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Review

Effects of exercise for older women with osteoporosis: A systematic review

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Abstract: Aim: This study aimed to systematically review the existing evidence on the effects of physical exercise on muscle strength, balance, risk of falls, and fractures for older women with osteoporosis. **Methods:** MEDLINE (PubMed), Cochrane Central Register of Clinical Trials, Web of Science, PEDro, and Lilacs were searched, and the methodological qualities were measured using the Assessing risk of bias—Cochrane Collaboration's tool scale. **Results:** Eight controlled clinical trials were included. **Conclusion:** Multicomponent physical exercise, not only balance, may be considered as an intervention for older women with osteoporosis due to its effects on balance, strength, and functional outcomes. Future new randomized controlled trials should focus on parameters to prescribe physical exercise as the progression of resistance and its effects on skeletal muscle function, balance, strength, risk, and number of falls and fractures for older women with osteoporosis.

Keywords: osteoporosis; older people; postural balance; accidental falls; exercises

1. Introduction

Osteoporosis (OP) is characterized by a reduced skeletal microarchitecture and musculoskeletal fragility and is associated with vitamin D and calcium deficiencies, loss of independence, physical inactivity, increased risk of falls and fractures, and mortality [1]. OP affects about 200 million people worldwide, with > 9 million osteoporotic fractures reported annually. Femoral fractures have a high incidence rate in the aged population and a large economic impact [2,3]. OP predominantly affects women compared with men and is particularly elevated among postmenopausal women with its incidence increasing with age [4].

After an initial fracture, the risk for subsequent fractures more than doubles in the next 6–12 months and persists for up to 10 years. Furthermore, one in three people is estimated to die within 12 months of a hip fracture, 40% will be institutionalized or unable to walk independently, and 60% will still require assistance a year later [1].

The management of OP includes pharmacological treatment with calcium supplementation, with concomitant vitamin D supplementation, for patients at high risk of calcium and vitamin D insufficiency and for those who are receiving treatment for OP and nonpharmacologic recommendations such as modifications in risk factors for falls and physical exercise [5–7]. However, pharmaceuticals do not affect key fracture risk factors, such as muscle strength, muscle power, dynamic balance, coordination, and overall functional performance, which have been associated with an increased risk for falls and fractures [1].

Training protocols using different types of exercise in the same session, i.e., progressive resistance, weight-bearing impact exercise, and balance, called multicomponent exercise training, are recommended for older people with OP [1,8]. Nevertheless, parameters for exercise prescription such as the type and dosage (frequency, intensity, and duration) and additive effects of vitamin D plus calcium on musculoskeletal function and risk for falls have not yet been established.

The effectiveness of the training regimen method on the bone mineral density (BMD) of the femoral neck and lumbar spine in adult women was investigated. Daly et al. [1] and Linhares et al. [8] revealed that femoral neck and lumbar spine BMD respond differently depending on the type of exercise. Whole-body vibration exercise (WBV) demonstrated better results in lumbar spine BMD when compared to aerobic, resistance, or combined training. Furthermore, WBV can be concluded as an effective regimen in improving lumbar spine BMD but not in the femoral neck BMD in postmenopausal women [9]. However, another systematic review involving adults aged $\geq$ 50 years revealed that WBV does not affect BMD but reduces fall rates and prevents fractures [10]. Another systematic review, including prospective randomized controlled trials (RCTs) comparing at least one exercise group with a control group, revealed that even unsupervised exercise improves femoral neck and lumbar spine BMD in adult women aged > 30 years. However, beneficial effects are more pronounced in those with poor bone health compared with healthy counterparts [11].

Studies involving older women with OP and a history of vertebral fractures revealed that 12 weeks of a supervised multicomponent resistance and/or balance exercise program improved muscle strength and balance and reduced fear of falling [12,13]. In addition, a significantly better result was recorded regarding the fear of falling even after 12 months of follow-up [12]. Moreover, when exercises were performed including dual tasks, other authors found greater effects compared with single-task gait, supporting the role of cognitively demanding exercises in maintaining safe ambulation in older women with OP [14].

