Comparison between two therapeutic modalities on postural balance and fear of falling in postmenopausal women: a randomized and controlled clinical trial

Laís Campos de Oliveira[1]
Raphael Gonçalves de Oliveira[1]
Angélica da Silva Ribeiro[2]
Deise Aparecida de Almeida Pires-Oliveira[2]

Abstract

Objective: To compare the effects of Pilates vs. whole body vibration (WBV) and no treatment controls on postural balance and fear of falling in postmenopausal women. *Method:* Single-blind randomized clinical trial, with 51 participants randomized into three groups (Pilates, WBV, or control). Evaluations were performed of static postural balance on a force platform, dynamic postural balance by the Timed Up & Go test, and fear of falling by the Falls Efficacy Scale-International (FES-I). Pilates and WBV were performed three times a week for six months. *Results:* After the intervention, no difference (p>0.05) was observed for static postural balance, however, for the majority of variables, Pilates and WBV demonstrated a large effect size (d>0.80) when compared to control. For dynamic postural balance and risk of falls, Pilates and WBV showed a significant (p=0.032) improvement compared to the control. Fear of falling did not change (p=0.055) between groups over time. *Conclusion:* In view of the clinical representativeness evidenced by the effect sizes, Pilates and WBV can be recommended to improve postural balance in postmenopausal women. However, in relation to fear of falling, these therapeutic modalities require further investigation.

Keywords: Exercise Therapy. Postural Balance. Accidental Falls. Menopause.

[1] Universidade Estadual do Norte do Paraná (UENP), Programa de Pós-graduação em Ciências do Movimento Humano. Jacarezinho, PR, Brasil.

[2] Centro Universitário de Anápolis (UNIEVANGELICA), Programa de Pós-graduação em Movimento Humano e Reabilitação. Anápolis, GO, Brasil.

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Correspondence
Laís Campos de Oliveira
oliveiralc@uenp.edu.br

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INTRODUCTION

Falls and their consequences are an important risk factor for morbidity and mortality in old people, being the most common cause of injuries and deaths from injuries in this population[1]. Among the variables that can potentiate the occurrence of falls are deficits in postural balance and fear of falls. During the aging process, these factors start to become more evident at menopause and tend to worsen over time. It has been demonstrated that postural balance suffers a significant decline during the transition to postmenopausal, considering, among other factors, the estrogen deficiency resulting from this period. On the other hand, fear of falls is also associated with a higher incidence of this event in postmenopausal women, which increases the risk of fractures and their consequences over the following years[2].

To mitigate these factors that significantly affect older people, different forms of interventions are being investigated. Evidence presented by meta-analysis studies shows that therapeutic modalities such as Pilates and whole body vibration (WBV) can improve postural balance, contributing to reducing the risk of falls during the aging process[3-9]. However, only two meta-analyzes, with contradictory results, were grouped in studies that assessed postural balance by displacing the plantar pressure center, using devices that provide more accurate data, such as area and speed of displacement in different directions[4,6]. In addition, meta-analysis studies conducted to date have described a high risk of bias in randomized controlled trials (RCTs) included in the analyzes[3-9].

Pilates is characterized as a therapeutic modality that involves physical exercise of localized muscular resistance, which uses springs of different intensities coupled in specific equipment, providing progressive muscular tension[10]. Pilates exercises focus on strengthening the entire body, with priority for the upper-body muscles that stabilize the spine. The muscular strength of the trunk, among other factors, is related to postural balance, when correcting the posture and preparing the body for the movements of the extremities (lower and upper limbs) during the execution of daily life tasks[6].

On the other hand, unlike therapeutic modalities that involve physical exercise, WBV requires little effort from the practitioner, requiring only that the person remain in an orthostatic position on a vibrating plate that oscillates in the vertical direction. Vibration can be administered at different intensities, with the aim of stimulating alpha motor neurons through mono-polysynaptic pathways, which leads to the adaptation of muscle tension, capable of directly impacting postural stability[7].

