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Effects of Whole Body Vibration on Muscle Strength and Quality of Life in Health Elderly: A Meta-Analysis

Efeitos da Vibração de Corpo Inteiro na Força Muscular e Qualidade de Vida em Idosos Saudáveis: Uma Meta-análise

Maíra Florentino Pessoa, Daniella Cunha Brandão, Rafaela Barros de Sá, Helga Cecília Muniz de Souza, Helen Kerlen Bastos Fuzari, Armele Dornelas de Andrade[*]

Universidade Federal de Pernambuco (UFPE), Recife, PE, Brazil

Abstract

Introduction: The literature presents different findings about the vibration training efficacy on muscle performance, even using protocols with similar parameters. **Objective:** The purpose of this systematic review was to investigate the effects of whole body vibration (WBV) on strength and quality of life in health elderly people, presenting a meta-analisys. **Methods:** PubMed, CINAHL, SciELO, LILACS and PEDro databases were systematically searched for studies that used WBV in healthy elderly. These searches were supplemented with material identified in references and a qualitative and quantitative analysis was performed to summarize the findings. The search was performed by two independent researchers with a third was selected to solve problems of search disagreement, data collection, and quality score. **Results:** Nine studies with strength outcome and two studies with quality of life outcome were identified, with sample ranging 21 to 220 elderly, all studies had control groups performing exercises or guidelines. Some studies have shown significant improvements in muscle strength, muscle power, vertical jump height, timed get up and go test and quality of life. **Conclusion:** The meta-analysis of the findings in these studies shows that WBV could benefit

[*] MFP: Doctoral student, e-mail: mairapessoa@yahoo.com.br
DCB: PhD, e-mail: daniellacunha@hotmail.com
RBS: MS, e-mail: rafaelabsa@hotmail.com
HCMS: Doctoral student, e-mail: helgamuniz@yahoo.com.br
HKBF: Doctoral student, e-mail: helen.fisio@uol.com.br
ADA: PhD, e-mail: armeledornelas@yahoo.com

health elderly, increasing muscle strength and improving the quality of life mainly in functional capacity. The number of publications found in the databanks searched is small, with limitations in design of protocols with a weakness to the interpretation of the findings, suggesting the need of investigation with WBV with well-designed protocols and controlled parameters into the effects of WBV training in elderly people.

Keywords: Whole Body Vibration. Muscle Strength. Quality of life. Aged.

Resumo

Introdução: *A literatura apresenta diferentes resultados sobre a eficácia do treinamento da vibração de corpo inteiro sobre o desempenho muscular, mesmo utilizando protocolos com parâmetros semelhantes.* ***Objetivo:*** *O objetivo desta revisão sistemática foi investigar os efeitos da vibração de corpo inteiro (VCI) sobre a força e a qualidade de vida em idosos saudáveis, apresentando uma meta-análise.* ***Métodos****: A busca ocorreu nas bases de dados PubMed, CINAHL, SciELO, Lilacs e Pedro visando estudos sobre o uso de WBV em idosos saudáveis. Essas pesquisas foram complementadas com material identificado nas referências e foi realizada uma análise quali-quantitativa resumindo os resultados. A pesquisa foi realizada por dois pesquisadores independentes, com um terceiro sendo selecionado para resolver problemas de desacordo na busca, coleta de dados e índice de qualidade.* ***Resultados:*** *Foram identificados nove estudos com desfecho força e dois estudos com desfechos na qualidade de vida, com amostras entre 21-220 idosos, todos com grupo controle recebendo orientações ou realizando outro tipo de exercício. Alguns estudos mostraram melhorias significativas da força e desempenho musculares, da altura do salto vertical, do teste Timed Up and Go e da qualidade de vida.* ***Conclusão:*** *A meta-análise dos resultados destes estudos indicam que VCI pode beneficiar idosos saudáveis, aumentando a força muscular e melhorando a qualidade de vida, principalmente na capacidade funcional. O número de publicações encontradas nas bases de dados pesquisadas foi pequeno, com limitações na concepção de protocolos com uma fragilidade na interpretação dos achados, sugerindo a necessidade de investigação da VCI com protocolos melhor desenhados e com parâmetros controlados na WBV em idosos.*

Palavras-Chave: *Vibração de Corpo Inteiro. Força Muscular. Qualidade de Vida. Idosos.*

Introduction

Vibration is a fast and oscillatory movement (1). It was first used therapeutically in the Soviet Union, in the prevention of hypotonia in cosmonauts. Initially used in segmental form, it evolved to the vibration of the whole body with the use of machines (2), with overall effect.

The Whole Body Vibration (WBV) is an alternative for resistance exercises (3 - 5), since stimulates muscle receptors through the vibratory tonic reflex (4, 6). This reflex is triggered by the oscillation of muscles and tendons, which causes small and fast changes in the muscle-tendon unit length. These changes are then detected by muscle spindles, which try to avoid muscle stretching by a reflex muscle contraction (6).

The high frequency and low amplitude vibration increases the gravitational force by changes in acceleration (7) benefiting bone morphology and promoting muscle toning (8). This mode of vibration can be used by groups with reduced tonus and mobility, as the elderly (7).

