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# Effects of bodyweight and traditional resistance training on the functionality of elderly people: a randomized clinical trial

## Efeitos do treinamento com peso corporal e do treinamento resistido tradicional sobre a funcionalidade de idosas: um ensaio clínico randomizado

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ABSTRACT
**Background:** The bodyweight training is a method that aims to improve physical fitness without the use of implements to generate overload, being an alternative to traditional resistance training. However, there are still few studies analyzing its effects on the functionality of active older women. **Objective:** To compare the effects of bodyweight training with traditional resistance training on functionality of active older women. **Methods:** Thirty-three older women (64.42 ± 4.22 years) completed twelve weeks of intervention and were randomized into three groups: Bodyweight Training (BWT: n = 13), Traditional Resistance Training (TT: n = 13) and Control (CG: n = 7). Functional responses were assessed using the Sit and Stand (SL), Gallon Jug Shelf Transfer (GJST), Stand Up (LPDV), Time Up and Go (TUG), Six-Minute Walk, Isometric Dead Lift (IDL) and Hand Grip Test. Self-perception of quality of life was assessed using the WHOQOL-BREF questionnaire. **Results:** After 12 weeks of intervention, TT demonstrated significant improvements in SL (3.23%), TUG (-6.06%) and WHOQOL-BREF (7.62%) tests. The BWT provided significant improvement in the IDL test (10.32%) and both experimental groups showed significant improvements in GJST (TT = -7.59% and BWT = -7.62%) and LPDV (TT = -9.28% and BWT = -12.25%) in relation to the initial values. **Conclusion:** Both programs proved to be effective for improving the functionality of the older women. Considering the similarity in the magnitude of the effects, BWT may be a viable, practical and inexpensive alternative to TT for this population.

Key-words: Aging, Functional Training, Bodyweight training, Daily activities, Quality of life.

RESUMO
**Introdução:** O treinamento com peso corporal é um método que visa melhorar a aptidão física sem a necessidade do uso de implementos para gerar sobrecarga, sendo alternativa ao treinamento resistido tradicional. Porém ainda são poucos os estudos analisando seus efeitos sobre a funcionalidade de idosas ativas. **Objetivo:** Comparar os efeitos do treinamento com peso corporal com o treinamento tradicional na funcionalidade de idosas. **Métodos:** Trinta e três idosas ativas (64,42 ± 4,22 anos) concluíram 12 semanas de intervenção, sendo randomizadas em três grupos: Treinamento com peso corporal (TPC: n=13), Treinamento resistido tradicional (TT: n=13) e Controle (GC: n=7). Para a verificação das respostas funcionais foram utilizados os testes de Sentar e Levantar (SL), *Gallon Jug Shelf Transfer* (GJST), Levantar-se da posição decúbito ventral (LPDV), *Time Up and Go* (TUG), Caminhada de seis minutos, *Isometric Dead Lift* (IDL) e o *HandGrip Test*. A autopercepção da qualidade de vida foi avaliada por meio do questionário WHOQOL-BREF. **Resultados:** Após as 12 semanas de intervenção, o TT demonstrou melhoras significativas nos testes SL (3,23%) e TUG (-6,06%), bem como no WHOQOL-BREF (7,62%). O TPC proporcionou melhora significativa no teste IDL (10,32%) e ambos os grupos experimentais apresentaram melhoras significativas no GJST (TT= -7,59% e TPC= -7,62%) e LPDV (TT= -9,28% e TPC= -12,25%) em relação aos valores iniciais. **Conclusão:** Ambos os programas se mostraram eficazes para melhora da funcionalidade de idosas. Considerando a semelhança na magnitude dos efeitos, o TPC pode ser uma alternativa viável, prática e de baixo custo ao TT para essa população.

Palavras-chave: Envelhecimento, Treinamento funcional, Atividades diárias, Qualidade de vida.

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## Introduction

Resistance training has been well recommended for the elderly population to mitigate the physiological and functional declines resulting from the aging process, so that it reduces fragility and preserves/increases functionality [1]. In this perspective, traditional resistance training - with free weights and machines - presents itself as the first intervention option due to the effectiveness and safety shown in several publications [2]. However, conventional gyms environment can be mainly focused on body aesthetics, in addition to the risk of accidents, so that is sometimes not so attractive to elderly people [3]. Thus, among the alternatives, bodyweight training (BWT) has been widely used, proving to be a viable option for this population [4]. It is a training that uses little or no implement [5] aiming to improve physical abilities with the use of bodyweight as overload [6]. In fact, applying BWT, Silva and Zácaro [7] found effects on knee flexion strength, and Lord *et al.* [8] found positive results in balance, reaction time, neuromuscular control and risk of falls, demonstrating the effectiveness of this method in variables related to the functionality of the elderly.