Thus, it is important to verify the differences between these therapeutic modalities, in variables related to postural balance and fear of falls, considering that Pilates exercises are increasingly sought after by women after the menopause period and throughout of the entire aging process[11], while WBV presents itself as an alternative modality, requiring reduced intervention time, little motivation and effort, which can be an alternative when conventional physical exercises are not possible[12]. Thus, the aim of the present study was to verify the effects of Pilates exercises, compared to WBV and no treatment, on postural balance and fear of falls in postmenopausal women.

METHODS

The present study is characterized as a mono-blind RCT, which followed the recommendations of CONSORT (http://www.consort-statement.org/). The intervention involved 51 postmenopausal women living in Jacarezinho, state of Paraná, Brazil. The sample was calculated using the Bioestat 5.3 program (Instituto Mamirauá, Amazonas, Brazil), taking into account the values of the average speed of displacement of the pressure center with eyes open, available in a previous study[13]. In this case, the post-intervention mean and standard deviation between the Pilates (0.68±0.04) and control (0.73±0.04) groups were used, with 80% test power and 0.05 alpha value, which generated the need for at least 10 participants in each group.

The ethical standards of Resolution No. 466 of December 12, 2012, were followed and all participants signed a Free and Informed Consent

Form, after approval by the Ethics Committee on Research with Human Beings (opinion 1.032.182). Participants were recruited through posters made available in public places, advertisements in newspapers, radio, Internet sites and leaflets left in medical clinics and health facilities. In this case, posters and leaflets were distributed at random in all districts of the municipality.

The inclusion criteria were: a) post-menopause, for at least 12 months; b) not practicing physical exercise for at least six months; c) agreement not to practice another type of exercise during the research; d) ability to perform basic and instrumental activities of daily life without assistance, using the Katz index[14], and Lawton and Brody[15], respectively; e) presentation of a medical certificate indicating that she is healthy and able to exercise; f) score ≥19 on the Mini Mental State Examination[16].

The exclusion criteria were: a) musculoskeletal disorders in the spine or lower limbs in the previous six months; b) fracture of the spine or lower limbs after 40 years of age; c) prosthesis in the lower limbs or implants in the spine; d) secondary causes of bone loss; e) other metabolic bone diseases or diseases that affect bone metabolism; f) history of cancer in the last five years; g) vascular changes, epilepsy or seizures; h) arrhythmia; i) use of pacemaker; j) eye disease that affects the retina; k) cardiorespiratory diseases; l) diseases of the neuromuscular system; m) labyrinthitis or vertigo; n) hospitalization in the previous six months for surgical reasons; o) thyroid disorder; p) smoking; q) frequent use of alcoholic beverages; r) use of supplements based on calcium or vitamin D, isoflavone, medications for increasing bone mineral density or increasing muscle mass in the previous 12 months; s) inability to tolerate WBV for five minutes.

Randomization occurred only after the inclusion of all participants. A random permutation of whole numbers (randomization.com) distributed equal numbers (n=17) of participants in each group. The process was carried out by an independent researcher, who sealed the opaque envelopes containing the group to which each participant would be allocated and handed them over to the main researcher.

All participants included in the present study were instructed to maintain their usual routines, as well as their daily physical activities (for example, household chores, paid work) and nutritional habits. They were also instructed not to take any medication or supplements that could influence muscle or bone mass.

All procedures were performed by blind evaluators. To assess static postural balance, a BIOMEC400 force platform (Sistema EMG do Brasil Ltda., São Paulo) was used. The evaluator explained the test procedures to the participants, who had a brief familiarization period (approximately 5 minutes) with the equipment and the tests to be performed. Subsequently, the participants performed the following tasks: bipedal support (eyes open and closed), semi-tandem (eyes open and closed) and unipedal with the dominant lower limb (eyes open) (Figure 1). The order of execution of each task (bipedal, semi-tandem and unipedal) was randomized. For each task, three attempts of 30 seconds were made, with an equal rest interval. For data analysis, the average of the three trials was used. The participants were barefoot, with their arms loose and relaxed at their sides and the cephalic positioning horizontal to the ground plane, keeping their gaze towards a fixed target (in the shape of a cross, measuring 15 cm x 15 cm), positioned at a wall, at eye level, at a distance of 2 meters

Figure 1. Positioning of feet on the force platform during postural balance tasks. Jacarezinho, PR, 2020.

Key: a) bipedal; b) semi-tandem; c) unipedal.

