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Acute effect of boing balance board on postural control in older adults

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HIGHLIGHTS

- Acute exercise training organized in blocks improved postural control in elderly individuals
- Dot and root mean square demonstrated improvements as a result of the acute motor intervention
- Intervention utilizing a balance apparatus proved effective in enhancing postural control performance
- The Boing session had an acute influence on postural control.

ABBREVIATIONS

ANOVA	Analysis of variance
AP	Antero-posterior
CG	Control Group
COP	Center of pressure
DOT	Total displacement
EMG	Electromyography
FT	Feet together
FA	Feet apart
IG	Intervention Group
ML	Medio-lateral
RMS	Root mean square
ST	Semi-tandem position

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BACKGROUND: Balance training has demonstrated a positive effect on older adults. However, the specific types and durations of interventions needed to effectively address postural deficits in aging individuals remain important areas of study. It is crucial to impact their motor performance quickly to bring about changes in postural control.
AIM: This study aims to investigate the effect of an acute motor intervention using a balance board called the "Boing" on postural control in elderly individuals.
METHOD: Twenty senior women between the ages of 60 and 78 were divided into two groups: Intervention Group (IG, n = 10) and Control Group (CG, n = 10). Both groups performed a pretest postural task on a force plate, including conditions with feet together, feet apart, and semi-tandem stance. Participants in the IG then underwent the motor intervention on the Boing balance board, which disturbed balance in the antero-posterior and medio-lateral directions, similar to the pretest conditions. The intervention consisted of 6 blocks of 10 trials, organized randomly, and lasted for 20 minutes with 1 minute of rest between each block. After the intervention, a posttest was conducted for both groups using the same procedure as the pretest. One week later, a retention test was performed. Analysis of center of pressure (COP) was conducted, examining total displacement (DOT) and root mean square (RMS) in the medio-lateral and antero-posterior directions.
RESULTS: A two-way repeated measures ANOVA revealed that during the posttest phase, there were significant differences between the groups in DOT and ML RMS specifically in the semi-tandem condition. The IG group exhibited lower values.
INTERPRETATION: The Boing balance board shows promise as a useful apparatus for improving postural control through acute motor intervention. Further studies comparing old adults' postural control with existing research are suggested to expand our understanding in this area.

KEYWORDS: Old adults| Motor control | Balance | Exercise

INTRODUCTION

Physical exercise has been shown to promote cognitive benefits [1] as well as motor benefits [2] for the elderly. However, the type, frequency, and delivery method of motor stimulus are still questions that need to be addressed, especially in determining which approach is more effective in preserving functions during old age. Various types of motor interventions [3–6] could be employed to promote motor functions that typically decline with aging [7,8,9]. These interventions aim to preserve the most compromised functions while enabling the performance of other, sometimes more challenging, motor activities.

Balance is one of the functions most affected by aging, and falls among older adults are a common cause of morbidity [1]. Delayed muscle activity is a common occurrence among the elderly, which can result in a greater displacement of the center of mass following a perturbation. However, exercise has the potential to impact postural control in a positive way. It can improve anticipatory postural adjustments, enhance compensatory mechanisms, and activate muscles [10].

Interventions targeting balance improvement, such as task-specific training, have demonstrated positive effects in older adults [11,12]. Various manipulations, including oscillating boards [3,11,13], slacklines [12], body vibration exercises [14], digital games [15], Pilates [16], treadmill training [2], and general training [10], have yielded significant findings in reducing balance deficits associated with aging. In a study by Egger et al (2021) [3], it was observed that balance tasks learned in a single session showed greater interference when subsequently tested with different balance tasks and non-postural tasks. This indicates that similar demands for controlling the center of gravity are crucial for inducing interference in balance tasks. However, while specific training may lead to specific improvements, other studies involving older adults have shown opposite results. A more generalized approach to training may ensure broader benefits, encompassing other functions affected by aging, including motor, psychological, and cognitive functions [17].

Furthermore, the use of different apparatus [3,11,13] for balance training is still an area requiring further understanding, as it may accelerate postural control improvement for older adults who need prompt improvement. In a training intervention involving young adults, a custom-made tilt board was used, which introduced perturbations in both the antero-posterior and medio-lateral directions [11]. The study [11] measured the time at equilibrium and platform displacement and demonstrated better performance in the post-test compared to the pre-test in young adults. Another kind of stability board was employed [13], which showed improvements in balance during and after the practice sessions for children, adolescents, and young adults.