A multicomponent program of high-speed training exercises combined with simulated functional tasks can efficiently improve mobility, balance, and self-reported measures of functioning. Moreover, physical exercise carried out at people’s homes can be beneficial for people with OP [15]. Multicomponent training for an average of 27.2 weeks, 2.6 sessions per week, and 45 min per session improved strength, flexibility, quality of life, BMD, balance, and functional fitness, and reduced the risk for falls in older women with OP [8].

Nevertheless, studies investigated different intervention protocols and the lack of patterns for the outcomes among the elected studies are limitations in the findings and should be analyzed with caution when prescribing physical exercises for women with osteoporosis.

Moreover, resistance training in patients with OP and risk for falls can improve femoral neck BMD, health-related quality of life, and physical function. However, whether resistance training contributes to preventing falls cannot be concluded [16].

Thus, studies describing the dosage of each type of exercise are limited, particularly with a gradual increase in load, intensity, duration, and frequency. Moreover, the dose-response effects of physical exercise in different parts of the body, i.e., in the lumbar spine and femoral neck, and detraining on BMD, falls, and fracture risk factors, mainly in individuals with osteoporotic fractures are unknown [17].

It is difficult to generate exercise recommendations on bone strengthening and precisely designed randomized controlled exercise trials may be the most appropriate tool to address the characteristics of a single exercise and thus generate exercise recommendations in the area of osteoporosis prevention and therapy.

Therefore, this systematic review aimed to verify the effects of physical exercise on muscle strength, balance, fear of falling, dizziness, risk of falls and fractures, and quality of life in older women with OP.

2. Materials and methods

This systematic review was developed based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) (**Figure 1**) [18], and was registered with the International Prospective Register of Ongoing Systematic Reviews (PROSPERO) under the registration number CRD 42018096205 [19].

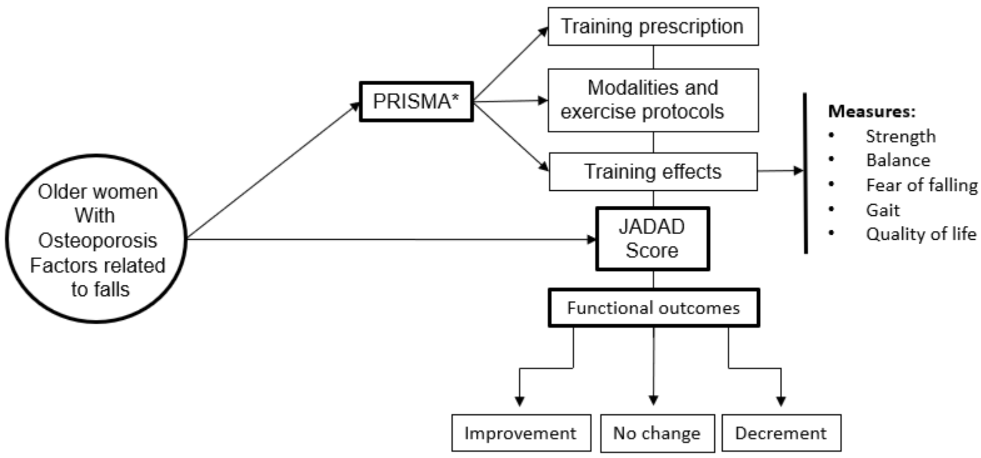

Figure 1. Research framework for preparing the systematic review.

Preferred reporting items for systematic reviews and meta-analysis—PRISMA.

2.1. Eligibility criteria

2.1.1. Type of study

Controlled and RCTs, including simple blinded, non-blinded, and crossover assays, comparing physical exercise with another intervention or control; in English; since 2010 were reviewed. Studies without the intervention of physical exercise, review studies, pharmacological drugs in the title, and experimental animal model studies were excluded.

2.1.2. Participants

This study considered older women (aged > 65 years) with OP diagnosed using bone mineral densitometry measured in the last 12 months, reduced by at least 2.5 standard deviations or more below the mean value for healthy young women (a T-score of < −2.5 SD) eligible for inclusion. Individuals with other associated diseases and/or fractures were excluded [20].

2.1.3. Interventions

Studies with physical exercise as an intervention were considered, including the following types of training: strength, stretching, and balance.