The signals of the ground reaction force were collected in a 100 Hz sampling, and passed through a second order Butterworth low-pass filter at 35 Hz. The signals were converted through a stabilographic analysis, compiled with the MatLab routines of the platform software itself (The Mathworks, Natick, MA). The equilibrium parameters calculated were: displacement area of the center of pressure (A-COP) expressed in square centimeters (cm2) and average oscillation speed (MVeloc) expressed in centimeters per second (cm/s), in the anteroposterior direction (A/P) and mid-lateral (M/L). These parameters were chosen because they showed good reliability in older adults[17].

Dynamic balance was assessed by the Timed Up & Go test[18]. Upon hearing the command "go", the participants got up from an armless chair, walked three meters to a mark placed on the floor, turned around, went back to the chair and sat down again. Three attempts were made for each volunteer and the average time in seconds was used in the analyzes.

The Brazilian version of the Falls Efficacy Scale-International (FES-I) was used to measure fear of falls[19]. FES-I is a structured questionnaire that contains questions about concerns about the possibility of falling when performing 16 activities, with the respective scores from one to four. The total score can range from 16 (no concern) to 64 (extreme concern).

The interventions took place three times a week, on non-consecutive days, for six months (78 sessions), in a private clinic located in the city of Jacarezinho, Paraná, Brazil. The experimental groups (Pilates and Vibration) were supervised by two professionals with experience in Pilates and WBV. As the intervention included physical exercise, it was not possible to blind the participants or the professionals responsible for the interventions.

The first Pilates session was used to familiarize participants with the technique, providing an explanation of the correct execution of each movement and the principles of the method. The following equipment was used to perform the exercises: Cadillac, Reformer, Ladder Barrel, Wall Unit, Chair, Spine Corrector and Small Barrel (ISP, Cascavel, PR, Brazil). 21 strengthening and stretching exercises were selected for the main body segments: a) lower limbs b) flexors, extensors and lateral flexors of the trunk; c) upper limbs. Two exercise protocols were applied during the six months of intervention, each performed for three months. Each session lasted 60 minutes.

All exercises were performed in a series of ten repetitions, with a one-minute interval between exercises. The intensity of the overload in Pilates is mainly determined by the use of springs, which have been modified according to the evolution of the strength of each participant (changing the position of the springs in the equipment or changing the spring for another one with greater resistance)[20], always maintaining the number of repetitions and sets. To determine the level of effort of the participants and the consequent evolution of overload, a verbal description was used according to the Borg CR10 scale: light load (Borg ≤2), moderate load (Borg> 2 and <5), heavy load (Borg ≥5 and <7) and load close to maximum (Borg ≥7)[21]. The level of perception of the effort maintained during the sessions was heavy (Borg between 5 and 6). Whenever the intensity of the exercise was changed, the new load was immediately noted on an individual record used to record the training.

The WBV group was exposed to whole-body vibration for five minutes, on an alternating-side vibrating platform (Arktus, Cascavel, PR, Brazil), which oscillates through an anteroposterior axis, causing the right and left sides to alternate horizontally. A frequency of 20 Hz (1 Hz = 1 oscillation / second) and a peak-to-peak displacement of 4 mm (with reference to the second toe) were used, resulting in a magnitude of 31.5 m/s^2 or 3.2 g (gravity: 1g = 9.8 m/s^2). The participants were instructed to remain on the platform's oscillation plate with their knees semi-flexed at 30 degrees and their bare feet spaced at a distance of 50 cm, keeping their torso upright and holding the platform support with both hands. No accessories were placed on the platform's oscillating plate to cushion the impacts. All parameters used in the equipment and positioning of the participants were maintained throughout the six months of intervention. A skid test ensured that the participants' feet remained in contact with the oscillating plate during WBV[12].

An exposure time of 5 minutes was chosen, since the alternating-side platform generates a wide amplitude peak-to-peak displacement, which does not allow prolonged exposure. Other studies that used similar vibration parameters to identify effects on postural balance also used equally short exposure times[22-24].

The control group did not perform any type of intervention. The researcher responsible for the study contacted the participants every month during the intervention, to emphasize the importance of maintaining the usual routine related to physical activity, eating habits, not using supplements or medications that could affect bone or muscle mass and not to start any kind of physical exercise. This procedure was also adopted for Pilates and WBV Groups. At that time, the participants were also asked about possible adverse events.