Another type of exercise, such as slackline, requires the ability to balance on a narrow nylon ribbon, maintaining an upright posture on a small and unstable base of support. This activity can serve as an alternative motor activity to enhance postural control and muscle strength [12]. Slackline has been studied in various populations, including older adults, using measures such as COP displacements and standing time. Although this exercise does not involve a specific board, it can be considered a form of apparatus that stimulates balance, particularly because it is performed on an unstable support. The improvements observed in slackline performance may have relevance to postural control, as it increases the demand for sensorial integration, neuromuscular control, and coordination of balance adjustments.

Additionally, the question of short-term or acute interventions [9,18,19] versus long-term interventions needs to be explored. Identifying interventions that can quickly enhance motor functions, particularly balance, which is crucial for daily activities, could yield valuable knowledge for advanced motor training in older adults.

Considering all the aforementioned aspects, particularly the improvement of balance in older adults after interventions involving specific apparatus and conducted acutely, further research is warranted in this field. The present study aims to investigate the postural control of elderly individuals before and after an acute motor intervention using a balance board called "Boing." We expect that older adults engaged in the motor intervention will demonstrate better postural control in the variables measured in this study (COP total displacement and root mean square) compared to those who did not participate in the intervention.

METHODS

Participants

The study included 20 female participants residing in the city of Londrina (PR) with ages ranging from 60 to 78 years. Out of the total sample, 10 participants were assigned to the Intervention Group (IG, n=10) with a mean age of 65.3 years (SD=3.68), mean height of 1.53 meters (SD=0.05), and mean BMI of 22.93 (SD=3.55). The remaining 10 participants formed the Control Group (CG, n=10) with a mean age of 71.8 years (SD=4.29), mean height of 1.51 meters (SD=0.025), and mean BMI of 21.01 (SD=1.16). All participants were female and engaged in dance activities at the Seicho-no-ie church, attending classes once a week for an average duration of 2 hours per class. The classes were led by a physiotherapist. It is worth noting that there were no male participants involved in these dance activities. No participants were lost during the evaluation phases.

The inclusion criteria were as follows: a) being female; b) being classified as physically independent (elderly level three in the functional status classification), according to Spirduso (2005) [20]; c) not having any musculoskeletal limitations that would prevent independent standing; d) being able to perform the proposed test protocols; and e) participating in both intervention days. This research received approval from the Research Ethics Committee at the State University of Londrina under opinion number 3.531.503.

Postural control assessment

The participants underwent testing using a force platform (AMTI, AccuSway Portable Platform, USA). The tests were conducted under three experimental conditions, which were randomized as follows: condition 1 involved standing with feet together (FT, joined by the medial part) in the center of the platform; condition 2 required standing with feet apart (FA, at waist-width distance); condition 3 involved standing with feet in a semi-tandem position (ST, feet together, joined at the medial part, with one foot positioned in front of the other) in the center of the platform. Each participant performed two trials [19,21–23] for each condition, with each trial lasting 36 seconds. The same sequence of conditions was performed on all test days.

Intervention with the Boing balance board

The Boing balance board (Figure 1) consists of two square wooden boards measuring 45 cm in length, 45 cm in width, and 2 cm in thickness. These boards are separated by a spring that is 18 cm high and 12 cm in diameter. Additionally, two rectangular blocks made of foam with a density of 50 were utilized. These blocks, measuring 47 cm in length, 12 cm in width, and 14 cm in height, were placed between the wooden boards of the Boing balance board. The purpose of these blocks was to limit the amount of board oscillation and ensure the safety of the participants during the study. To further enhance safety, a black fabric was adhered to these foam blocks to prevent any risk of tearing during the intervention.