2.2. Outcome measures

Outcomes

Isometric muscle strength (measured with a dynamometer); postural control and balance measured using limits of stability, Clinical Test Sensory Interaction Balance, one-leg and modified figure of eight tests, Berg balance scale, timed up and go, and Romberg; preferred gait speed with and without a cognitive dual task (measured by gait speed); fast gait speed (measured by gait speed); fear of falling (measured with the question: Are you afraid of falling? and using the Falls Efficacy Scale-International); physical activity level (Frandin-Grim by activity scale); and physical function measured with Late Life Function and Disability Instrument (LLFDI) were obtained.

2.3. Search strategy

The study was conducted in September 2023 and included studies published in scientific journals in English between 2010 and 2023. The search sources were MEDLINE (PubMed), The Cochrane Central Register of Controlled Trials (CENTRAL), Web of Science, PEDro, and Lilacs (BIREME). To identify other relevant test data, the authors of published trials with incomplete data were contacted, but no response was received.

The search strategy included a combination of the Medical Subject Heading terms described as follows: (“elderly “) and (“osteoporosis “) and (“fall “), (“elderly “) and (“osteoporosis “) and (“exercise “), (“elderly “) and (“osteoporosis “) and (“balance “).

2.4. Selection of studies

Two independent reviewers (CFS and MR) assessed the study eligibility independently. The reviewers screened the titles and abstracts of the articles for subject relevance. Studies that could not be excluded based on abstract information were also selected for full-text screening. During the second phase, the same reviewers independently assessed the full articles in duplicate to select those that met the eligibility criteria. Differences between reviewers were resolved by consensus.

2.5. Data extraction

The following data were extracted and recorded in tables of evidence: author and year of publication, study population (number of individuals, age, and sex), study design, rating scale, study duration, and results of the intervention period. If any inconsistency occurred, the original documents were analyzed by both reviewers to resolve the disagreement.

2.6. The risk of bias assessment

The risk of bias was evaluated in duplicate by the same independent reviewers using the Cochrane Handbook for Systematic Reviews of risk of bias tool (assessing risk of bias (Rob) Cochrane Collaboration's tool) that considers whether randomization was adequate, if there was concealment of the allocation in groups, if there was blinding of patients and investigators, if there was blinding of the assessors, if there was a description of losses and exclusions, if there were descriptions of the results in all outcomes, and if there were other biases not described in the instrument itself.

3. Results and discussion

3.1. Study characteristics

Eight (100%) studies included in this systematic review were RCTs (**Figure 2**), with female patients (100%), and were published between 2010 and 2023 [21–28]. These studies were conducted in several countries: Filipović et al. [21]; Conradsson and Halvarsson [22]; Miko et al. [23]; Halvarsson et al. [24,25]; Burke and França [26,27]; and Madureira et al. [28].