However, there is a lack of a BWT model in the current scientific literature, as well as a lack of investigations comparing this method with more traditional ones, which makes it difficult to robustly compare the characteristics of each protocol used and the results found. Thus, the aim of the present study was to analyze the effects of BWT and traditional resistance training on physical fitness associated with functionality in the daily activities of active elderly women. The initial hypothesis was that the BWT would improve physical fitness, reflecting positively on functionality, similar to traditional training.

## Methods

### *Study design*

This study is a controlled and randomized clinical trial lasting 12 weeks, composed of two experimental arms, in which physical fitness was associated with improved functionality in the daily activities of active elderly women. The present study complied with the model proposed by CONSORT (http://www.consort-statement.org), was approved by the Research Ethics Committee (nº 2.947.316) and by the Brazilian Registry of Clinical Trials (RBR-89KCHG).

### *Sample*

The sample consisted of physically active elderly women (≥ 60 years old), recruited through leafleting and social media ads. Volunteers who presented a medical certificate with permission to practice high-intensity physical exercises, considering orthopedic and cardiovascular conditions, were included. Thus, thirty-three elderly women were allocated by stratified randomization in blocks, in which the participants were equally distributed according to the strength of the lower limbs, verified by the Sit and Stand tests, in two experimental groups and one control: Bodyweight Training (BWT=13), Traditional resistance training (TT=13) e control (GC=7) (Figure 1).