The aging process triggers a muscle, joint, and bone degradation process (9, 10), reducing muscle mass and strength up to 40% after the 40th life year (11). Although resistance exercises is the treatment of choice for the reduction of sarcopenia and increase of strength, it is considered a relatively aggressive training for the elderly, due to its wide range of motion and the risk of fractures and strains (12). WBV reduces the risks of weight-lifting training (13), although its effects are still poorly documented and little assessment has been done on the impact on the elderly's quality of life.

Systematic reviews about the specific effects of vibration on bone density (14 - 16), balance, strength, walk ability and functional mobility of the elderly are found in the literature (14 - 17). Although the latter has made a summarized assessment on muscle performance, it does not present a meta-analysis. The literature presents different findings about the vibration training efficacy on muscle performance, even using protocols with similar parameters (14 - 17).

The purpose of this systematic review was to investigate the effects of WBV on muscle strength and quality of life on healthy elderly people, presenting a meta-analysis.

Methods

Randomized or quasi-randomized clinical trials that assessing the vibrating platform effects on muscle strength or quality of life, in healthy aged 65 or over, both sexes were included, without linguistic or date restrictions. The search was performed by two independent researchers between December 15th to December to March 10th with pre-determined keywords and word crossing. The data were compared between researches, observing material disparity, inclusion/exclusion disagreement, and duplicity of studies. A third researcher was selected to solve problems of search disagreement, data collection, and score quality.

Search Strategy

The research was performed in the PubMed databases via Medline, Scientific Electronic Library Online (SciELO), Latin American and Caribbean Health Sciences Literature (LILACS), Cumulative Index to Nurse and Allied Health Literature (CINAHL) and Physiotherapy Evidence Database (PEDro), with adjustments in each database, including the following MeSH descriptors: (i) "Muscle Strength", (ii) "Aged" and (iii) "Quality of life". "Whole-body vibration" or variations, like "Whole body vibration" or "WBV", does not appear in MeSH and it was inserted as keyword in search.

The strategy used the following variations according to the databases: (muscle *strength* OR *strength* OR *force* OR *força* OR *fuerza*) AND (*aged* OR *elderly* OR *idosos* OR *ancianos*) AND (*quality of life* OR *qualidade de vida* OR *calidad de vida*) AND (*whole-body vibration* OR *whole body vibration* OR *WBV* OR *vibração de corpo inteiro* OR *vibraciones de cuerpo*).

Inclusion Criteria for Publication Selection

Controlled and randomized or quasi-randomized clinical trials were analyzed. The potentially eligible studies were assessed by title and abstract, observing strength by dynamometry or quality of life outcome by validated scales.

The WBV training was defined as global sinusoidal vibrations in any axis, non-stochastic, without restrictions on frequency, amplitude, magnitude and dosage (18). The control groups could exercise freely or be oriented. Were excluded studies with subjects diagnosed with any pathology, that using medication for increase muscle strength or follow-up studies.

Qualification of Studies

The qualification of the studies used on *The Cochrane Collaboration Reviewers' Handbook*, version 5.1.0 (19) that evaluates the risk assessment as high, low, or unclear bias, according to the methodological descriptions in each study. The assessed domains in papers were: selection (sequence random generation and allocation concealment), implementation (blinding of participants and evaluators), detection (blinding of each outcome), attrition (assessment of incomplete data), and data reporting (selective information). For judgment, the non-citation of process was considered as high risk, citation without clarification as obscure risk, and operation, description citation as low risk. The scores were independently measured by the researchers and compared.

Data Extraction and Analysis

The data extraction was independently done by the researchers, containing: title, author, year, number of participants, eligibility criteria, group characteristics, exclusions, intervention, and measurement of results. The data was summarized in tables and compared, being combined in a meta-analysis of fixed effect evaluation, after application of the Q Cochran Test (19) for heterogeneity.

Results

Qualitative Synthesis

From the 1912 potentially eligible titles, 1893 were excluded for not filling the inclusion criteria. From the remaining 19, after abstract or text reading, seven were excluded for duplicates, different outcomes, follow-up studies and presence of neuromuscular disease. One more study, Bogaerts, 2007, was excluded for using same sample as Bogaerts, 2009. From the remaining, nine studies verified outcome strength and two verified quality of life outcome (Figure 1).