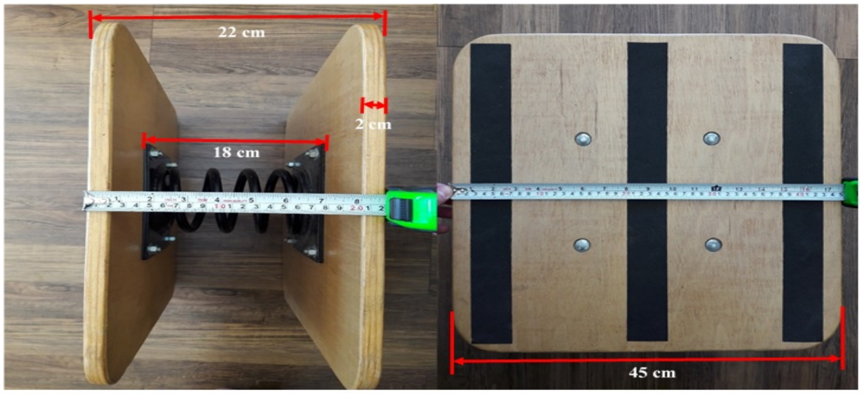

Figure 1. Boing balance board (top and lateral view)

The acute motor intervention was administered to the IG group using the balance board known as the Boing. The pre-test consisted of 3 experimental conditions: (FT), (FA), and (ST) stance. Each condition had 5 randomized support conditions, with each condition being performed twice and lasting 10 seconds. This ensured that all support conditions were performed an equal number of times during the total practice period. A total of 10 trials were performed for each block, resulting in a total of 60 trials (20 trials for FT, 20 trials for FA, 20 trials for ST). After every 2 blocks of randomized trials, a one-minute rest period was provided (Figure 2).

INTERVENTION PROTOCOL					
Block 1			Block 2		
2X10”	FT	10 trials	2X10”	FA	10 trials
2X10”	FA		2X10”	FT	
2X10”	ST		2X10”	ST	
2X10”	FA		2X10”	FA	
2X10”	FT		2X10”	ST	
1 MINUTE REST					
Block 3			Block 4		
2X10”	ST	10 trials	2X10”	FT	10 trials
2X10”	FA		2X10”	ST	
2X10”	FT		2X10”	FA	
2X10”	ST		2X10”	FT	
2X10”	FT		2X10”	FA	
1 MINUTE REST					
Block 5			Block 6		
2X10”	FA	10 trials	2X10”	ST	10 trials
2X10”	ST		2X10”	FT	
2X10”	FT		2X10”	FA	
2X10”	ST		2X10”	ST	
2X10”	FA		2X10”	FT	

Figure 2. Protocol on the Boing balance board for the IG group.

Experimental protocol

The application of the tests consisted of 5 phases: pre-test, intervention, post-test and retention. However, the Control Group (CG) only underwent 4 phases as there was no intervention for this group.

The entire testing and intervention period lasted for 8 days, with the first day dedicated to the pre-test and the final day dedicated to the retention test. During the tasks conducted on the force plate, the participants were barefoot, with their arms positioned along their bodies (palms facing inward, lightly touching the thighs), and they were instructed to look at a fixed point on the wall at eye level, which was marked at a distance of 2 meters.

After a 20-minute interval, the post-test was administered to both groups, following the same procedure as the pre-test to allow for data comparison. During this time, the control group did not engage in any postural activities. They stayed with other participants, including those who did not take part in the study but were members of the dance activities at the Seicho-no-ie church.

After one week had passed, both groups underwent the retention test. The retention test followed the same format as the pre-test and post-test, aiming to assess the persistence of the acquired performance during the practice phase. Each participant made 2 attempts [19,21–23] in this condition, with each attempt lasting 36 seconds.

Data Analysis

The data were processed and analyzed using Matlab (version 2020, Mathworks, Natick, USA). The force plate had a data acquisition frequency of 100Hz. It provided forces along 3 axes (Fx, Fy, and Fz) and moments (Mx, My, and Mz). These components were filtered using a fourth-order low-pass Butterworth filter with a cutoff frequency of 4Hz. After filtering, the components were used to calculate the position of the Center of Pressure (COP) in the antero-posterior and medio-lateral directions. The dependent variables analyzed from the force plate data were COP total displacement (DOT) in millimeters, which represents the length of the COP trajectory on the support base, and root mean square (RMS) in millimeters, which represents the standard deviation of the COP signal with an average of zero [24].

