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RESEARCH ARTICLE

Effects of Pilates compared to whole-body vibration on range of motion in postmenopausal women: A randomized controlled trial

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Abstract

Background: Postmenopause is marked by a sudden drop in hormone levels, leading to several physical, psychological, and functional changes. Thus, range of motion (ROM), an important component for maintaining functionality, is also affected. One way to improve ROM is by using the Pilates method, which has already proven effective for this component. Another intervention option is whole-body vibration (WBV), however, little is known about the effectiveness of this therapy in ROM. **Objective:** To compare the effects of Pilates vs. WBV on ROM in postmenopausal women. **Methods:** Randomized, single-blind, controlled study with 51 postmenopausal women. Pilates and WBV were performed three times a week for six months, totaling 78 sessions. The control group maintained their usual routine. ROM was assessed in trunk flexion and extension movements using a fleximeter. **Results:** Post-intervention, no difference ($p > 0.05$) was observed between Pilates and WBV (trunk flexion: 4.9º [95% CI, -0.4 to 10.2] p=0.247, d=0.62; trunk extension: 1.9º [-0.2 to 4.0] p=0.262, d=0.62). Compared with the control group, only Pilates was significantly superior for trunk flexion (8.8º [95% CI, 3.4 to 14.3] p=0.009, d=1.09) and extension (3.2º [95% CI, 0.8 to 5.6] p=0.024, d=0.90), with a large effect size ($d > 0.80$). **Conclusions:** Pilates and WBV did not differ significantly for ROM, either in trunk flexion or extension in postmenopausal women. However, only Pilates was superior to the control group, which maintained the usual routine.

Keywords: Exercise therapy; menopause; women's health; flexibility.

BACKGROUND

Post-menopause is the period defined after one year of the last menstruation, which occurs approximately between 48 and 52 years of age, influenced by different factors, such as socioeconomic and racial[1]. This period is marked by a decline in fertility, caused by abrupt hormonal changes, such as falling levels of estrogen and progesterone[2,3]. These changes generate several physical, psychological and functional alterations, directly affecting the performance of activities of daily living (ADLs), compromising the different components of physical fitness, such as range of motion (ROM)[1].

Hormonal reduction, especially of estrogen, leads to deficits in ROM, due to its role in the maintenance of connective tissues and cartilage[4]. In addition to post-menopause, natural aging leads to declines in neuromuscular function, balance and coordination. These factors combined can generate compensations that restrict and interfere with ROM[5]. It is important to note that ROM is an important component for performing ADLs, such as: squatting, lifting, reaching, getting dressed and walking. When compromised, it directly affects the functionality and quality of life of postmenopausal women[6,7].

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One way to preserve and improve ROM is through physical exercise, especially those that involve stretching, with static and dynamic stretching being the most traditional forms[8]. A well-known method for incorporating stretching into your exercise routine is Pilates. This method is characterized by being a type of physical training that mainly involves resistance and stretching exercises. The execution of the movements respects six basic principles: breathing, control, concentration, centering, fluidity and precision[9]. Different studies have already proven the effectiveness of Pilates in improving ROM[10-12]. However, it requires time and motivation, which can be a barrier for some people, particularly postmenopausal women. It has been shown that older people and women are less likely to engage in traditional exercise routines[13].

One possible intervention that requires little motivation and short intervention time is whole-body vibration (WBV), which is an exercise option for postmenopausal women. WBV is transmitted through devices called vibrating platforms. Vibration intensity can be defined by three main parameters: peak-to-peak displacement amplitude in millimeters (mm), frequency in hertz (Hz), and acceleration magnitude in grams (g) or meters per second (m/s^2). Frequency and acceleration magnitude can be classified as high (>20Hz and ≥1g) or low (≤20Hz and <1g)[14,15]. This method has a low risk of adverse events and is commonly used as an effective way to increase bone mineral density and muscle strength in postmenopausal women[16,17].

However, the use of WBV has not been widely explored to improve ROM. Therefore, the aim of this study is to compare a widely used technique to improve flexibility, which is Pilates vs WBV exercises in ROM in postmenopausal women.