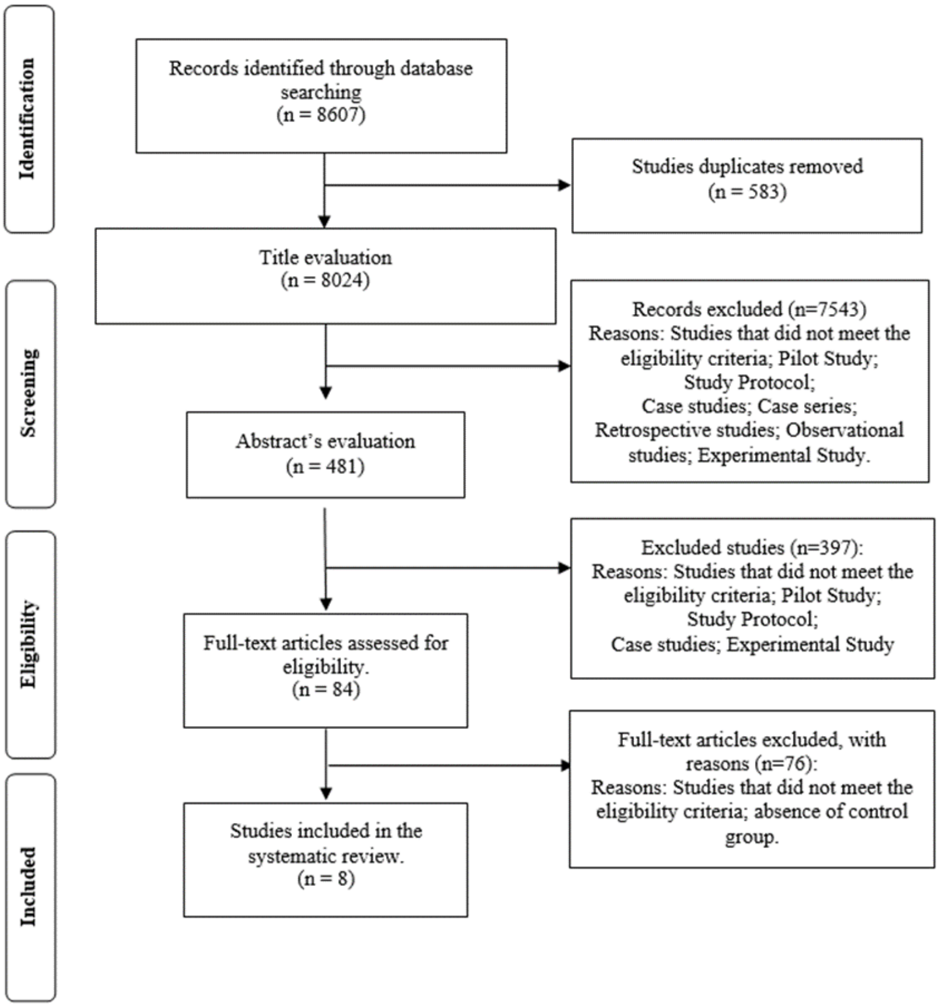

Figure 2. Stages of the study selection process and exclusions.

Table 1 describes the study characteristics included in this review based on the following items: author, year of publication, study participants (number, age, and gender), methodology, interventions, variables analyzed, and results obtained.

Table 1. Description of study characteristics included in this review.

Author, year	**Design**	**Subjects (*n*)**	**Intervention groups and time**	**Control group (CG)**	**Variables assessed**	**Results**
Filipović TN et al. (2021)	RCT	96 (women)	Exercise group (EG, $n = 47$): resistance training, balance exercise, and aerobic exercise. 4 and 12 weeks	CG, ($n = 49$), had not participated in any exercise program	Functional outcomes: timed up and go test (TUG); Sit-to-stand test (STS); One-leg stance test "(OLST); Falls Efficacy Scale—International (FES-I); Osteoporosis Knowledge Assessment Tool (OKAT-S)	Significant improvement in all observed measurements in EG after 4 and 12 weeks. OLST significantly changed only in EG, not in CG, in both experimental periods. Comparison between groups showed improvement in EG compared with CG in all functional outcomes in observed periods ($p < 0.001$ for all). OLST significantly changed only in EG, not in CG, in both experimental periods. After 4 weeks, in CG, no statistically significant changes were observed in any of the monitored parameters, while after 12 weeks, improvements were detected with TUG, STS, FES-I, and OKAT-S.
Conradsson D and Halvarsson A. (2019)	RCT	43 (women)	BT: balance training group ($n = 43$) 12 weeks	CG ($n = 25$), care as usual	Gait with GAITRite® Level of physical activity during free-living conditions (waking hours of the day) with accelerometers (Actigraph, GT3X+)	GAITRite: The training group walked faster for single- and dual-task gait following training ($p \leq 0.044$) by increasing their cadence ($p \leq 0.012$) and reducing the step and swing time ($p \leq 0.045$) compared with the control group. Significant between-group differences in favor of the training group were found for gait variability during dual-task gait ($p \leq 0.041$). The speed improvement was greater for dual- than single-task gait (0.10 vs. 0.05 m/s), and the effect sizes revealed small to medium effects for dual-task gait, and either nonexistent or small for single-task gait. The level of community ambulation has not shown significant improvement.
Miko I et al. (2016)	RCT	100 (women)	BT ($n = 50$) 12 months	CG ($n = 50$), only received osteoporosis treatment and had no intervention	Balance static and dynamic (BBS; TUGT); Static postural balance ("Romberg1" "Romber 2").	The Berg balance scale and the timed up-and-go test showed some statistically significant improvement in balance in the intervention group ($p = 0.001$ and $p = 0.005$, respectively). Balance tests using the stabilometer also showed a statistically significant improvement in static and dynamic postural balance for osteoporotic women after the completion of the Balance Training Program. As a consequence, the 1-year exercise program significantly decreased the number of falls in the exercise group compared with the control group.

