REVIEW ARTICLE

Effectiveness of whole-body vibration in older adults: systematic review overview

Eficácia da vibração de corpo inteiro em idosos: visão geral de revisão sistemática

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Abstract

Introduction: The whole body vibration exercise (WBV) is considered an alternative to resistance exercises, offering a lower risk of complications and standing out for being an easy method for older adults. However, due to the great diversity of protocols used, the effectiveness of WBV in muscle performance and risk of falls for this population is inconclusive. **Objective:** To evaluate the systematic reviews which have analyzed the effectiveness of WBV on muscle strength and risk of falls in older adults, and to establish the best protocol for implementing training in this population. **Methods:** Systematic reviews of randomized controlled trials were included in this overview, being conducted according to the PRISMA guidelines. To assess methodological quality and risk of bias, the instruments AMSTAR 2 and ROBIS were used, respectively. **Results:** Three systematic reviews were included in the study. The studies were classified as low and critically low methodological quality according to AMSTAR 2, and risk of low and uncertain bias according to ROBIS. **Conclusion:** This overview finds weak evidence of effectiveness on muscle strength and reduced risk of falls in older adults through WBV training.

Keywords: Aging. Longevity. Quality of life. Physical and functional performance. Exercise.

Resumo

Introdução: *O exercício de vibração de corpo inteiro (VCI) é considerado uma alternativa aos exercícios resistidos, oferecendo menor risco de complicações e destacando-se por ser um método de fácil utilização para idosos. No entanto, devido à grande diversidade de protocolos utilizados, a eficácia da VCI no desempenho muscular e no risco de quedas para essa população é inconclusiva.* ***Objetivo:*** *Avaliar as revisões sistemáticas que analisaram a eficácia da VCI na força muscular e no risco de quedas em idosos e estabelecer o melhor protocolo para implementação do treinamento nessa população.* ***Métodos:*** *Revisões sistemáticas de ensaios clínicos randomizados foram incluídas nesta revisão, conduzidas de acordo com as diretrizes PRISMA. Para avaliar a qualidade metodológica e o risco de viés, foram utilizados os instrumentos AMSTAR 2 e ROBIS, respectivamente.* ***Resultados:*** *Três revisões sistemáticas foram incluídas no estudo. Os estudos foram classificados como de baixa e criticamente baixa qualidade metodológica, de acordo com o AMSTAR 2, e com risco de viés baixo e incerto, de acordo com o ROBIS.* ***Conclusão:*** *Esta revisão encontra evidências fracas de eficácia do treinamento de VCI na força muscular e na redução do risco de quedas em idosos.*

Palavras-chave: *Envelhecimento. Longevidade. Qualidade de vida. Desempenho físico e funcional. Exercício.*

Introduction

Aging is understood as a natural, inevitable and irreversible process of progressive reduction of functional reserve, which causes physical, psychological and social changes in the individual, and should be evaluated from chronological, biological, psychological and social perspectives.[1,2] Aging causes functional changes in the musculoskeletal system which trigger a reduction in muscle strength and mass, postural instability and a consequent increased risk of falls.[3]

Although physical exercises, especially resistance exercises, are one of the main factors which can counteract the deleterious effects of aging, positively contributing to the general health of older adults, the older adult population has low adherence to these programs, increasing a sedentary lifestyle and enhancing dependence on activities of daily living.[4]

New exercise modalities have emerged as an alternative to resistance exercises; among them, whole-body vibration (WBV) exercise offers a lower risk of complications, such as joint discomfort, muscle distension and fracture risk.[5] In addition, it does not require great effort or postures which hinder the execution, standing out for being an easy-to-perform method.[6] WBV exercise promotes improvement in muscular strength, static and dynamic balance, bone morphology, cardiopulmonary performance, and functional capacity through fast and oscillatory movements by individuals with limited mobility and functionality, such as older adults.[7]

Systematic reviews on the effects of WBV on muscle strength, postural balance, bone mineral density, fractures, and risk of falls in the older adult population are found in the literature.[8] However, due to the great diversity of protocols used, the studies published so far present different results regarding the effectiveness of WBV training on muscle performance and reducing falls.[8]

Therefore, the objective of this overview was to evaluate the systematic reviews which have analyzed the effectiveness of WBV on muscle strength and risk of falls in older adults, and to establish the best protocol for implementing training in this population.