Statistical Analysis

The statistical analysis was performed using IBM SPSS Statistics (version 23, SPSS Inc., Chicago, USA). The assumptions of normality and variance homogeneity were met. A two-way repeated measures analysis of variance (ANOVA) was conducted to compare the pre-test, post-test and retention phases for root mean square (RMS) sway in the Antero-Posterior (AP) and Medio-Lateral (ML) directions, as well as total oscillation displacement (DOT), between the Intervention and Control groups. The Sidak post hoc test was applied. The significance level was set at $p<0.05$ to determine statistical significance.

RESULTS

Figure 3 illustrates the RMS in the ML and AP directions, as well as DOT, presented in Panel A, B, and C, respectively. All participants recruited on the first day of the postural control assessment also participated in the assessment on the second day.

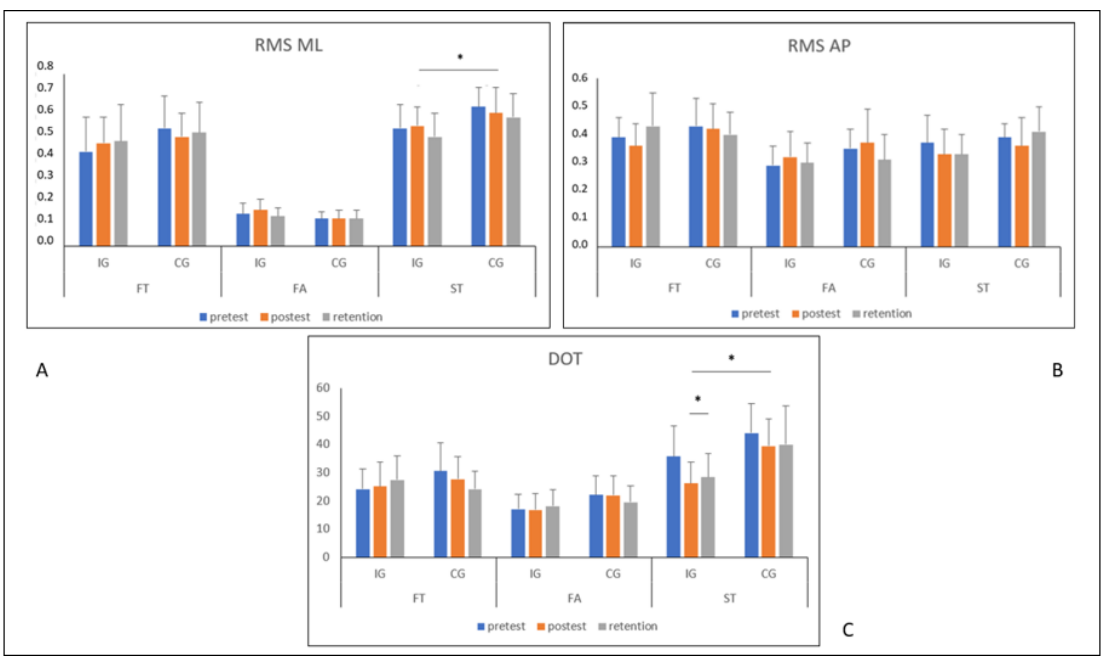

Figure 3. RMS ML of the intervention and control groups in FT (feet together), FA (feet apart), and ST (semi tandem) conditions during the pretest, posttest, and retention phases (Panel A); RMS AP of the intervention and control groups in FT, FA, and ST conditions during the pretest, posttest, and retention phases (Panel B); DOT of the intervention and control groups in FT, FA, and ST conditions during the pretest, posttest, and retention phases (Panel C).

Table 1 presents the statistical results obtained, showing significant differences only for DOT and RMS ML during the posttest conditions between the groups, with lower values observed for the IG. For DOT, the results also indicated significant differences within the IG group between the posttest and retention phases.

Table 1. F and p-values between the groups (intervention and control), phases of the tests (pretest, posttest, and retention), and the interaction (between group and phase) during the three manipulated conditions (FT, FA, and ST) for the DOT, RMS ML, and RMS AP variables. Bold p-values indicate statistical significance.