Table 1. (*Continued*).

Author, year	Design	Subjects (*n*)	Intervention groups and time	Control group (CG)	Variables assessed	Results
Halvarsson A et al. (2015)	RCT	3 months = 69; 9 months = 60; 15 months = 55 (women)	BT (n = 22) BT + PA (n = 14). 12-weeks Follow ups: 9 months and 15 months	CG (n = 19), offered participation in the balance training program at the end of the study and was encouraged to live their regular lives during the study period	Balance (one-leg stance; the modified figure of eight tests); Fear of Falling (are you afraid of falling?); Falling (the Falls Efficacy Scale–International FES); physical activity level (Frãndin-Grimby Activity Scale (1–6)); referred and fast gait speed with and without dual-task (GAITRite); physical function (LLFDI).	Participants in the training group maintained positive effects throughout the study period for concerns about falling (baseline vs. 15 months, median 27.5 vs. 23 points, p < 0.001) and walking performance (baseline vs. 15 months, $p \leq 0.05$ with an improvement of 0.9–1.4 m/s). The training + physical activity group declined to baseline values at the 9-month follow-up and were even lower at the 15-month follow-up for concerns about falling (median 26 vs. 26 points), walking performance (changes of−0.02 to 0.04 m/s), and physical function (mean 44.0 vs. 42.9 points). The control group remained unchanged throughout the study period.
Halvarsson A et al. (2014)	RCT	69 (women)	BT (n = 25) BT + PA (n = 18); 12 weeks	CG (n = 26) were encouraged to live their regular lives and were offered the same balance training at the end of the study.	Balance (one-leg stance; the modified figure-of-eight test); fear of falling (are you afraid of falling?); fall-related self-efficacy (the falls efficacy scale—international, FES-I); physical activity level (Frãndin-Grimby Activity Scale (1–6)); preferred and fast gait speed with and without cognitive dual-task (GAITRite); physical function (LLFDI).	All groups improved their fall-related self-efficacy; Intervention groups decreased their fear of falling, increased their preferred and fast walking speed, and increased balance; BA + PA increased their preferred walking speed with a cognitive dual-task, increased balance (modified figure-of-eight test), and improved physical activity
Burke T et al. (2012)	RCT	50 (women)	SG (n = 17) STG (n = 17) 8 weeks	CG (n = 16) Did not receive any treatment.	Postural control (CTSIB; LOS); Strength (Dynamometer and the shortening).	Relative to controls, participants in the strengthening group displayed significantly increased dorsiflexion strength and knee flexion strength, as well as the center of pressure velocity, directional control, and oscillation velocity (CTSIBm test). The stretching group had significant improvements in hamstring length, knee flexion strength, center of pressure velocity, and amplitude of movements. Relative to the stretching group, the strengthening group yielded better knee extension strength and directional control
Burke T et al. (2010)	RCT	33 (women)	BT + ST (n = 17) 8 weeks	CG (n = 16) did not practice exercises.	Isometric Muscular Strength (dynamometer); Postural Control (LOS; CTSIBm).	Adherence to the program was 82%. When compared with the control group, individuals in the intervention group significantly improved the center of pressure velocity (P = 0.02) in the modified clinical test of sensory interaction for balance test, the center of pressure velocity (P < 0.01), and directional control (P < 0.01) in limits of stability test, isometric force during ankle dorsiflexion (P = 0.01), knee extension (P <0.01), and knee flexion (P < 0.01)

Table 1. (*Continued*).