A standardized form was used to record occurrences of adverse events in the three groups. Every month, participants were asked about any complications, such as muscle spasms or pain, joint pain, dizziness, falls, cramps and changes in blood pressure.

Regarding the statistical analysis, the normality of the data was assessed by the Shapiro-Wilk test. To compare groups at baseline, one-way ANOVA was used for data with normal distribution. Otherwise, the Kruskal-Wallis test was used. This same test was used to compare differences between groups after the intervention, except for the Timed Up & Go test, for which covariance analyzes were used, adjusted for the pre-intervention results. Effect sizes were calculated using Cohen's d, which was considered small (0.2), medium (0.5) or large (0.8). The data were analyzed by intention to treat (baseline data were allocated in the post-intervention for two participants in the control group). The level of significance was set at $p<0.05$.

RESULTS

Initially, 620 women were interviewed. After applying the inclusion / exclusion criteria, 51 participants were eligible and agreed to participate. Of these, 49 (96.1%) completed the follow-up. Two participants in the control group abandoned the study (Figure 2). The average rates of participation in intervention activities in the Pilates and WBV groups were 92.6% and 91.3%, respectively.

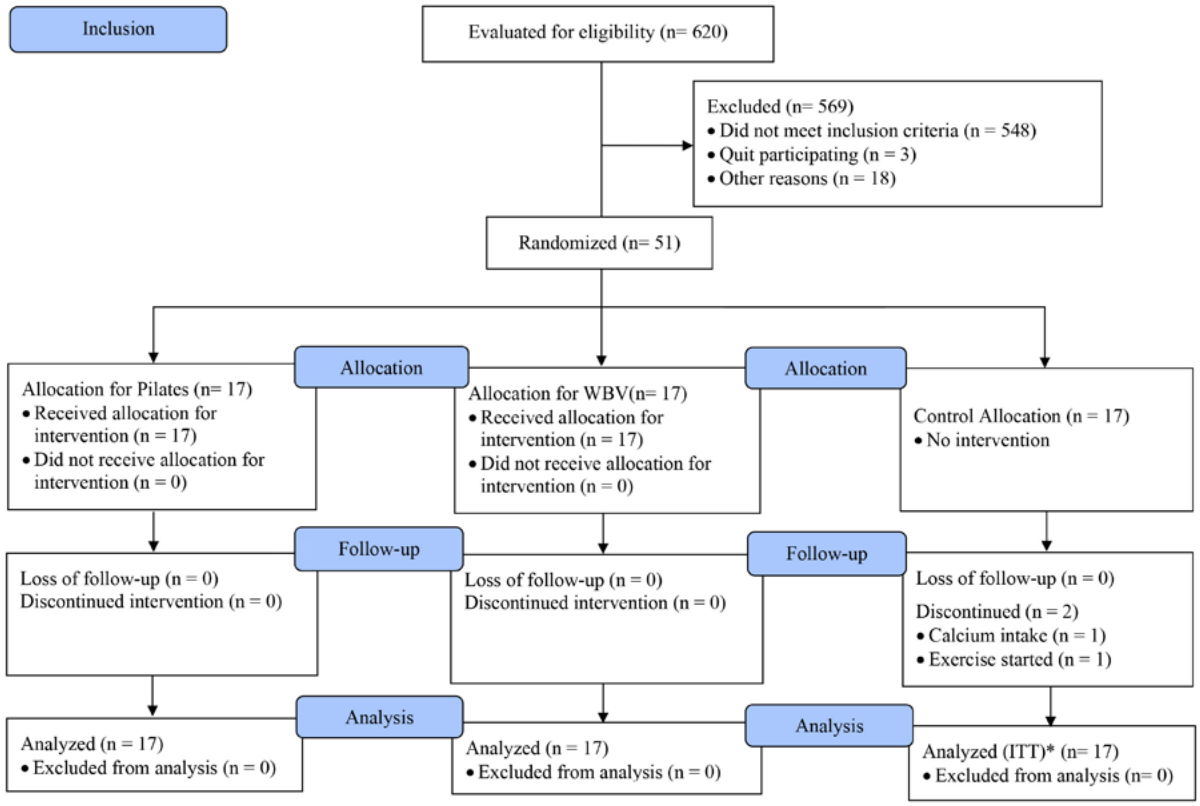

Figure 2. CONSORT Diagram. Jacarezinho, PR, 2020.