METHODS

This study is a single-blind, randomized controlled trial (RCT) (registered at www.clinicaltrials.gov: NCT02769143). The intervention involved 51 postmenopausal women living in Jacarezinho, state of Paraná, Brazil. The ethical norms of the Declaration of Helsinki were followed and all participants signed a Free and Informed Consent Term. As this is a larger study, involving different outcomes, recruitment details, inclusion criteria and randomization can be accessed elsewhere[18,19]. Randomization occurred only after inclusion of all participants. A random permutation of integers (randomization.com) distributed equal numbers (17 participants) in each group. Each process was performed by an independent researcher, who sealed the opaque envelopes containing the group that each participant would be allocated and delivered to the principal investigator.

Range of motion assessment

To assess range of motion, with the standing participant and the fleximeter instrument attached laterally to the trunk, a blind assessor stabilized the lower limbs and provided three trunk flexion movements. Subsequently, the same procedure was performed for trunk extension movement. Details of the procedure can be accessed in another location[20].

Interventions

The interventions occurred three times a week, on nonconsecutive days, for six months (78 sessions). Pilates: two protocols of exercises in equipment were applied, each one for three months, with each sessions lasting 60 minutes. WBV: each session lasted five

minutes on a side-alternating type vibratory platform, with frequency of 20 Hz and a peak-to-peak displacement of 4 mm, resulting in a magnitude of 3.2 g. Control: The participants of this group did not carry out any intervention. A standardized form was used to record occurrences of adverse events in all three groups. Details of intervention protocols can be accessed elsewhere[18,19].

Statistical analysis

The normality of the data was verified by the Shapiro-Wilk test. The homogeneity of the variances was determined by the Levene's test. To compare the groups in the baseline, one-way ANOVA was used for data with normal distribution. Otherwise (time since menopause), the Kruskal-Wallis test was used. To verify the between-group differences for the flexibility, covariance analysis (ANCOVA) was applied, with the follow-up data used as the dependent variable and baseline data as covariate. The Bonferroni Post Hoc was used for multiple comparisons between pairs. Effect sizes were calculated using Cohen's d, which were considered small (0.2), medium (0.5), or large (0.8). Data were analyzed by intention-to-treat (baseline data carried forward for two in control participant lost to follow-up). The level of significance was $p < 0.05$. Analyzes were processed in the SPSS 20.0 program (Chicago, IL, USA).

RESULTS

Participation

After applying inclusion/exclusion criteria, 51 participants were eligible and agreed to participate. Two control group participants dropped out of the study (Fig 1). The average participation rate in the Pilates and WBV groups was 92.6% and 91.3%, respectively.