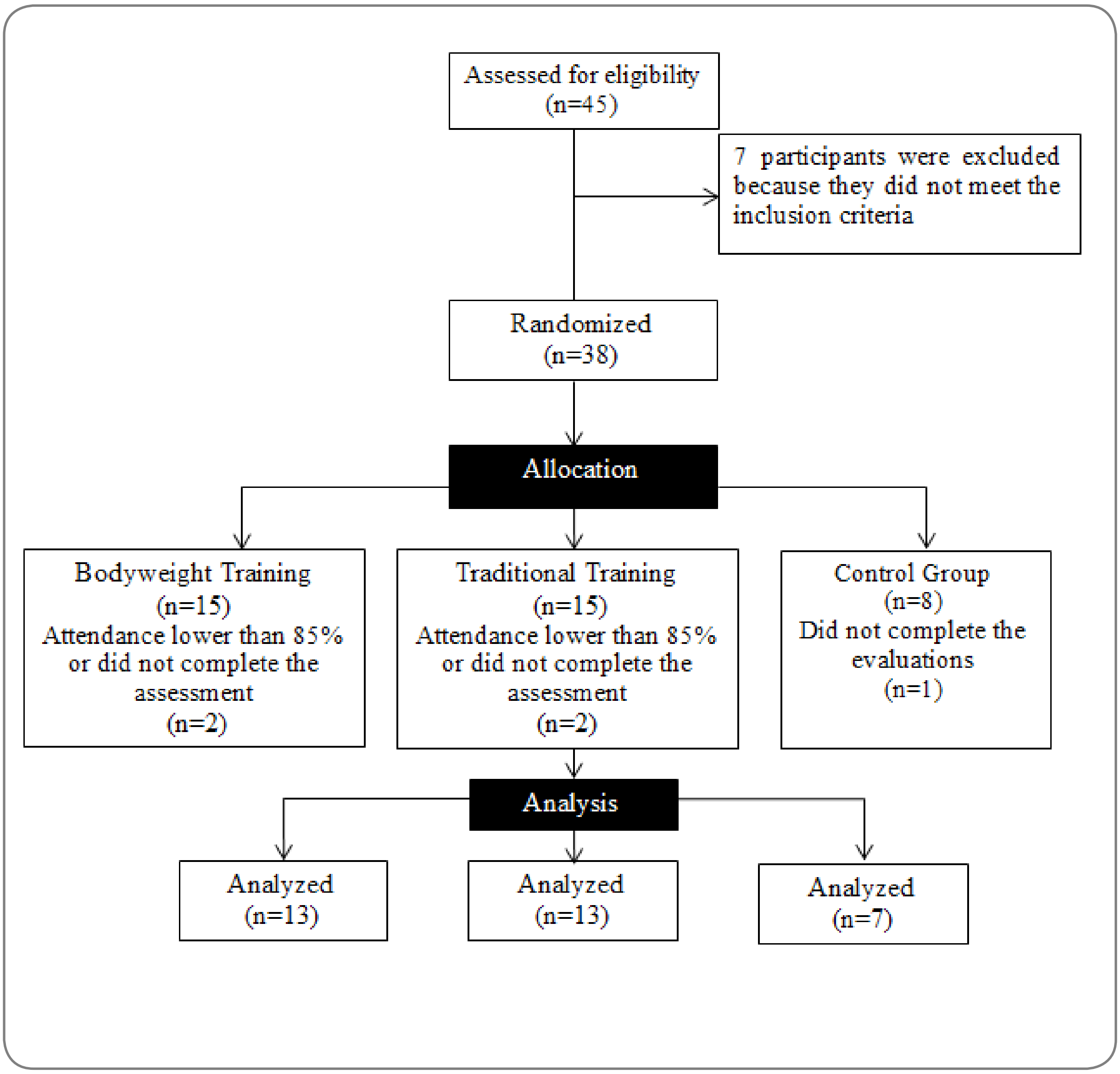



**Figure 1 - Sample procedure flowchart.**

## Measurements

### *Anthropometry*

Body mass was assessed using a scale (Lider®, P150C, São Paulo, Brazil), height (cm) was determined using a stadiometer (Sanny, ES2030, São Paulo, Brazil) and body mass index (BMI) was calculated using the equation "body mass/height$^2$".

### *Quality of life*

To assess the perception of quality of life, the WHOQOL-BREF [9] questionnaire was used, widely used in this population [10]. The instrument consists of 26 questions, encompassing four domains of life: physical, psychological, social and environmental. Each question was answered using a likert scale ranging from 0 to 5, generating a score between 0 and 130, the higher the value, the better the perceived quality of life.

### *Functional fitness*

Functional fitness was assessed using the following tests, the details and procedures of which are described in references [11-13]: Sit and Stand, raise from the prone position, timed up and go, six-minutes' walk test (6MWT), Gallon jug shelf transfer (GJST), handgrip strength (Jamar Plus® Sammons Preston, Illinois, United States), lumbar traction (Crown®, dorsal, Ribeirão Preto, Brazil) and the isometric dead lift test.