*ITT: Intention-to-treat (pre-intervention data were allocated to two participants).

Initial characteristics and post-intervention outcomes

Table 1 shows the participants' initial characteristics. Of the total sample, 12 (23.5%) postmenopausal women were 60 years of age or older, being: five (29.4%) in the Pilates group; five (29.4%) in the WBV group and two (11.8%) in the control group. There were no significant differences between groups for any variable. Table 2 shows the results for postural balance and fear of falling after six months of intervention. No variable of static postural balance measured by the force platform showed any difference between the groups after the intervention ($p>0.05$). However, for most variables, Pilates and WBV demonstrated a large effect size ($d> 0.80$) when compared to the control group (Table 3).

Table 1. Initial characteristics of the participants (N= 51). Jacarezinho, PR, 2020.

Variables	Pilates n = 17 Média (dp)	WBV n = 17 Média (dp)	Control n = 17 Média (dp)	P Value*
Age	55.5±6.8	56.3±6.4	54.1±5.2	0.571†
BMI (Kg/m^2)	27.2±2.7	26.2±2.5	27.3± 2.4	0.410†
Years of menopause	8.8± 5.1	8.4±7.1	9.1± 7.0	0.503
A-COP (cm^2)				
Bipedal eyes open	1.3 ±0.8	1.3±0.6	1.1±0.5	0.225
Bipedal eyes closed	1.7±1.7	1.2±0.6	1.2±0.4	0.731
Semi-tandem eyes open	8.2±3.6	7.3±4.8	6.6±3.8	0.225
Semi-tandem eyes closed	12.0±8.5	9.8±5.1	7.5±3.7	0.225
Unipedal eyes open	21.9±15.0	21.0±18.0	16.0±4.6	0.361
MVeloc A/P (cm/s)				
Bipedal eyes open	1.4±0.3	1.5±0.2	1.4±0.2	0.225
Bipedal eyes closed	1.5±0.4	1.6±0.3	1.5±0.3	0.088
Semi-tandem eyes open	1.9±0.4	2.2±1.0	1.8±0.3	0.111
Semi-tandem eyes closed	2.7±0.8	2.6±0.8	2.1±0.4	0.141
Unipedal eyes open	4.5±1.4	4.6±1.6	3.8±0.9	0.111
MVeloc M/L (cm/s)				
Bipedal eyes open	1.1±0.2	1.2±0.2	1.1±0.2	0.492
Bipedal eyes closed	1.2±0.2	1.2±0.2	1.2±0.2	0.361
Semi-tandem eyes open	2.4±0.5	2.6±1.3	2.1±0.3	0.731
Semi-tandem eyes closed	3.2±0.9	3.3±1.2	2.7±0.6	0.361
Unipedal eyes open	5.0±1.1	5.3±1.3	4.5±0.9	0.225
Dynamic balance				
Timed Up & Go test (s)	6.5±1.0	6.8±1.1	6.5±1.1	0.697†
Fear of falling (*score*)				
FES-I	25.1±5.9	25.4±5.7	26.7±7.0	0.577

Median±DP; *Kruskal–Wallis test, unless otherwise noted (†*ANOVA one way*); WBV: whole body vibration; BMI: body mass index; A-COP: pressure center displacement area; MVeloc A/P: average oscillation speed in the anteroposterior direction; MVeloc M/L: average oscillation speed in the mid-lateral direction; FES-I: *Falls Efficacy Scale-International.*

Table 2. Result for postural balance and fear of falling after six months of intervention (N= 51). Jacarezinho, PR, 2020.