Methods

This review was performed according to a previously registered protocol under No. CRD42020140374 in the International Prospective Register of Systematic Reviews (PROSPERO) database. Systematic reviews of randomized controlled trials were included to compose this overview. Participants were active or sedentary older adults aged 65 years and older of both genders, undergoing WBV training for a period ≥ 4 weeks, evidencing better responses in muscle strength, postural balance, risk of falls compared to a simulated training (WBV Sham), no intervention, balance exercise, flexibility, strength and muscular endurance. Systematic reviews working with older adults with some neurological, auditory or visual impairment which prevented indepedent WBV training and acute effect WBV training were excluded.

Two independent reviewers used the following databases for data collection: Cochrane Library, Scopus, PubMed/MEDLINE, LILACS/BIREME, SciELO, CINAHL, Physiotherapy Evidence Database (PEDro), Web of Science, and grey literature by means of research of theses and dissertations through IBICT (Instituto Brasileiro de Informação em Ciência e Tecnologia). The search strategy consisted of the following descriptors (MeSH and DeCS) and keywords: "whole body vibration" OR "vibration exercise" OR "vibration training" OR "vibration therapy" OR "biomecanical oscillation" AND "clinical trial" OR "controlled clinical trial" OR "randomized controlled" OR "double-blind method" OR "single-blind" AND "systematic review" OR "review".

The search was performed from May 1, 2019 through August 1, 2019 and updated from May 1, 2025. Language restrictions or year of publication were not imposed on the search.

Data extraction was performed by two independent reviewers. Included revisions were read in full text and data were later extracted. The two reviewers performed methodological quality assessment using the Assessing the Methodological Quality of Systematic Reviews (AMSTAR 2) tool. AMSTAR 2 performs a detailed review of the revisions and detects possible misconduct errors.[9] The instrument consists of 16 items, seven of which considered critical (Items 2, 4, 7, 9, 11, 13, 15).[9] The risk of bias was assessed by the Risk of Bias in Systematic Reviews (ROBIS) tool consisting of three phases[10] (Table 1). Any disagreement in conducting the evaluations was resolved through a meeting between the two reviewers. If there was no consensus, a third reviewer would be contacted.

Table 1 - Tabular presentation for the Risk of Bias in Systematic Reviews (ROBIS) results

Systematic reviews	Phase 2				ROBIS
	1. Study eligibility criteria	2. Identification and selection of studies	3. Data collection and study evaluation	4. Summary and results	
Sitjá-Rabert et al.[11]	☹	?	☺	?	?
Rogan et al.[12]	☹	☺	☺	☺	☺
Rogan et al.[13]	☺	☺	☺	☺	☺

Note: ☹ = high risk; ☺ = low risk; ? = uncertain risk.

Results

The search in the databases resulted in 5,746,252 articles. After identifying and deleting duplicate articles and selected articles for reading titles and abstracts, 12 articles were selected for full-text reading, nine of which were excluded for not meeting the eligibility criteria. Finally, three systematic reviews were included in this overview.[11-13] These data are presented in more detail in Figure 1. The characteristics of the included reviews are presented in Table 2.

Of the three systematic reviews included, two obtained poor methodological quality from the AMSTAR 2 assessment because they had a critical failure (Item 7),[12,13] and one obtained critically poor methodological quality because of more than one critical failure (Items 2, 7, and 15)[11] (Table 3).

The two reviews that obtained low methodological quality were classified as low risk of bias by the ROBIS tool, presenting good study conduction, contrasting the result found in the methodological quality assessment by the AMSTAR 2 instrument,[12,13] while the one which obtained a critically low methodological quality was classified as presenting risk of uncertain bias; among the identified biases there was an absence of a previous protocol, confirming the findings of the evaluation by AMSTAR 2[11] (Table 1).