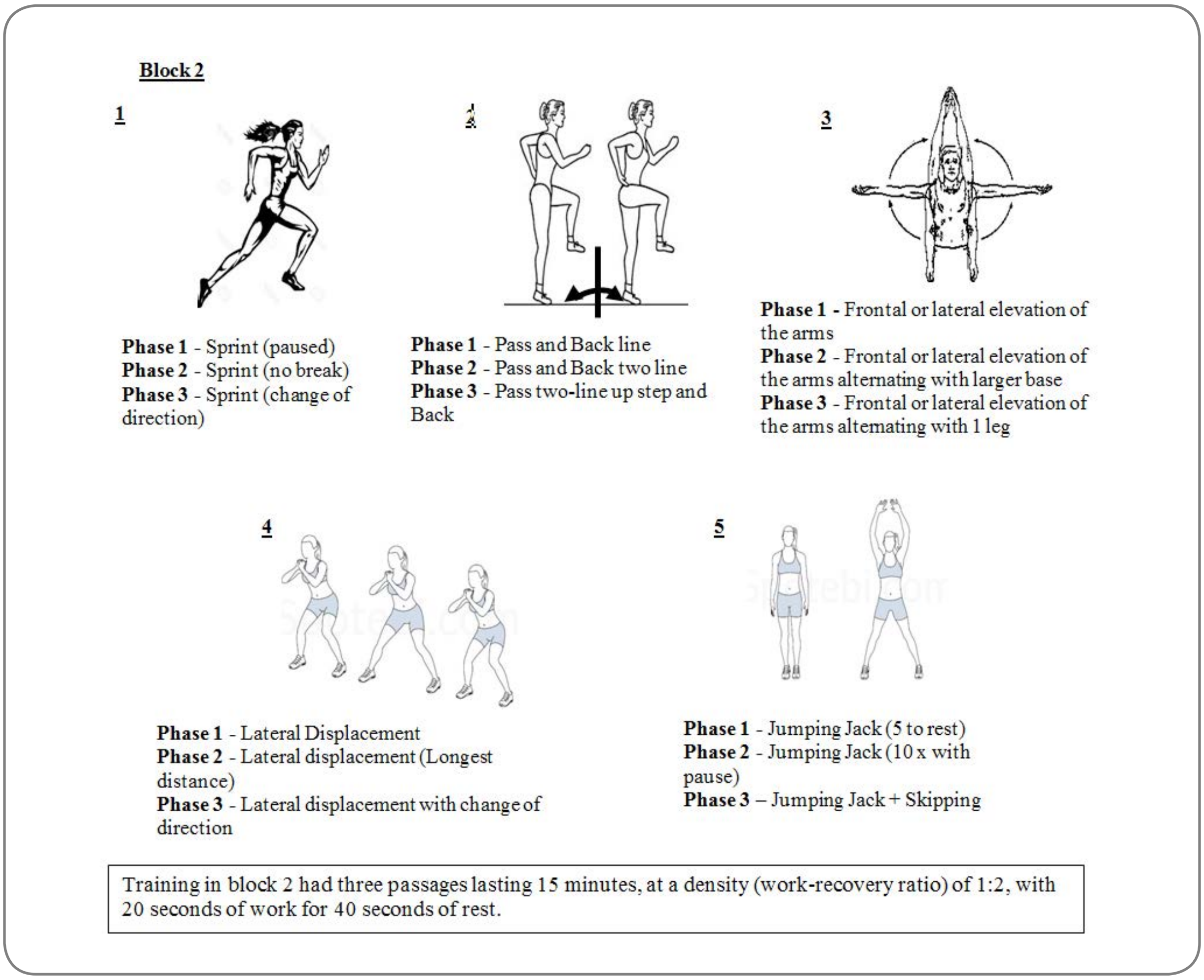
### *Intervention design*

The intervention lasted 12 weeks, consisting of 36 training sessions, with exercises progressions every 18 (for the TT group) and 12 (for the BWT group) sessions maintaining the total session time in both experimental groups. Each session lasted 55 min and a minimum interval of 48 hours between sessions was applied. After the initial evaluations, the sample was submitted to two weeks of familiarization, in which 60% of the intensity predicted for the 1st training session was applied. At the BWT, integrated and multiarticular exercises were performed using bodyweight, while at the TT, resistance exercises were performed on machines.

The CG did not perform any type of intervention, being instructed to continue with their daily activities. To maintain this group, weekly calls were made in order to monitor actions during the week and encourage them to remain in the study until the final evaluation.

The experimental protocols were structured in four blocks, the first and the last block being carried out jointly by the groups in the same space, as described in detail in figures 2, 3 and table 1.

**Figure 2 - Description of the exercises performed in block 2 and their respective progressions during Bodyweight Training.**