VARIABLES	GROUP	PHASE	GROUP*PHASE
FEET TOGETHER			
DOT	p=0.448 $F_{1,9}$=0.629	p=0.673 $F_{2,18}$=0.405	p=0.052 $F_{2,18}$=4.995
RMS ML	p=0.246 $F_{1,9}$=1.537	p=0.523 $F_{2,18}$=0.671	p=0.302 $F_{2,18}$=1.282
RMS AP	p=0.620 $F_{1,9}$=0.264	p=0.260 $F_{2,18}$=1.451	p=0.071 $F_{2,18}$=3.077
FEET APART			
DOT	p=0.178 $F_{1,9}$=2.131	p=0.821 $F_{2,18}$=0.200	p=0.063 $F_{2,18}$=3.237
RMS ML	p=0.171 $F_{1,9}$=2.209	p=0.193 $F_{2,18}$=1.806	p=0. 108 $F_{2,18}$=2.523
RMS AP	p=0.229 $F_{1,9}$=1.664	p=0.161 $F_{2,18}$=2.024	p=0.216 $F_{2,18}$=1.671
SEMITANDEM			
DOT	p=0.788 $F_{1,9}$=0.078	p=0.225 $F_{2,18}$=1.662	***p=0.017**** $F_{2,18}$=5.553
RMS ML	p=0.664 $F_{1,9}$=0.201	p=0.990 $F_{2,18}$=0.010	***p=0.048**** $F_{2,18}$=1.178
RMS AP	p=0.077 $F_{1,9}$=3.997	p=0.129 $F_{2,18}$=2.063	p=0.224 $F_{2,18}$=1.55
Follow-up univariate			
DOT			
Post hoc Sidak	Phase		
Intervention vs. Control Group	Pretest	Postest	Retention
	p=0.524	***p=0.020****	p=0.610
	Pretest vs. postest	Postest vs. retention	Pretest vs. retention
Intervention group	p=0.552	***p=0.046****	***p=0.022***
Control group	p=0.196	p=0.242	p=0.999
RMS ML			
Post hoc Sidak	Phase		
Intervention vs. Control Group	Pretest	Postest	Retention
	p=0.234	***p=0.028****	p=0.389
	Pretest vs. postest	Postest vs. retention	Pretest vs. retention
Intervention group	p=0.264	p=0.977	p=0.286
Control group	p=0.306	p=0.416	p=0.969

DISCUSSION

The aim of this study was to investigate the effect of an acute motor intervention using the "Boing" balance board on postural control in the elderly. Examining balance maintenance and postural control during upright posture is crucial as it helps us understand how different mechanisms interact, ultimately aiding in performing daily activities. Neuromuscular responses play a vital role in ensuring that the center of gravity remains within the support base, thereby generating stability for various tasks [25]. According to Horak, Diener, and Nashner (1989) [25], the support base itself does not change with age, but the limits of stability are significantly reduced.

The choice of using the "Boing" balance board in this study was based on several factors, including its ease of use, portability, and its ability to replicate the functionality of other balance boards used in previous research [11–13]. One key advantage of the "Boing" board is its practicality, as it does not require additional computational equipment or specialized laboratory accessories. We assumed that the use of the "Boing" balance board for balance training can effectively stimulate the body's ability to handle perturbations. By exposing participants to various perturbations, the board prompts them to actively seek and implement strategies to maintain balance. This process is directly associated with improvements in postural control. By incorporating the "Boing" balance board into our intervention, we aim to enhance participants' ability to respond to and recover from balance disturbances. This practical and versatile tool provides an opportunity to challenge the body's postural control system in a controlled manner, fostering adaptive responses and ultimately leading to improvements in balance and stability.

Our findings indicate that the use of the "Boing" balance board did not result in a reduction of postural sway between the pretest and posttest phases for the intervention group. This was observed in terms of the DOT, RMS ML, and RMS AP variables when comparing the posttest phase to the pretest phase. However, in terms of the RMS ML and DOT variables, the intervention group exhibited significantly lower values (indicating better postural control) during the posttest phase compared to the control group. This suggests that the motor intervention may be associated with improved postural control. These results partially support our initial hypothesis that older adults participating in the acute motor intervention would demonstrate enhanced postural control after the intervention.