Data collection and extraction of all included reviews were performed in duplicate by consensus, with two reviews being performed by two independent reviewers overview[11,13] and one by five reviewers overview.[12] Tables with characteristics of the included studies such as intervention, population, duration of training and main findings were presented in all included reviews, but the authors did not provide reasons for excluding the other articles overview.[11-13]

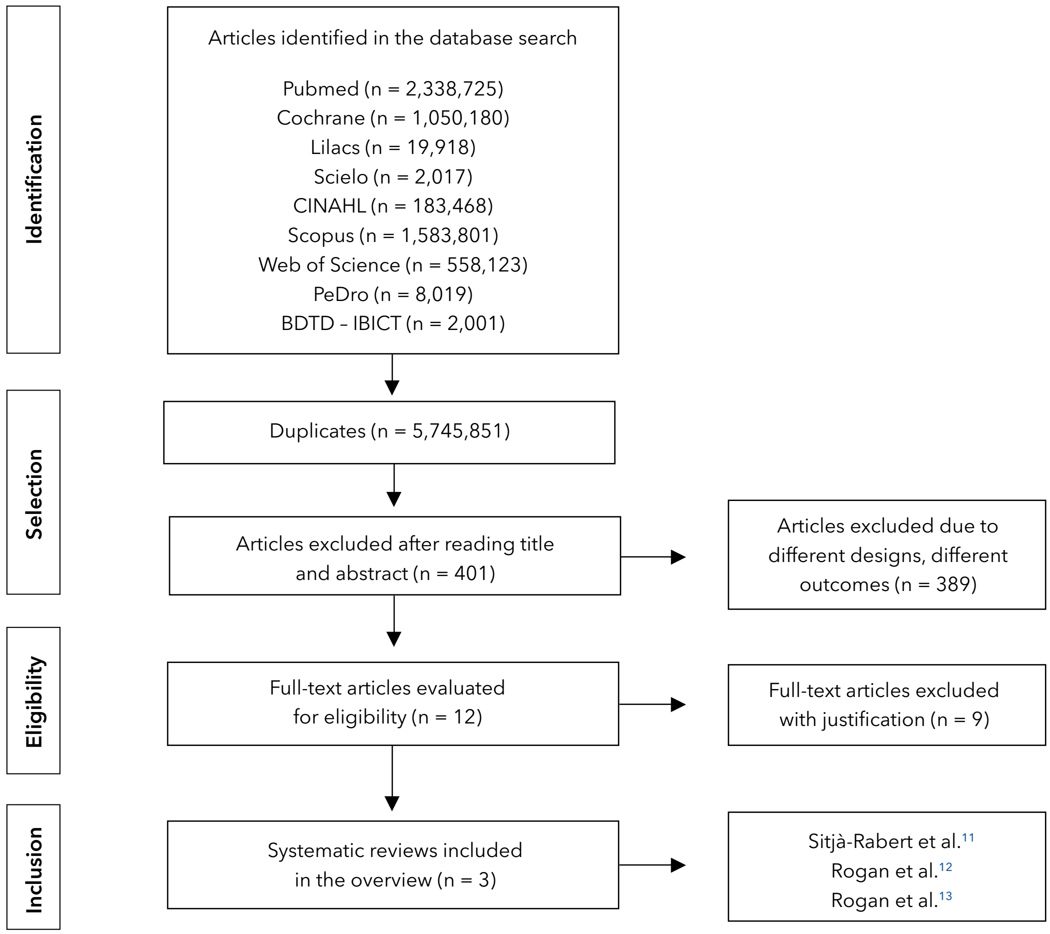

Figure 1 - Research process for the inclusion of systematic reviews in the overview.

Table 2 - Characteristics of the included systematic reviews

Systematic reviews	Type of study included	Total included studies	Primary outcome	Secondary outcome	Metanalysis conducted	Bias risk/ AMQ
Sitjà-Rabert et al.,[11] Spain, 2012	Randomized controlled clinical trial	16	Muscle strength and postural balance	Risk of falls, fractures, bone mineral density and adverse events	Yes	Cochrane Collaboration's Risk of Bias (RoB)
Rogan et al.,[12] Switzerland, 2015	Randomized clinical trial	37	Maximum voluntary contraction, strength development rate, power, functional strength	None	Yes	Cochrane Collaboration's Risk of Bias (RoB)
Rogan et al.,[13] Switzerland, 2017	Randomized controlled clinical trial	33	Dynamic balance	Static and functional balance	Yes	Cochrane Collaboration's Risk of Bias (RoB)

Note: AMQ = assessment methodological quality.