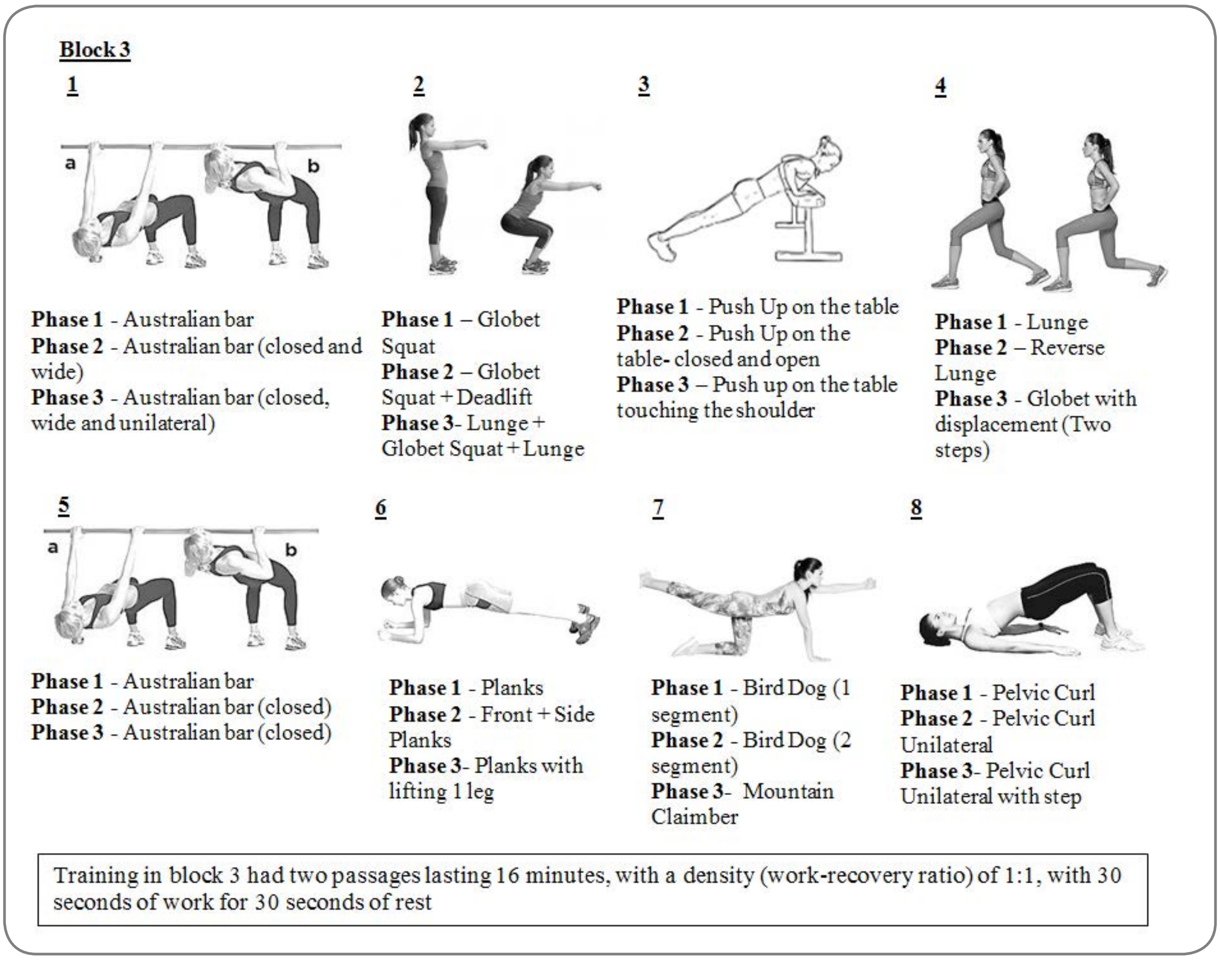



**Figure 3 - Description of the exercises performed in block 3 and their respective progressions during Bodyweight Training.**

**Table I - General description of the exercises performed in block 3 of Traditional Training and their respective progressions.**

| Block 3 Exercises - Traditional training | |
|---|---|
| **Phase 1 (1-18 sessions)** | **Phase 2 (18-36 sessions)** |
| Squat (Smith) | Squat (Free) |
| Vertical pull (Articulated row) | Vertical pull (Articulated row) |
| Knee extension (Leg press 45°) | Knee extension (Extending chair) |
| Vertical push (Bench press) | Horizontal push (Bench press) |
| Knee flexion (Flexing table) | Knee flexion (shin guard) |
| Pulled front with open footprint (lat pulldown) | Pulled front with neutral footprint (lat pulldown) |
| Bilateral standing calf (PP) | Bilateral calf (leg press 45°) |
| Stiff (Bar and washers) | Abdominal (curl up) |

### *Bodyweight training protocol*

The BWT exercises used bodyweight as an overload, so the strategy used to increase the number of stimuli and intensity was the combination of exercises within the same movement pattern, stimulating the musculature at different angles, increasing the neuromotor component and complexity activities.

In block 2 of the BWT, a circuit was performed with 5 stations, 3 passages, with a density of 30 seconds of work and 30 seconds of rest (1:1 work-recovery ratio). From the 6th week on, 40 seconds of work and 20 seconds of rest (2:1 work-recovery ratio) were applied and the standardized intensity was between 6 and 7 on the OMNI-GSE scale [14]. The elderly women were encouraged to perform all the patterns at maximum concentric speed. In block 3, a circuit with 8 stations was performed, two passes at a fixed density of 30 seconds of work and 30 seconds of rest (1:1 work-recovery ratio), with the intensity between 7 and 9 in the OMNI-GSE.

*Traditional training protocol*

In block 2, an intermittent activity was performed, in which the elderly alternated walking every 20 meters with the run for 15 min at an intensity between 6 and 7 on the OMNI-GSE scale. In block 3, they performed circuit exercises on weight training machines, focusing on functional movement patterns, consisting of 8 stations, two passes at a density of 30 seconds of work for 30 seconds of rest and intensity between 7 and 9 on the OMNI-GSE scale. In order to maintain an adequate progression of the load, a range between 8 to 12 repetitions was established for each exercise, which when exceeded, suffered an increase of 5 to 10% in the external load.