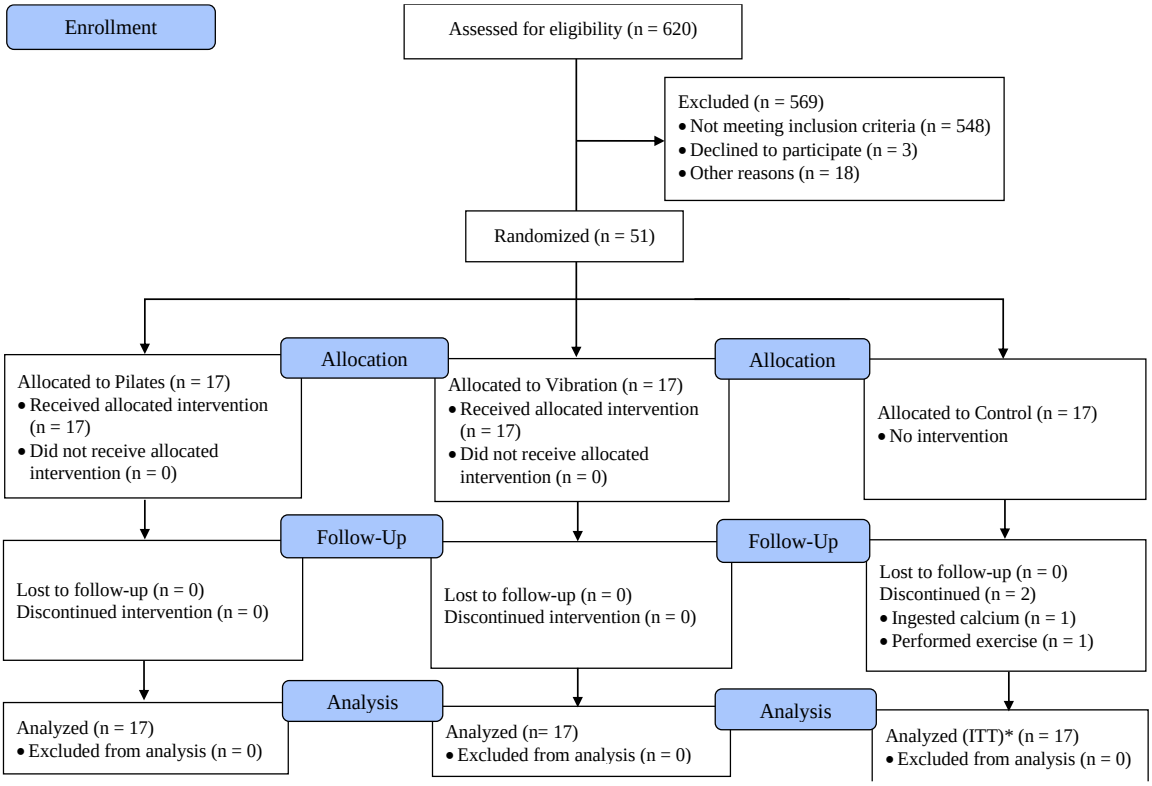

Figure 1. CONSORT diagram.

Note: *ITT, Intention-to-treat (baseline data carried forward for two in control participant lost to

Baseline Characteristics

There were no differences ($p > 0.05$) between Pilates (mean ± SD: n = 17, 55.5 ± 6.8 years, 27.2 ± 2.7 Kg/m², 8.8 ± 5.1 years of menopause, 97.4 ± 16.0º trunk flexion, 29.9 ± 7.1º trunk extension), WBV (n = 17, 56.3 ± 6.4 years, 26.2 ± 2.5 Kg/m², 8.4 ± 7.1 years of menopause, 94.9 ± 14.4º trunk flexion, 26.7 ± 7.2º trunk extension) and control (n = 17, 54.1 ± 5.2 years, 27.3 ± 2.4 Kg/m², 9.1 ± 7.0 years of menopause, 101.5 ± 10.3º trunk flexion, 27.0 ± 8.9º trunk extension) groups for the initial characteristics of the participants.

Outcomes

Table 1 and 2 shows range of motion outcomes in postmenopausal women after six months of intervention. When comparing Pilates and WBV no significant difference was observed ($p > 0.05$), although there was a moderate effect size in favor of Pilates. In comparison to the control group, only Pilates allowed an increase in the range of motion of the trunk in flexion ($p = 0.009$) and extension ($p = 0.024$), with a high effect size ($d > 0.80$).

Table 1. Outcome data for range of motion at six months

	Pilates n = 17	Vibration n = 17	Control n = 17	F	P‡
Trunk flexion movement (º)					
Baseline	97.4 (16.0)	94.9 (14.4)	101.5 (10.3)		
6 months	104.1 (17.2)	96.7 (16.8)	99.4 (13.0)	4.924	0.011
Change	6.7 (8.3)[a]	1.8 (7.5)	-2.1 (7.9)		
Trunk extension movement (º)					
Baseline	29.9 (7.1)	26.7 (7.2)	27.0 (8.9)		
6 months	32.5 (6.7)	27.4 (8.8)	26.4 (8.0)	3.916	0.027
Change	2.6 (1.5)[a]	0.7 (4.1)	-0.6 (4.8)		

Note: Mean (sd); †Intra-group comparison (Student t test for dependent samples); ‡Between-group comparison (ANCOVA adjusted for baseline outcomes); [a]Significantly different ($P < 0.05$) from the control group (Post Hoc Bonferroni test).