Author, year	**Design**	**Subjects (*n*)**	**Intervention groups and time**	**Control group (CG)**	**Variables assessed**	**Results**
Madureira M et al. (2010)	RCT	60 (women)	BT ($n = 30$) 12 months	CG ($n = 30$) no intervention.	Quality of life (Osteoporosis Assessment Questionnaire-OPAQ); Functional balance (Berg Balance Scale-BBS); Static Balance (CTSIB).	The comparison of OPAQ variations (INITIAL-FINAL) revealed a significant improvement in the quality of life in all parameters for BT compared with CG: well-being (1.61 ± 1.44 vs. −1.46 ± 1.32, $p < 0001$), physical function (1.30 ± 1.33 vs. −0.36 ± 0.82, $p < 0.001$), psychological status (1.58 ± 1.36 vs. −1.02 ± 0.83, $p < 0.001$), symptoms (2.76 ± 1.96 vs. −0.63 ± 0.87, $p < 0.001$), and social interaction (1.01 ± 1.51 vs. 0.35 ± 1.08, $p < 0.001$). Of note, this overall benefit was paralleled by an improvement in BBS (−5.5 ± 5.67 vs. 0.5)

Key: BT, balance training; PA, physical activity; RT, resistance training; ST, strength training; SG, strengthening group; STG, stretching group; CTSB, Clinical Test Sensory Interaction Balance; LOS, limits of stability; LLFDI, Late-Life Function and Disability Instrument; TUGT, Time “Up and Go” Test; BBS, Berg Balance Scale; NW, Nordic Walking; RCT, randomized controlled trial.

3.2. Risk of bias assessment

Of the studies included in the systematic review, 100% underwent appropriate randomization; no studies were double-blind; and 100% reported monitoring losses and exclusions and 0.5% (one study) reported appropriate blinding (**Table 2**).

Table 2. Risks of errors in the included studies and JADAD score.

Study	Randomized?	Double blind?	Described the losses?	Appropriate randomization?	Appropriate masking?	Jadad classification
Filipović et al. (2021)	Yes	No	Yes	Yes	Yes	High quality
Conradsson and Halvarsson (2019)	Yes	No	Yes	Yes	No	High quality
Miko et al. (2016)	Yes	No	Yes	Yes	No	High quality
Halvarsson et al. (2015)	Yes	No	Yes	Yes	No	High quality
Halvarsson et al. (2014)	Yes	No	Yes	Yes	No	High quality
Burke et al. (2012)	Yes	No	Yes	Yes	No	High quality
Burke et al. (2010)	Yes	No	Yes	Yes	No	High quality
Madureira et al. (2010)	Yes	No	Yes	Yes	No	High quality

3.3. Modalities and exercise protocols used

Exercise modalities found in the articles were balance [21–25,27], strength training or muscle strengthening [26], cardiorespiratory fitness [21,24,25], and balance and cardiorespiratory fitness [24,25], and only one study used stretching [26].

Balance exercises were developed with tandem and semi-tandem gait, single-leg support, walking on toes and toes, with and without eyes open, on hard and soft floors [21], dual-task balance training differentiated between single and dual tasks [22], a compilation of exercises (unspecified) [23], changes in the base of support during sitting and standing, reaching/leaning, walking/standing/sitting on uneven surfaces, eyes open/closed, walking at a different pace, and/or performing dual and multiple tasks that is, adding cognitive and/or motor tasks to an exercise and reactions to the loss of balance that will occur when the balance is highly challenged [24,25] and conducted in dynamic and static postures (unspecified) [26]. Exercises used for strength training or muscle strengthening were not specified [21]. For cardiorespiratory fitness exercises or aerobic activity, brisk walking [21] and light walks [24,25] were performed, and for stretching training, static stretching was used (unspecified) [26].

Regarding the weekly frequency, interventions were evaluated in two sessions per week [26,27] and three times per week [21–25,28]. The duration of training programs varied from 8 [26,27] to 12 weeks [21,24,25], 12 months [22,23,28], and 9- and 15-month follow-ups [24,25]. The duration of each training session varied from 15 [21], 30 [23], 45 [22,24,25], and 60 min [26–28].

All studies have a control group that did not receive any type of treatment during the study.