Variables	Pilates After 6 months n = 17 Median (dp)	Pilates Difference pre-post	WBV After 6 months n = 17 Median (dp)	WBV Difference pre-post	Control After 6 months n = 17 Median (dp)	Control Difference pre-post	*P Value**
A-COP (cm^2)							
Bipedal eyes open	1.1±0.5	-0.2±0.4	1.1±0.5	-0.2±0.2	1.7±0.9	0.6±0.8	0.088
Bipedal eyes closed	1.6±1.2	-0.1±0.6	1.3±0.6	0.1±0.2	1.8±0.9	0.6±0.7	0.577
Semi-tandem eyes open	7.5±3.1	-0.7±2.4	7.2±4.1	-0.1±1.5	8.3±2.9	1.7±3.3	0.225
Semi-tandem eyes closed	12.6±8.4	0.6±2.1	11.0±5.1	1.2±1.5	11.6±4.7	4.1±3.8	0.925
Unipedal eyes open	17.8±4.9	-4.1±12.3	17.3±7.6	-3.7±14.8	19.6±6.2	3.6±4.5	0.088
MVeloc A/P (cm/s)							
Bipedal eyes open	1.2±0.2	-0.2±0.1	1.3±0.3	-0.2±0.2	1.3±0.2	-0.1±0.1	0.361
Bipedal eyes closed	1.3±0.3	-0.2±0.2	1.4±0.2	-0.2±0.1	1.5±0.2	0.0±0.3	0.389
Semi-tandem eyes open	1.6±0.3	-0.3±0.2	1.8±0.7	-0.4±0.4	1.7±0.2	-0.1±0.1	0.225
Semi-tandem eyes closed	2.1±0.4	-0.6±0.5	2.3±0.7	-0.3±0.4	2.2±0.4	0.1±0.2	0.225
Unipedal eyes open	3.8±0.7	-0.7±1.1	4.0±1.6	-0.6±0.7	3.8±1.1	0.0±0.6	0.577
MVeloc M/L (cm/s)							
Bipedal eyes open	0.9±0.2	-0.2±0.1	1.0±0.2	-0.2±0.1	1.0±0.2	-0.1±0.0	0.141
Bipedal eyes closed	1.0±0.2	-0.2±0.1	1.1±0.2	-0.1±0.1	1.1±0.1	-0.1±0.1	0.361
Semi-tandem eyes open	2.1±0.4	-0.3±0.3	2.2±0.8	-0.4±0.6	2.2±0.3	0.1±0.3	0.225
Semi-tandem eyes closed	2.9±0.9	-0.3±0.4	2.9±1.3	-0.4±0.3	2.9±0.6	0.2±0.4	0.790
Unipedal eyes open	4.8±1.1	-0.2±0.8	5.0±1.3	-0.3±0.9	5.3±1.4	0.8±1.1	0.790
Dynamic balance							
Timed Up & Go test (s)	5.7±0.9	-0.8±1.1§	5.9±1.1	-0.9±0.6§	6.3±1.1	-0.2±0.7	0.032†
Fear of falling (*score*)							
FES-I	22.7±4.4	-2.4±3.3	23.4±4.8	-2.0±4.6	26.2±5.7	-0.5±3.3	0.055

Median±dp; *Kruskal–Wallis test, unless otherwise noted (†ANCOVA adjusted for pre-intervention results with the Bonferroni *post-hoc* test); WBV: whole body vibration; A-COP: pressure center displacement area; MVeloc A/P: average oscillation speed in the anteroposterior direction; MVeloc M/L: average oscillation speed in the mid-lateral direction; FES-I: *Falls Efficacy Scale-International.* §Significantly different from the Control Group (p<0,05).

Table 3. Effect sizes (Cohen's d) for measures of postural balance and fear of falling after 6 months (N= 51). Jacarezinho, PR, 2020.

Variables	Pilates *vs* WBV	Pilates *vs* Control	WBV *vs* Control
A-COP (cm^2)			
Bipedal eyes open	0.00	1.26	1.37
Bipedal eyes closed	0.44	1.07	0.97
Semi-tandem eyes open	0.29	0.83	0.70
Semi-tandem eyes closed	0.32	1.14	1.00
Unipedal eyes open	0.02	0.83	0.66
MVeloc A/P (cm/s)			
Bipedal eyes open	0.00	1.00	0.63
Bipedal eyes closed	0.00	0.78	0.89
Semi-tandem eyes open	0.31	1.26	1.02
Semi-tandem eyes closed	0.66	1.83	1.26
Unipedal eyes open	0.10	0.79	0.92
MVeloc M/L (cm/s)			
Bipedal eyes open	0.00	1.40	1.40
Bipedal eyes closed	1.00	1.00	0.00
Semi-tandem eyes open	0.21	1.33	1.05
Semi-tandem eyes closed	0.28	1.25	1.69
Unipedal eyes open	0.11	1.03	1.09
Dynamic postural balance			
Timed Up & Go test (s)	0.11	0.65	1.07
Fear of falling (*score*)			
FES-I	0.09	0.57	0.37

