Arai H, Uemura K, Mori S, Nagai K, et al. (2011) Effect of resistance training on physical performance and fear of falling in elderly with different levels of physical well-being. *Age Ageing* 40(5): 637-641.
- Aartolahti E, Lonroos E, Hartikainen S, Hakkinen A (2020) Long-term strength and balance training in prevention of decline in muscle strength and mobility in older adults. *Aging Clin Exp Res* 32(1): 59-66.
- Lacroix A, Kressig RW, Muehlbauer T, Gschwind YJ, Pfenninger B, et al. (2016) Effects of a Supervised versus an Unsupervised Combined Balance and Strength Training Program on Balance and Muscle Power in Healthy Older Adults: A Randomized Controlled Trial. *Gerontology* 62(3): 275-288.
- Miko I, Szerb I, Szerb A, Poor G (2017) Effectiveness of balance training programme in reducing the frequency of falling in established osteoporotic women: a randomized controlled trial. *Clin Rehabil* 31(2): 217-224.
- Joshua AM, D'Souza V, Unnikrishnan B, Mithra P, Kamath A, et al. (2014) Effectiveness of progressive resistance strength training versus traditional balance exercise in improving balance among the elderly - a randomised controlled trial. *J Clin Diagn Res* 8(3): 98-102.
- Motalabi SA, Cheong LS, Iranagh JA, Mohammadi F (2018) Effect of low-cost resistance training on lower-limb strength and balance in institutionalized seniors. *Exp Aging Res* 44(1): 48-61.

- 26 Marques EA, Mota J, Machado L, Sousa F, Coelho M, et al. (2011) Multicomponent training program with weight-bearing exercises elicits favorable bone density, muscle strength, and balance adaptations in older women. *Calcif Tissue Int* 88(2): 117-129.
- 27 Lee IH, Park SY (2013) Balance improvement by strength training for the elderly. *J Phys Ther Sci* 25(12): 1591-1593.
- 28 Seco J, Abecia LC, Echevarria E, Barbero I, Torres Unda J, et al. (2013) A long-term physical activity training program increases strength and flexibility and improves balance in older adults. *Rehabil Nurs* 38(1): 37-47.
- 29 Gschwind YJ, Kressig RW, Lacroix A, Muehlbauer T, Pfenninger B, et al. (2013) A best practice fall prevention exercise program to improve balance, strength / power, and psychosocial health in older adults: study protocol for a randomized controlled trial. *BMC Geriatr* 2013; 13: 105.
- 30 LaStayo P, Marcus R, Dibble L, Wong B, Pepper G (2017) Eccentric versus traditional resistance exercise for older adult fallers in the community: a randomized trial within a multi-component fall reduction program. *BMC Geriatr* 2017; 17(1): 149.
- 31 Halvarsson A, Franzen E, Faren E, Olsson E, Oddsson L, et al. (2013) Long-term effects of new progressive group balance training for elderly people with increased risk of falling - a randomized controlled trial. *Clin Rehabil* 27(5): 450-458.
- 32 Jacobson BH, Thompson B, Wallace T, Brown L, Rial C (2011) Independent static balance training contributes to increased stability and functional capacity in community-dwelling elderly people: a randomized controlled trial. *Clin Rehabil* 25(6): 549-556.
- 33 Sparrow D, Gottlieb DJ, Demolles D, Fielding RA (2011) Increases in muscle strength and balance using a resistance training program administered via a telecommunications system in older adults. *J Gerontol A Biol Sci Med Sci* 66(11): 1251-1257.
- 34 Wolfson L, Whipple R, Derby C, Judge J, King M, et al. (1996) Balance and strength training in older adults: intervention gains and Tai Chi maintenance. *J Am Geriatr Soc* 44(5): 498-506.
- 35 Lord SR, Sherrington C, Menz HB (2001) Epidemiology of falls and fall-related injuries. In: Lord SR, Sherrington C, Menz HB. Falls in older people: Risk factors and strategies for prevention. Cambridge: Cambridge University Press, p. 3-16.
- 36 Howe TE, Rochester L, Neil F, Skelton DA, Ballinger C (2011) Exercise for improving balance in older people. *Cochrane Database Syst Rev* 2011(11): CD004963.
- 37 Daubney ME, Culham EG (1999) Lower-extremity muscle force and balance performance in adults aged 65 years and older. *Phys Ther* 79(12): 1177-1185.
- 38 Lang T, Streeter T, Cawthon P, Baldwin K, Taaffe DR, et al. (2010) Sarcopenia: etiology, clinical consequences, intervention, and assessment. *Osteoporos Int* 21(4): 543-559.
- 39 Hakim RM, DiCicco J, Burke J, Hoy T, Roberts E (2004) Differences in balance related measures among older adults participating in Tai Chi, structured exercise, or no exercise. *J Geriatr Phys Ther*, p. 13-17.
- 40 Xu D, Hong Y, Li J, Chan K (2004) Effect of tai chi exercise on proprioception of ankle and knee joints in old people. *Br J Sports Med* 38(1): 50-54.
- 41 Rubenstein LZ (2006) Falls in older people: epidemiology, risk factors and strategies for prevention. *Age Ageing* 35 Suppl 2: ii37-ii41.
- 42 Thomas E, Battaglia G, Patti A, Brusa J, Leonardi V, et al. (2019) Physical activity programs for balance and fall prevention in elderly: A systematic review. *Medicine (Baltimore)* 98(27): e16218.
- 43 Pitchai P, Dedhia HB, Bhandari N, Krishnan D, D'Souza NRJ, et al. (2019) Prevalence, risk factors, circumstances for falls and level of functional independence among geriatric population - A descriptive study. *Indian J Public Health* 63(1): 21-26.
- 44 Kumar A, Srivastava D, Verma A, Kumar S, Singh N, et al. (2013) The problems of fall, risk factors and their management among geriatric population in India. *Indian J Community Health* 25(2): 89-94.
- 45 Dsouza SA, Rajashekar B, Dsouza HS, Kumar KB (2014) Falls in Indian older adults: a barrier to active ageing. *Asian J Gerontol Geriatr* 9(1): 33-40.
- 46 Simonsick EM, Lafferty ME, Phillips CL, Mendes de Leon CF, Kasl SV, et al. (1993) Risk due to inactivity in physically capable older adults. *Am J Public Health* 83(10): 1443-1450.

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