During almost all test phases, IG consistently demonstrated lower values for the variables measured in postural control compared to CG. Although the lack of significance suggests that some points need to be considered, it is worth noting that a previous study examined two types of postural board task [3] interventions for young adults (mean age=24.7 years). The study utilized electromyography (EMG) measurements and found that the activity of the soleus muscle increased when transitioning from a quiet standing position to both board conditions. This indicates that the soleus muscle was necessary for balancing in both tasks, leading to improvements in postural control. Several factors could explain the differences in results, such as the fact that the intervention involved young adults, the apparatus only rotated along the forward and backward axis, and a different measurement method (EMG) was employed.

In relation to these previous studies that investigated motor interventions to improve postural control, it is important to mention that the decline in postural control among the elderly necessitates specific interventions tailored to their needs. However, the absence of studies utilizing different apparatus for postural control improvement compelled us to present these results. Additionally, the use of force plate measures, which are considered the gold standard and widely used for understanding postural control, has been shown to be a more accurate measure for discussing this topic. On the other hand, we acknowledge that the aim of these previous studies was to closely replicate the task, but in our case, we prioritized preserving and ensuring the most accurate variable measurement. However, this decision may have limited our ability to incorporate a different postural task between the test and intervention phases. Consequently, this could explain why we did not find improvements in postural control between the pre-test and post-test. It is worth noting that the success of motor interventions often depends on the similarity and specificity of the interventions themselves, as transfer effects in postural control primarily occur in tasks closely related to the training contents. This requirement has been recognized in previous studies [3,11,13] as an important factor for achieving successful motor interventions [12,26].

When the force plate was used [9] after acute strength training, the COP velocity vector and wavelet entropy variables showed improvement in balance control. However, in this study, similar improvements were found from pretest to posttest in both the intervention and control groups, particularly in the antero-posterior direction. These results were assumed to be related to a possible beneficial effect on attentional balance control. The medio-lateral condition, which required more focus due to the narrow dimensions of the support, played a significant role in sway. This could also explain our results, as we observed differences between the intervention and control groups in the posttest during the semi-tandem condition for RMS ML but not for RMS AP. Moreover, we can infer that the intervention helped participants pay more attention to the challenging task (ML condition) after experiencing the exercises. In other words, the intervention facilitated a heightened awareness of the task performed under more challenging conditions.

In a similar manner to our study, Oliveira et al [19] investigated the effects of an acute intervention on postural control in young adults, comparing two interventions: core stability exercises and sensory-motor exercises. However, similar to our findings, this study did not observe improvements in postural control. It is worth noting that, despite involving young adults and a different motor intervention, this study, like ours, used an intervention task that differed from the postural test conducted on the force plate.

Nevertheless, the lack of difference between the pre and posttest phases in our results may be attributed to the duration of time spent on the Boing task, the number of trials conducted, and the sessions administered. In contrast to previous studies [3,11,13] that utilized acute interventions with similar trial practices, we proposed a different task for the test (using the force plate). Therefore, it can be inferred that more practice was necessary. By repeatedly exposing our sensorimotor system to postural perturbations, it learns internal models for sensory predictions and motor commands, enabling us to plan new solutions and improve compensatory reactions [27].

Another argument for conducting more practical trials and sessions is the potential to incorporate proactive postural adjustments during the interventions. Through repeated exposure to postural perturbations, individuals may develop proactive strategies that reduce the need for compensatory adjustments after the perturbation occurs. This approach could promote the development of recovery skills and facilitate neuroplastic changes following training.

Although our results did not demonstrate improvements in postural control for all conditions and variables, three key points should be considered. First, we introduced a new apparatus that is easy to use and portable. Second, the stabilographic measures employed are highly accurate and widely applicable in robust postural control investigations. Finally, there is a scarcity of studies investigating the acute effects of motor interventions on older adults, which holds significant relevance for clinical practice and the application of physical activity in sports.

In order to determine the most effective type of exercise intervention for improving postural control, Kim et al [27] found that balance exercises incorporating a reactive balance component yielded the greatest improvements. They observed that using the same parameter components during both the intervention and the assessment resulted in greater effectiveness [27]. This assumption is grounded in the idea that cognitive processes, muscle synergies, and kinematic strategies work together to counteract the perturbations encountered, including their type, magnitude, direction, and point of application. Consequently, reactive balance training enhances performance specifically in tasks that involve the same parameters [27].