3.4. Effects of physical exercises

Effects of physical exercises on strength and balance control

Strength and balance training were used in two studies [26,27]. One study investigated the effects of two physical training regimens: balance and strengthening and balance and stretching, compared to no activity. Both modes of intervention were effective in improving postural control when compared with the control group; however, the muscle-strengthening group achieved better results than the stretching group in knee extension strength and directional control [26]. In another study, evaluations demonstrated an improvement in the isometric strength of the knee flexors, extensors, and ankle flexors and postural control after balance and strength training, compared with the control group [27].

Other results, such as improvements in fall-related self-efficacy, balance performance, walking speed with a dual-task, fast walking speed and lower extremity physical function [24,25], balance enhancement, a significant decrease in the number of falls in postmenopausal women who have already had at least one fracture in the past [23], a significant improvement in the quality of life, functional balance, and a reduction of falls, were found [28]. Greater training effects were reported in various domains of dual-task gait compared with single-task gait [22]. Significant improvement in muscle strength and balance, decreased fear of falling, and increased knowledge about OP were also reported [21].

4. Discussion

The present study showed that physical exercise reduced fear of falling and improved OP knowledge, physical activity level, physical function, gait speed, and balance [21,22,24,25]. Moreover, static, dynamic, and functional balance and quality of life were improved [23,28]. Isometric knee flexors and extensors, ankle flexors strength, postural control [26,27], and lower-limb strength and power were also enhanced [21].

Physical exercise is recommended to prevent falls in older people with OP because it can improve modifiable factors such as strength, BMD, and balance. However, physical exercise should be performed as a multicomponent (multimodal) training, including two or more activity modes, such as weight-bearing, resistance exercises, and/or balance training. The multi-modal training should be performed with progressing resistance, beginning between 30% and 70% of one-repetition maximum (1RM) and increasing to 75%–85% of 1RM (Borg 5–7/8 of 10); at least twice a week; starting with slow and controlled movements and emphasizing correct lifting technique; progressing to higher speed and functional and multidirectional movements, targeting muscles attached or crossing the hip and spine; eight different exercises at each training session with two sets of each exercise at 8–12 repetitions. Exercises should include weight-bearing impact-loading activities such as jumps, and 3–5 sets of 10–20 repetitions. Balance exercises are recommended for 2–3 h per week, 10–30 for each exercise, improving the movement speed and challenge, progressing from static to dynamic exercises, and adding motor and cognitive dual-task [1].

A multimodal exercise program, including resistance exercises, weight-bearing impact loading, and balance improved functional performance and BMD and reduced the risk of falls in community-dwelling older people [8]. Some studies included in the present systematic review investigated the effects of a multi-modal exercise program [21,24–26]. Linhares et al. [8] reported that multi-modal training can be a training option for older women with OP. Furthermore, Gordt et al. [14] reported that multicomponent exercises, when diversified with high-speed training and simulated functional tasks, can be efficient in improving the functional status of people with OP.

The studies included in the present review investigated the effects of an intervention program constituted by balance and strengthening training; twice a week; lasting for 8 weeks compared with the control group, not practicing any exercises. They found that balance and strength exercises are effective in improving postural control and lower-limb strength in older women with OP [27].

Another clinical trial was carried out to compare the effectiveness of balance training associated with muscle strengthening or stretching, with no intervention, on the postural control of older women with OP divided into three groups: the strengthening group, which performed balance training with muscle strengthening; the stretching group, which carried out balance training with stretching; and the control group, with no activities, with interventions for 8 weeks, twice a week, 60 min a day. Compared with the controls, participants in the strengthening group showed a significant increase in dorsiflexion strength and knee flexion strength, as well as the center of pressure velocity, directional control, and sway velocity. The stretching group had significant improvements in hamstring length, knee flexion strength, center of pressure velocity, and range of motion. Compared with the stretching group, the strengthening group had better knee extension strength and directional control. The study concluded that both interventions are effective in improving postural control when compared with the control group, with the strengthening group being superior to the stretching group in knee extension strength and directional control [26].