A-COP: pressure center displacement area; MVeloc A/P: average oscillation speed in the anteroposterior direction; MVeloc M/L: average oscillation speed in the mid-lateral direction; FES-I: Falls Efficacy Scale-International.

Regarding the dynamic postural balance, measured by the Timed Up & Go test, Pilates and WBV performed better ($p<0.05$) when compared to the control group, with medium ($d = 0.65$) and large (d=1, 07) effect size, respectively. For fear of falling, no changes were observed after the interventions ($p>0.05$), although the Pilates group had a medium effect size ($d=0.57$) when compared to the control group.

Serious adverse events were reported in the three groups: two falls in the Pilates group (11.8%), two in the WBV group (11.8%) and one fall in the control group (5.8%) (which led to a fractured wrist for the control group participant). All falls occurred outside exercise sessions. Other less serious adverse events, such as pain in specific regions of the body, muscle spasms and cramps, occurred less frequently.

DISCUSSION

Meta-analysis studies with older adults, which aimed to verify the effects of Pilates on static and dynamic balance, mostly identified significant results in favor of this intervention when compared to control groups[3-6]. However, in general, the analyzes were performed with more simplified and low-cost motor tests, such as One Leg Stance and Timed Up & Go, for example. The exceptions are the studies by Bueno de Souza et al.[4] and Casonatto and Yamacita[6], who carried out analyzes involving the displacement of the plantar pressure center through a force platform and found controversial results. In the first study, the analysis involved only two RCTs that used a force platform, in which no significant results were observed[4]. However, in the second study, the analyzes involved six RCTs, which demonstrated significant effects of the Pilates method on static postural balance[6]. Still, both studies included a small number of RCTs, which limits the extrapolation of results.

In all studies included in the analyzes by Bueno de Souza et al.[4] and Casonatto and Yamacita[6], the intervention time was a maximum of 12 weeks. The present study was carried out for six months and, in spite of that, no results were observed for static postural balance. However, despite the non-significant result, for most variables, the clinical effect of Pilates exercises draws attention when compared to no treatment (d>0,80).

For dynamic balance, measured by the Timed Up & Go test, as in the present study, all meta-analyzes found significant results in favor of Pilates exercises[3-5]. In the present study, the significant result was accompanied by a moderate effect size (d=0.65). This result corroborates the meta-analyzes by Moreno-Segura et al.3 and Barker, Bird and Talevski[5], who also found a moderate effect size for Pilates exercises compared to control groups, while the study by Bueno de Souza et al.[4] observed a large effect size.

Regarding WBV, meta-analysis studies conducted with older adults showed conflicting results for postural balance[7,8]. Rogan et al.[7] grouped studies that assessed static postural balance using three different motor tests (Single Leg Stance, Limits of Stability, and Balance Index). In this case, there were significant results in favor of WBV only when synchronous type vibration was used, with no significant results for alternating-side vibration. Furthermore, in Orr's meta-analysis[8], in which only the Single Leg Stance test was considered, the WBV also did not demonstrate significant effects for static balance. In the present study, we used alternating-side vibration and we also found no significant effects on static postural balance, in this case, in five different tasks on the force platform.

Although no significant results were observed, it is worth mentioning that, in the present study, WBV demonstrated a large effect size to improve static postural balance when compared to the control group, for most variables (d> 0.80), this should be considered in clinical practice. It is possible that the large effect size is linked to the frequency of vibration used in the present study (20 Hz). Tseng et al.[25] demonstrated that the WBV configured at 20 Hz provides a large effect size in improving postural stability measured by a balance platform in old people, but not when using frequencies of 0 Hz (control) or 40 Hz.