Regarding the retention results observed in the intervention group during the post-test phase (where higher values indicated worse postural control), similar findings were reported by Egger [3]. In their study, despite using a different measurement method (electromyography), no improvement in the retention task was observed. Conversely, previous research [28] yielded contrasting results, suggesting that older adults did not experience a disruption in postural stability during the retention test. This finding implies that there may be a preservation of the capacity to extract relevant features from the environment, which could be influenced by motor interventions [29].

The process of motor learning can lead to the development of various strategies related to postural control. On one hand, we observe an improvement in postural control characterized by reduced oscillation, while on the other hand, we have the issue of maintaining performance over time (retention). However, our current results did not confirm the permanence of postural control improvements, further highlighting the necessity for additional practice.

The characteristics of the applied protocol, which were implemented acutely, could be adapted for a longer duration, such as a chronic approach. Based on the findings of Lesinski et al. (2015) [30], training periods lasting between 11-12 weeks may yield more significant results for postural control compared to periods shorter than 11 weeks. However, this does not imply that shorter training periods do not lead to improvements in postural control [6,30]. It is important to comprehend various modes of motor interventions in order to determine whether faster and more concentrated training, or certain types of acute interventions [28,29,31], can be equally effective as longer-duration practices.

Especially for older individuals, who experience gradual declines in sensory, physical-motor, and neurological functions, offering shorter and more effective modes of intervention becomes crucial. These interventions aim to rapidly minimize declines and promote improvements in postural control, making them an appealing option for aging populations. Given that postural control is essential for performing various daily tasks, enhancing it can help older adults maintain their autonomy, independence, and active engagement in physical, sports, and leisure activities.

In our study, it is possible that the amount of practice conducted in a single session may have induced fatigue, which could have influenced the results. However, we believe that for more substantial improvements in postural control, combining different types of practice may yield better outcomes. Research on aging has been extensively conducted due to its significant relevance in the field of health. The importance of physical exercise for the health of older adults has been scientifically proven, and maintaining body balance is a crucial aspect in preventing falls and potential accidents. Various studies involving training on vibrating platforms [32–34], gait training with different types of support using the Berg scale [35], feedback mechanisms [36], biofeedback training [37], postural instructions [38], and arm-raising movements towards a target in virtual reality [6,39] have contributed to advancing our understanding of the relationship between exercises and postural control. However, some results have been contradictory, highlighting the need for further scientific research in this area. Investigations involving other age groups, such as young individuals, have also shown that training with balance-stimulating devices like rockers and proprioceptive discs for a period of 5 weeks can reduce postural oscillations [40]. Utilizing instrumentation for measuring [41] and training postural control could be a promising approach to enhance its improvement.

Some limitations were encountered during the execution of this study. Firstly, the challenge of finding suitable participants who would adhere to the training sessions posed difficulties in data collection, as the tests involved two separate application moments. Additionally, the previous motor experience of the participants was a limiting factor. Given our aim to engage older adults in motor activities, it was necessary to select individuals who were not already engaged or exhibited similar motor abilities, further complicating the recruitment process. Another limitation pertains to the lack of cognitive assessment of the participants. While our focus was primarily on postural control training for older adults, both healthy and those with health conditions, we acknowledge that evaluating cognitive status could have provided valuable insights, as it influences performance and strategies in motor control. The combination of these challenges resulted in a reduced number of participants in each group, limiting the generalizability of our findings. Nevertheless, we believe that our study has raised important questions in the field of Physical Education and aging, stimulating discussions on motor practice aspects and introducing the potential use of diverse and effective devices in motor interventions directly related to promoting postural control. For future studies, we recommend exploring associated training, multi-modal interventions, and dynamic activities that challenge postural control. Aging and the increasing life expectancy call for preventive measures involving health professionals, government initiatives, and individual efforts. Collectively, these actions are essential for preventing potential negative consequences associated with the natural aging process and ensuring that this stage of life is navigated with minimal difficulties.

CONCLUSION

Based on the findings of our study, we can conclude that motor practice using the Boing apparatus holds promise for enhancing postural control. We are of the opinion that incorporating variability and employing diverse modes of motor practice and intervention could have a positive association and contribute to further improving postural control.

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