Table 2. Comparisons of pairs for range of motion at six months

Change between baseline and follow-up, mean (sd)				md (95% CI) between-group	p‡	Cohen's d
Trunk flexion movement (º)						
Pilates	6.7 (8.3)	Vibration	1.8 (7.5)	4.9 (-0.4, 10.2)	0.247	0.62
Pilates	6.7 (8.3)	Control	-2.1 (7.9)	8.8 (3.4, 14.3)	0.009	1.09
Vibration	1.8 (7.5)	Control	-2.1 (7.9)	3.9 (-1.6, 9.4)	0.560	0.51
Trunk extension movement (º)						
Pilates	2.6 (1.5)	Vibration	0.7 (4.1)	1.9 (-0.2, 4.0)	0.262	0.62
Pilates	2.6 (1.5)	Control	-0.6 (4.8)	3.2 (0.8, 5.6)	0.024	0.90
Vibration	0.7 (4.1)	Control	-0.6 (4.8)	1.3 (-1.7, 4.3)	0.919	0.29

Note: sd, standard deviation; md, Mean Difference; 95% CI, 95% confidence interval; ‡Multiple comparisons (Post Hoc Bonferroni test).

Serious adverse events were reported in all three groups: two falls in the Pilates, two in the WBV and one fall in the control group (that led to a fractured wrist for control group participant). All falls occurred outside exercise sessions. The complete list of adverse events can be accessed elsewhere[18,19].

DISCUSSION

The present study aimed to verify ROM in postmenopausal women after completing a Pilates program compared with WBV. In summary, the results did not demonstrate significant differences between the groups for ROM, although only Pilates was superior to no intervention in trunk extension and flexion tests, presenting a high effect size.

No other RCT was found in the literature that aimed to verify a WBV protocol on ROM in postmenopausal women compared to Pilates, a method widely known for improving flexibility. The results of this RCT corroborate previous systematic review studies regarding ROM gain through Pilates protocols, especially in older adults[10-12]. Clinical trials conducted with older women reported improvements in several physical components when practicing Pilates exercises, with a notable significant improvement in flexibility[21,22]. The present study demonstrates that, when implementing a Pilates exercise routine in postmenopausal women, a significant improvement in ROM occurred compared to the control group.

Regarding WBV, no improvement was observed in ROM, either when compared with Pilates or control. The findings in the literature on the use of WBV for ROM gain are still not sufficiently clear, in addition, no study found specifically analyzed postmenopausal women. A meta-analysis performed to verify the effects of WBV on ROM in individuals with metabolic syndrome found promising results for ROM gain compared to the control group[23]. The platform used in the studies included in this meta-analysis was side-alternating, with low-frequency and low-magnitude parameters. It is important to highlight that only two studies were included in the analyses, thus reducing the statistical power of the results.

A systematic review, which sought to analyze the effectiveness of WBV in healthy adults, found three studies with positive results for increasing ROM, however, with little robustness in the results and distinct vibration parameters, with similarity only in the use of high frequency[24]. In the present study, a WBV protocol classified as low frequency and high magnitude was used, on an side-alternating platform, with a session time of 5 minutes, without the association of other types of exercises. The difficulty in comparing with other studies is due to the lack of standardization regarding the parameters of frequency, peak-to-peak displacement, acceleration magnitude, exposure time and body position on the platform. These factors make it difficult to choose the best parameter for the use of WBV for a possible gain in ROM.

Furthermore, the populations of the studies included in the reviews varied, including, for example: healthy adults, individuals with metabolic syndrome, older adults and athletes. This diversity generates a lack of consensus in the results, as they are distinct populations, also highlighting the lack of studies with postmenopausal women. Another factor implicating the evidence on the improvement of ROM through WBV is the association of other types of exercises during the practice of vibration, which can cause a confounding effect when analyzing the results[23-27].

In this study, it is worth highlighting that 96.1% of participants initiated and completed the interventions. Another important point was the frequency of participants in the interventions, with an average of over 90%. A limitation of this study was the

impossibility of blinding the participants and the professionals who administered the interventions.

CONCLUSION

Pilates and WBV exercises applied over six months, three times a week, did not significantly differ in trunk ROM in flexion and extension in postmenopausal women. However, it is noteworthy that only Pilates exercises were superior to the control condition, which maintained the usual routine, with a large effect size. Therefore, at this time, it is possible to recommend the use of Pilates to improve trunk ROM in flexion and extension in postmenopausal women, while more research needs to be carried out to identify the effects of WBV on this outcome.

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