Regarding the assessment of dynamic postural balance, the Orr meta-analysis[8] demonstrated that a significant improvement in the Timed Up & Go test occurred only when WBV was associated with physical exercise. In the meta-analysis by Lam et al.[9], WBV proved to be significantly effective in improving the dynamic balance measured by that same test; however, there were no subgroup analyzes to demonstrate whether the effects were dependent on physical exercise during vibration[6]. In the present study, significant results were found for the Timed Up & Go test, in which alternating-side vibration without the addition of exercises provided significant effects on dynamic postural balance, with a large effect size (d = 1.07), when compared with no treatment.

Although the protocol of the present study did not include exercises during WBV, the significant improvement and the large effect size observed for the Timed Up & Go test may be related to the intervention time (6 months), in addition to the type of vibration (side -alternated). Subgroup analyzes of the meta-analysis studies carried out to date have not explored these factors in isolation. In Orr's meta-analysis[8], that did not observe significant results for WBV performed without the addition of exercises, most studies performed synchronous vibration and with intervention time ≤2 months.

Regarding the fear of falls, in the present study, we did not observe any significant difference in favor of Pilates exercises, compared to WBV or control through FES-I. Despite this, it should be considered that a moderate effect size (d=0.57) was observed in comparison with no intervention. The average reduction of -2.4 points on the scale after Pilates exercises, which went from 25.1 to 22.7, may be clinically relevant, since the cut-off point of 23 at FES-I was shown to differentiate old people with and without incidence of falls[19].

The few studies that explored the fear of falling in interventions with Pilates found contradictory results. Aibar-Almazán et al.[26] identified a decrease in fear of falling in old people after 12 weeks of Pilates compared to the control group, however, the decrease in the FES-I score had a small effect size (d=0.41). The authors also used the Activities-Specific Balance Confidence Scale (ABC), which assesses confidence in balance, without significant differences between groups being observed, in addition to a small effect size (d=0.30). In the study by Irez[27], also through the ABC scale, a significant improvement in confidence in balance was found in old people after 14 weeks of intervention with Pilates; however, the authors performed only intra-group comparisons, which limits the validity of the findings. Besides that, Josephs et al.[28], when comparing Pilates with conventional exercises, did not identify any significant difference between the groups for confidence in the balance measured by the ABC, after 12 weeks of intervention in old people.

For WBV, the present study also did not identify any significant results in relation to the fear of falling, in addition to a small effect size when compared with no intervention (d = 0.37). For comparison, only two RCTs were found that verified the effects of WBV on fear of falling in old people. Pollock, Martin and Newham[29] performed eight weeks of intervention comparing WBV with addition of physical exercise and WBV alone, without differences being observed between groups for FES-I. Sobhani et al.[30] did not identify any significant differences in fear of falling using FES among old people who wore shoes with a stable base compared to an unstable base during WBV sessions, after four weeks of intervention.

For both Pilates and WBV, the results of the present study suggest that the fear of falling variable should be further investigated. A possible limitation of this and other studies may be linked to the sample size. Sample size calculations are performed for the main variable and fear of falling is typically a secondary objective. In this sense, it is possible that the number of volunteers did not make it possible to detect post-intervention differences between groups for this variable.

Finally, it is worth noting that the fear of falling is dependent on different factors that coexist and interact, in addition to postural balance or the incidence of falls, such as physiological, psychological and neurocognitive mediators[31], not being so, exclusively associated with the effectiveness of the interventions proposed in this study. In addition, adverse events demonstrated that Pilates and WBV were not sufficient to prevent the incidence of falls.

This study has limitations that need to be highlighted: a) comparison of results in just two moments; b) not being able to blind participants and therapists; c) use of a simplified test to assess dynamic balance. Regarding the strengths, we highlight: a) use of a "gold standard" instrument to analyze static postural balance; b) six-month intervention time; c) follow-up rate of 96.1% of participants.

CONCLUSION

The results of the present study suggest that Pilates and WBV can be recommended for the improvement of static and dynamic postural balance in postmenopausal women, evidenced by the clinical representativeness demonstrated by the treatment effect sizes. On the other hand, Pilates and WBV should be better investigated with regard to reducing the fear of falling, so that they can eventually be indicated for this purpose.

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