*Statistical analysis*

The sample size was calculated in the G*Power program (Erdfelder, Faul and Buchner, 1996; Kiel, Germany - version 3.1.9.2) in the Senior Fitness Test battery variables from the results obtained by Resende-Neto *et al.* [15] expecting an average increase of 15% in the performance of the participants. Thus, we consider a power of 0.80 for the analysis performed for the sample size of this study.

The data were expressed as mean, standard deviation and percentage delta. The reproducibility of the measurements was assessed based on the analysis of the Interclass Correlation Coefficient (ICC), adopting ≥ 0.90 as the acceptance criterion. The homogeneity of the data was confirmed using the Levene test. They were analyzed using a Repeated-measures ANOVA (3x2) followed by Bonferroni post hoc into the Statistical Package for the Social Sciences (SPSS - version 22) software, adopting a significance level of 5%. The effect size was calculated using the equation proposed by Cohen [16], as well as the classification of each result (small effect: 0.2-0.4; moderate: 0.5-0.7; large: 0.8-1.33; and very large: > 1.33).

## Results

Table II presents the sample characterization and shows that there were no statistically significant differences between the groups before the intervention with physical exercises. Table III shows the intra and intergroup comparisons, being possible to observe significant differences of the experimental groups in the tests of Raising from the prone position, Sitting and Stand and Gallon Jug Shelf Transfer, when compared to the pre protocol values. In Time up and go test, only TT showed a significant difference from pre to post. The BWT showed a significant improvement in the Sit and Stand tests in relation to the TT, as well as in the 6-minute walk and Gallon Jug Shelf Transfer tests in relation to the CG.

**Table II - Characteristics of participants of Bodyweight training (BWT), Traditional training (TT) and Control (CG) groups. Values presented in mean ± standard deviation.**

| | BWT (n=13) | TT (n=13) | CG (n=7) |
|---|---|---|---|
| Age (years) | 64.5 ± 5.07 | 64.6 ± 3.40 | 63.7 ± 5.82 |
| Height (m) | 153.5 ± 6.20 | 152.3 ± 8.41 | 155.2 ± 2.30 |
| Weight (kg) | 68.0 ± 13.10 | 64.8 ± 13.17 | 71.6 ± 9.61 |
| BMI (kg/m²) | 28.8 ± 5.19 | 27.9 ± 5.33 | 29.7 ± 3.87 |

No significant difference was found ($p < 0.05$) for any of the variables analyzed in the pre-test. M: meters; kg: kilogram; BMI: Body mass index.

**Table III - Effects of 12 weeks of Bodyweight Training (BWT), Traditional Training (TT) and Control (CG) on the functionality of physically active elderly women. Values are presented as mean ± standard deviation.**

| Tests | Pre | Post | (%Δ) | IC (95%) | ES | P |
|---|---|---|---|---|---|---|
| **Sit and Stand (rep)** | | | | | | |
| TT | 13.26±2.10* | 15.30±3.22 | 15.45 | 12.50 - 18.10 | 0.97 | 0.012 |
| BWT | 18.46±5.78* | 20.46±6.84# | 11.30 | 17.66 - 23.26 | 0.34 | 0.014 |
| CG | 14.14±2.04 | 13.86±2.79 | 1.67 | 10.04 - 17.67 | 0,13 | 0.786 |
| **Gallon Jug Shelf Transfer (seg)** | | | | | | |
| TT | 13.71±1.49* | 12.67±1.44 | 7.59 | 11.86 - 13.48 | 0.69 | 0.001 |
| BWT | 12.47±1.21* | 11.51±1.39 † | 7.62 | 10.70 - 12.32 | 0.79 | 0.002 |
| CG | 12.87±1.14* | 13,82±1.46 | -7.57 | 12.71 - 14.92 | 0.83 | 0.018 |
| **Rising from prone position (seg)** | | | | | | |
| TT | 3.85±0.74* | 3.48±0.69 | 9.28 | 3.02 - 3.93 | 0.5 | 0.037 |
| BWT | 3.67±1.32* | 3.10±0.91 | 12.25 | 2.65 - 3.55 | 0.43 | 0.002 |
| CG | 3.76±0.46 | 4.78±0.73 | 0.70 | 3.17 - 4.40 | 2.21 | 0.933 |
| **Time Up and Go (seg)** | | | | | | |
| TT | 5.24 ± 0.48* | 4.90 ± 0.28 | 6.06 | 4.64 – 5.16 | 0.70 | 0.013 |
| BWT | 4.96 ± 0.58 | 4.97 ± 0.57 | 0.54 | 4.72 – 5.22 | 0.01 | 0.911 |
| GC | 5.44 ± 0.94 | 5.49 ± 0.29 | 2.70 | 5.09 – 5.90 | 0.05 | 0.773 |
| **Six-minute walk (m)** | | | | | | |
| TT | 544.3 ± 59.99 | 560.16 ± 50.5 | 3.23 | 529.29 – 591.02 | 0.26 | 0.132 |
| BWT | 579.8 ± 64.37 | 592.06 ± 58.6 † | 2.36 | 561.20 – 622.93 | 0.18 | 0.142 |
| CG | 523.7 ± 42.59 | 518.74 ± 53.4 | 0.70 | 476.67 – 560.80 | 0.11 | 0.721 |
| **Isometric Dead Lift (Kgs)** | | | | | | |
| TT | 54.46 ± 14.20 | 56.85 ± 13.08 | 5.72 | 49.88 – 63.80 | 0.6 | 0.188 |
| BWT | 57.7 ± 11.68* | 63.23 ± 11.26 | 10.32 | 56.26 – 70.19 | 0.46 | 0.004 |
| CG | 61.86 ± 12.94 | 63.43 ± 12.63 | 3.71 | 53.93 – 72.91 | 0.12 | 0.520 |
| **Hand Grip Test (Kgs)** | | | | | | |
| TT | 18.34 ± 3.82 | 18.57 ± 2.97 | 2.40 | 16.40 – 20.74 | 0.06 | 0.638 |
| BWT | 19.42 ± 4.44 | 20.15 ± 5.01 | 3.61 | 17.98 – 22.32 | 0.16 | 0.143 |
| CG | 20.21 ± 1.07 | 19.67 ± 2.30 | -2.65 | 16.71 – 22.62 | 0.50 | 0.419 |