Table 3 - Evaluation of revisions by Assessing the Methodological Quality of Systematic Reviews (AMSTAR 2)

Systematic review	Sitjà-Rabert et al.[11]	Rogan et al.[12]	Rogan et al.[13]
1. Presents PICO?	No	Yes	Yes
2. Declare protocol? Record?	No	Yes	Yes
3. Explanation for study design selection?	No	No	No
4. Comprehensive search strategy?	Partially yes	Partially yes	Partially yes
5. Duplicate study selection?	Yes	Yes	Yes
6. Data extraction in duplicate?	Yes	Yes	Yes
7. Studies excluded list?	No	No	No
8. Description of included articles?	Partially yes	Partially yes	Partially yes
9. Bias risk assessment?	Yes	Yes	Yes
10. Sources of funding?	No	No	No
11. Appropriate methods for statistical combination (meta-analysis)?	Yes	Yes	Yes
12. Assessment of the potential impact of bias risk?	No	No	No
13. Did RoB evaluate individual studies to interpret/discuss review results?	Yes	Yes	Yes
14. Discussion of heterogeneity?	Yes	Yes	Yes
15. Proper investigation of publication bias?	No	Yes	Yes
16. Conflict of interest?	No	No	No

Note: PICO = patient, intervention, comparison and outcome; RoB = Cochrane Collaboration's Risk of Bias.

Only one review did not define language limitation overview,[13] while the other reviews restricted the language in the studies into English and German overview,[12] and English, French and Spanish overview.[11] Restrictions were not justified in any of the revisions. Two reviews assessed the risk of publication bias by presenting a funnel plot.[12,13]

The systematic reviews overview[11-13] included in this study yielded a total of 86 articles. Among these studies, 29 met the eligibility criteria of more than one included systematic review, of which three[14-16] were selected by all authors. WBV training was performed using three device categories: sinusoidal vertical, lateral alternating sinusoidal, and stochastic resonance overview.[10-12]

Training using WBV with sinusoidal vertical stimulation overview[11-13] used parameters with amplitude ranging from < 0.1 – 5.0 mm with frequency between 12 - 40 Hz for four to 77 weeks, with training ranging from two to five times per week; among these studies, one reported immediate effect without specifying the range used and one performed two sessions daily for four weeks. For WBV training with lateral alternating sinus stimulus overview,[11-13] the amplitude varied between 0.05 – 8.00 mm, frequency between 2.5 and 35 Hz, lasting five to 48 weeks, with a total of one to five sessions per week. Lastly, the training using stochastic resonance vibration overview[12,13] used a frequency ranging from 3 to 6Hz for four weeks, with three weekly sessions, with two of the studies being an immediate effect without specifying the amplitude used.

Discussion

Our overview found that evidence on the effectiveness of WBV training on muscle strength and risk of falls in the older adult population and the choice of the most appropriate protocol remain inconclusive due to the low methodological quality of the included systematic reviews.

The studies selected in this overview showed that WBV training can improve muscle strength and power when compared to a control group without intervention, as well as providing potential for postural balance gains, thereby reducing the risk of falls in older adults overview.[11-13] However, when compared to an exercise group, WBV training did not provide superior effects, leaving a gap in the true effectiveness of WBV training for this population overview.[11-13] Nonetheless, the authors believe that WBV training holds promise as an accessible and low-barrier intervention for older adults, particularly for those who may find conventional exercise programs challenging.[11-13]

Despite little evidence, studies have shown that WBV training is considered an easy-to-perform and high-adherence method for functionality-impaired individuals, such as older adults, and is estimated to be preparatory training to engage these individuals in conventional exercise programs overview.[11-13]

Muscle strength

Studies have shown that WBV training for at least eight weeks is effective in gaining muscle strength, mass and power, as well as reducing the risk of falls and improving mobility, positively contributing to quality of life and general health in older adults.[17] Confirming these findings, Tseng et al.[18] found that WBV training promoted increased muscle strength and balance performance, suggesting clear benefits for the functional health of older adults. In contrast, Bautmans et al.[14] found no positive effects on muscle strength and power in an older adult population after training, raising questions about the effectiveness of WBV in different contexts or demographic characteristics. Studies show that changes in muscle strength, mass, and power are directly related to functional disability, mobility deficit, and increased risk of falls in older adults.[19]

Risk of falls

Regarding the risk of falls, Leung et al.[20] demonstrated that WBV training reduced the incidence of falls, contributing to a decrease in the fracture rate in older adults. Similar results were observed in the stu dy by Pollock et al.,[21] who observed that WBV training reduced the number of falls, improved postural balance and gait, providing functional independence in these individuals. The study by Buckinx et al.[22] found no reduction in falls after WBV training in older adults, however they reported improvement in motor performance, suggesting that WBV might influence motor skills even if it doesn't directly affect fall incidence.