One of the factors related to falls in older people is the fear of falling. In the present systematic review, two studies [24,25] reported that balance training isolated or in combination with physical activity is effective in reducing fear of falling. Previous study findings support the idea that muscle strengthening, balance improvement, and mobility training are effective in minimizing associated fear, by neuromuscular positive impact on physiological mechanisms that enhance motor function and physical activity [29]. Thus, both studies revealed that balance and strengthening training improve directional control, oscillation speed, and strength corroborating the principle of specificity of training [29]. Moreover, when balance was performed with stretching improvements in hamstring length, knee flexion strength, center of pressure speed, and amplitude of movements were found, but the strengthening group was superior to the stretching group in knee extension strength and directional control. Thus, to maximize efficacy, older women with OP are recommended to undergo a combination of balance and strengthening training to improve balance and strength, increase muscle and bone mass, to prevent bone loss, at least twice weekly, progressing intensity, volume, and difficulty level [30].

In the present review, two studies developed by the same group of authors investigated the effects of dual and multi-tasks, both three times/week over 12 weeks. The one published in 2014 found that a balance training program improved fall-related self-efficacy, gait speed, balance performance, and physical function in older adults with OP. The study published in 2015 reported not only the effects of a 12-week balance training but also investigated a group with or without supplementary physical activity. Moreover, they included follow-ups after 9 and 15 months. They detected that positive effects of walking performance and concerns about falling were maintained even after 15 months. The group with supplementary physical activity declined at the 9-month follow-up and was even lower at the 15-month follow-up for concerns about falling, walking performance, and physical function [24,25].

The effects of balance training were investigated in 30-min sessions, twice a week, with 8 weeks of intervention. An improvement in the functional balance of older women with OP was observed, even after 8 weeks of intervention [30,31], although other studies reported that after a training period of 1, 2, or 3 months, the gains were not maintained [32,33]. Therefore, older people should adhere to and attend exercises using video games, also known as exergames, which are considered to be a dual motor-cognitive task, because motor actions and cognitive aspects must be processed simultaneously. It has been used as a motivating tool to perform exercises and improve balance, functionality, and strength, as well as cognitive and psychological factors in older adults [34].

Another study included in this systematic review found greater training effects after 12 weeks in various dual-task gait domains compared with a single-task gait, supporting the role of cognitively demanding exercises in maintaining safe ambulation in older women with OP [22].

The most part of the studies included in the present systematic review reported improvements in balance after a training period of at least four weeks of balance or multicomponent (balance and/or resistance and/or aerobic) exercises [21,22]. However, it is important to assess not only balance but the risk and number of falls. In this regard, only two studies showed that 12-month balance training reduced the number of falls in osteoporotic women who have already had at least one fracture [23,28].

Regarding the period of physical training, the present systematic review found significant gains after 4 [21], 8 [26,27], and 12 weeks [21,24,25], and two longer studies with 12 months [23,28].

Some limitations were found in the present systematic review. The lack of adequate descriptions in the studies included in this review—particularly descriptions of methods, exercise prescriptions, and methods used to assess the outcomes—made it impossible to conduct a meta-analysis of the included studies. Also, descriptions of adverse effects in the included studies are lacking, which compromises the safety of reported interventions. Although the results of this review indicate that physical exercise improves balance and strength, further studies are needed to determine whether longer intervention periods can modify different aspects of postural control and factors related to falls. A follow-up of these patients is also desirable to investigate if these gains remain after the intervention and influence in reducing the number of falls and fractures in this population. We therefore suggest that new RCTs be conducted with more participants and greater standardization of the evaluation and intervention methods. Multi-modal physical training, including strength and balance exercises, may be recommended for clinical practice, for intervention periods of 4 weeks or more, to increase muscle strength; improve knowledge about OP, quality of life, lower-limb physical function, gait and balance, self-efficacy related to falls; reduce worries about falls and the number and risk of falls. Moreover, motor and/or cognitive dual tasks should be added to physical training to improve physical function in older women with OP and multi-modal physical training, including strength and balance exercises for 4 weeks.

5. Conclusions

In conclusion, it can be recommended a multi-modal training including resistance; balance and/or stretching, at the same physical training session for at least a period of 12 weeks. Regular physical exercise with motor and/or cognitive dual task can be effective to enhance balance confidence and reduce fear of falling and fall incidence. A multi-modal training improved factors related to falls as balance, fear of falling; gait; strength and quality of life in older women with osteoporosis.

Ethical approval: Not applicable.

Conflict of interest: The authors declare no conflict of interest.

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