**Table III - Continuation**

| Tests | Pre | Post | (%Δ) | IC (95%) | ES | P |
|---|---|---|---|---|---|---|
| **WHOQOL-BREF (scores)** | | | | | | |
| TT | 93.4 ± 10.17* | 100.31 ± 10.8 | 7.62 | -11.08 – -2.61 | 0.67 | 0.041 |
| BWT | 104.0 ± 13.22 | 104.62 ± 13.6 | 1.20 | -7.72 – 6.49 | 0.04 | 0.952 |
| CG | 99.71 ± 16.58 | 97.57 ± 16.89 | 1.54 | -8.22 – 12.50 | 0.12 | 0.816 |

Rep = repetitions; m = meters; sec = seconds; Kgs = Kilogram of strength, * = Significant difference from the pre and post-intervention moment, # Significant difference in relation to the TT group; Significant difference in relation to the CG (values of P≤0.05). %Δ = change percentage; CI = Confidence interval; ES = Effect size; P = P value.

## Discussion

The main finding of the present study was that both training protocols proved to be effective in maintaining or improving all the variables analyzed, being able to positively contribute to independence and security during daily activities.

The ability to transfer objects is often used in the elderly daily lives, being an important functional activity for autonomy [1,17]. Regarding Gallon jug shelf transfer test, we noticed that both methods were efficient in improving this functional action, corroborating Buskard *et al.* [18], who also showed significant increases after 12 weeks of intervention. This response is expected when analyzing the effectiveness of multi-component training that stimulates power, muscle strength and the ability to transfer to daily activities in the elderly [18].

BWT favors neuromuscular coordination and postural control due to not using external loads and exercises commonly applied in a closed kinetic chain. The strategy of combining different movement patterns, as well as exercises of progressive motor complexity, both in activities aimed at muscle power (Block 2) and strength (Block 3) justify the significant improvement in the sit and stand tests, Gallon jug shelf transfer, rise from the prone position and isometric dead lift, since such tests evaluate components related to neuromuscular strength and coordination. Furthermore, the literature demonstrates that free movements generate neuromuscular readjustments and increases in coordinative capacity [19]. On the other hand, the TT used basic actions of pushing, pulling and squatting, with high speed and overload in all exercises, contributing with the increase of the muscular strength and power, and consequently, with the increase of the functionality [20,21].

Regarding the lower limbs functional capacity, both protocols were effective in improving the sitting and standing action, which represents an important movement pattern for functional independence [22]. Corroborating our study, Yamauchi *et al.* [4] showed improvements in strength (15%) and muscle power (13%) of lower limbs after 10 months of BWT in untrained elderly. In addition, Watanabe *et al.* [23] showed similar results after 16 weeks of intervention. We emphasize that the present investigation had a shorter intervention period than the studies mentioned; however, it demonstrated a similar improvement. This can be attributed to the fact that training consists of 60% of exercises for lower limbs, thus highlighting the importance of greater volume of exercises for this body segment in training programs for the elderly [2].