The incidence of falls is one of the main consequences of inefficiency of the muscular system, leading to increased morbidity and mortality, increased hospitalization rates and restricting the lives of older adults.[3]

Studies indicate that balance deficit, reduced muscle strength, and postural changes increase the risk of falls in older adults, resulting in inability to perform daily living activities, higher incidence of fractures and impaired functional independence of these individuals.[22]

WBV protocols

Regarding the protocol, studies indicate that WBV training is performed with amplitudes ranging from 0 to 12 mm, frequency between 1 and 60 Hz, in addition to variable training duration, type of device and adopted posture.[23] Training using a device which provides a lateral alternating sinusoidal and sinus vertical vibratory stimulus is able to promote increased activity of the extensor and flexor muscles, which stabilize the joints around the transverse and sagittal axis through a frequency range between 12 and 60 Hz and amplitude between 0 and 12 mm.[23] Studies that performed training with these types of devices showed positive effects in strength gain and muscle power, reducing the risk of falls in older adults.[24]

The study developed with stochastic resonance vibration, which promoted a three-dimensional vibratory stimulus, found increased muscle activity around the joints when a frequency variation between 1 and 12 Hz and amplitude between 0 and 12 mm were used.[23] Studies which used this type of vibration found positive results regarding improved functional performance, dynamic balance and strength development in older adults.[25,26]

Some authors suggest that the response of WBC training in older adults depends on the level of physical activity of these individuals, with better observed response to WBV training when they present lower physical performance level.[27] Thus, the exercise prescription for this population should take into consideration the level of physical activity of older adults to obtain an improvement in functional performance.[28]

Despite the diversity of parameters used by the studies, devices which promote sinusoidal, lateral alternating sinusoidal vertical vibration, and stochastic resonance stimuli were able to promote benefits in muscle strength, gait and postural balance, reducing the risk of long-term falls in older adults.[11-13] Despite the variety of WBV protocols and devices used between studies, the authors suggest further studies to establish a more effective training protocol for the outcomes evaluated for this population.[11-13]

Adverse effects

Adverse events after WBV training are poorly reported and considered transient and mild.[29] Studies have found erythema, edema, pruritus, pain located on the knees, lower back, quadriceps and gastrocnemius muscles after training, but none of these symptoms developed severely.[29] According to Abercromby et al.,[30] these symptoms can be prevented with slight knee flexion during training, enabling better responses using WBV. This suggests that with appropriate adjustments to posture and technique, potential adverse effects can be reduced, leading to more favorable outcomes.[29,30]

Limitations

Limitations were found during the development of this overview. First, the age group of the population was considered high, excluding systematic reviews that included individuals under 65 years of age. The intervention time was considered another limitation, as some studies considered the acute intervention of WBV. Thus, we can consider that the eligibility criteria in this overview may have minimized our results.

Implications for physiotherapy practice

The strength of the current overview is to present findings involving innovations and applications of the WBV in older population, and due to the characteristics of the intervention there are important perspectives when well established protocols were defined. The development of a specific WBV protocol for this population will promote the effective implementation of WBV in clinical practice, improving adherence to physical exercise, and contributing to improve the quality of life of these individuals.

Conclusion

This overview finds weak evidence of effectiveness on muscle strength and reduced risk of falls in older adults through WBV training. Due to the variability in study methodologies, it was not possible to establish the best protocol for implementing training in this population. Studies with better methodological quality need to be developed in order to define WBV protocols which promote benefits on the considered outcomes, as well as those which can report any possible adverse events of this training for this population.

Authors' contributions

AXPA and HKBF were responsible for the study conception; AXPA, HKBF, DNP and PEMM, for writing the manuscript; WSG and MBF, for data analysis and interpretation. All authors approved the final version.

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