Only TT provided significant improvement in Time Up and Go. This effect on agility and dynamic balance can be justified by the fact that TT used exercises with progressive external load in functional actions that provide power gains, in addition to alternating walking with running (block 2), which requires acceleration, deceleration and gait variability that favors speed gains. On the BWT group, this test did not show any significant change, a result that differs Kaya *et al.* [24], who performed a longer intervention (24 weeks).

In the 6MWT, the experimental groups did not show significant improvements compared to the initial moment. The absence of adaptations in cardiorespiratory resistance may be related to the physically active condition of the participants, since Marin *et al.* [25] found significant improvements in the distance walked after BWT in elderly people with peripheral arterial obstructive disease, and Langoni *et al.* [26] stated that the 6MWT has good applicability only in the elderly with limited physical condition. It is noteworthy that the average expected performance in this test is 500 meters [27] and the distance covered in the initial moment by the experimental groups of the present was greater than that.

Also, BWT showed significant improvements in isometric strength of the posterior chain when compared to TT. In this sense, the use of machines may have disadvantaged the work of the muscles of the posterior trunk chain in the TT, which did not occur in the BWT, since the exercises explored characteristics that favor the intense activation of this muscle group [28]. However, for handgrip strength, no significant results were found in the experimental groups after 12 weeks, possibly due to the lack of specific stimuli. However, because this variable presents a gradual and expressive decline after the age of 45, we consider the percentage improvement found in the present study to be clinically important for physically active elderly women [29].

Regarding the ability to raise from the ground, the experimental groups showed significant improvements after the intervention. These results can be explained due to the application of multicomponent, multisegmental and multiplanar exercises in both training protocols, which favor intrinsic elements of this functional action, such as dynamic balance, flexibility, stability, coordination, power and the muscular strength necessary for total extension of the body [30].

In the perception of quality of life, only the TT showed significant improvement in relation to the initial values. However, the BWT started the intervention with relatively high scores (104 points), which may have hindered the increments in this variable over time, while the TT had a lower average score in the initial moment (93 points). As indicated by Pereira *et al.*, [31] the maintenance of this score throughout the intervention is indicative of training effectiveness, which leads us to believe that BWT can be effective in this regard.

Among the limitations of the present study, we highlight the lack of studies in the scientific literature that proposed intervention protocols with bodyweight training so that there would be a deeper discussion and comparisons. However, this fact highlights the unprecedented proposal of our training program that can represent a usual and ecological way of how the method is practiced. The learning time of the exercises in the BWT group must also be considered since due to the cognitive and coordinating characteristics of the protocol, the elderly women took time to get used to the exercises to perform them properly, even with the weeks of familiarization. In addition, we highlight the need for further progression of bodyweight training to be able to match the adaptations of traditional training. However, we emphasize that the total session time and the work and recovery ratio remained the same in both experimental protocols.

From the professional practice point of view, bodyweight training has great versatility, since it can be applied in different environments. In addition to having an excellent benefit-cost ratio, since it does not need implements to be performed. Thus, this training method seems to be a feasible public policy strategy for maintaining the health and functionality of the elderly, with protocols that can be applied in their own homes and/or neighborhoods, as long as safe and effective strategies are used for the monitoring and progression of activities.

## Conclusion

The results of the present study confirm the efficacy of traditional resistance training for improving the functionality of active elderly women. In addition, considering that the bodyweight training provided results with similar magnitude of effect, it presents itself as an alternative to the traditional resistance training model.

**Potential conflict of interest**
No conflicts of interest with potential potential for this article have been reported.

**Financing source**
There were no external sources of funding for this study.

**Academic link**
There is no link between this study and graduate programs.

**Author's contributions**
Conception and design of the research: Santos GV, Jesus LC, Chaves LMS. Obtaining data: Santos GV, Jesus LC, Chaves LMS, Resende-Neto AG, Monteiro MRP. Data analysis and interpretation: Santos GV, Jesus LC, Chaves LMS, Resende-Neto AG. Statistical analysis: Resende-Neto AG; Da Silva-Grigoletto ME. Obtaining financing: None. Writing of the manuscript: Santos GV, Chaves LMS, Jesus LC. Critical review of the manuscript for important intellectual content: Vasconcelos ABS, Barranco-Ruiz Y, Bocalini DS, Teixeira CVLS, Da Silva-Grigoletto ME.

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