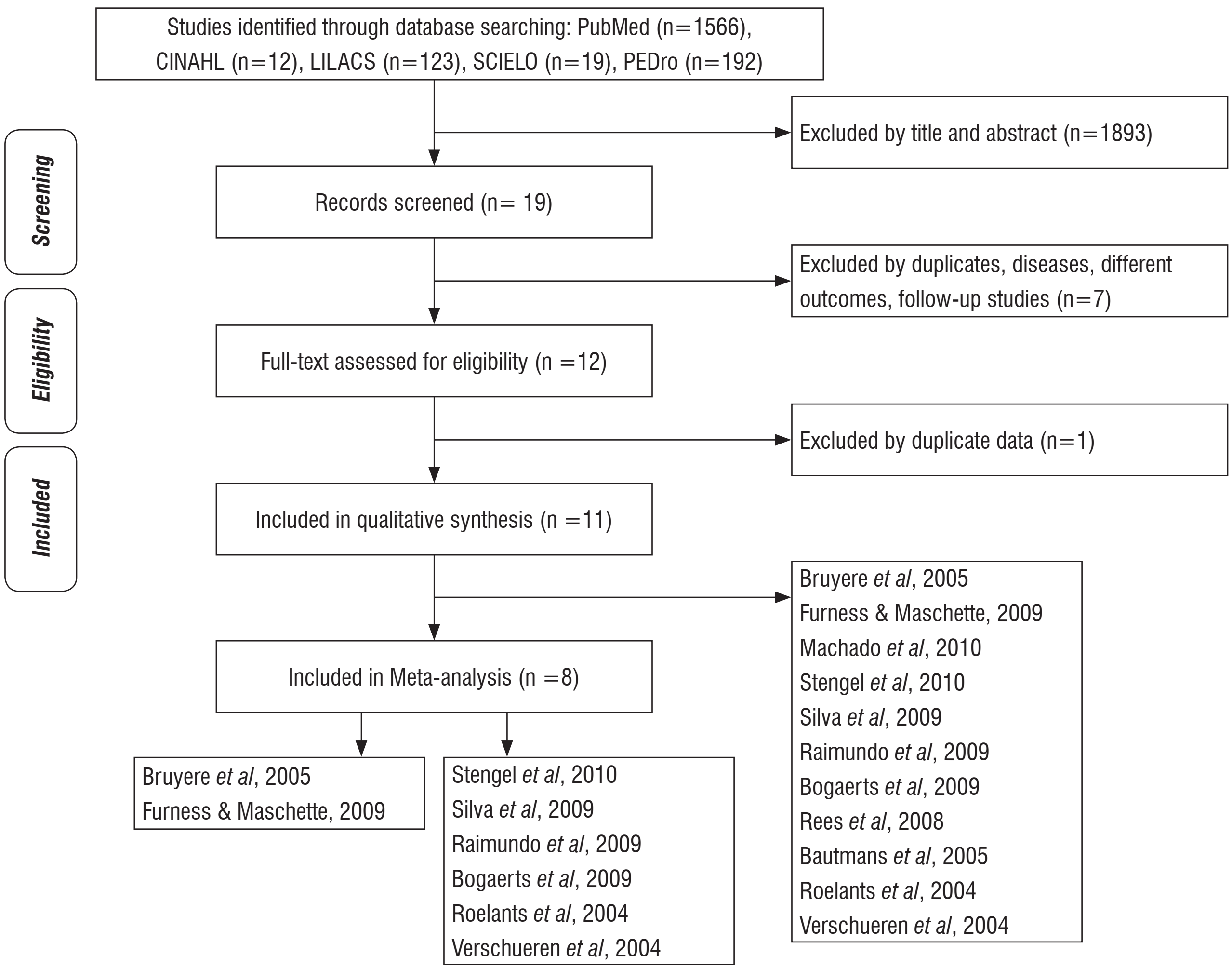

Figure 1 - Search and selection of studies for systematic review in accordance with PRISMA.

Strength Outcome

Among the nine studies, four were randomized with method description, four were called randomized but with no description and one was considered quasi-randomized. All of them had active or passive control group. Three studies were self-called blind, with only one describing the method. The studies were performed in Germany (20), Australia (21), Belgium (4, 22 - 24), Brazil (25), Spain (26), and Portugal (27). The population was only female (20, 22, 23, 26, 27), only male (4), or both genders (21, 24, 25). The sample sizes ranged from 16 to 220 people and the intervention length was from 1 1/2 to 12 months (Figure 2).

The WBV protocol varied in frequency and dosage. The interventions occurred twice a week, being in some studies three times a week (4, 21, 22, 23, 27). Vibration amplitudes ranged from 02 to 10 mm. Strength was measured with an isokinetic dynamometer and in two studies also with a handgrip (20, 24). Two studies did not present increase in strength outcome (24, 27). The remaining studies obtained significant increases in relation to the control groups, regardless these being active or passive.

Question: Should Whole body vibration vs control groups, performing exercises or guidelines be used for strength and quality of life in health eldely people?												
Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Whole body vibration	Control groups, performing exercises or guidelines	Relative (95% CI)	Absolute		
Muscle strength (follow-up mean 6 to 48 weeks; Measured with: Isokinetic dynamometer/handgrip; Range of scores: 0-15; Better indicated by higher values)												
9	randomised trials	serious[1]	no serious inconsistency	no serious indirectness	serious[1, 2]	none	157	167	–	MD 5.54 higher (0.43 to 10.65 higher)	⊕⊕○○ LOW	IMPORTANT
Physical function outcome in elderly (follow-up 6 to 12 weeks; Measured with: Short Form Health Survey (SF 36); Range of scores: 0-100; Better indicated by higher values)												
2	randomised trials	serious[2, 3, 4, 5, 6]	no serious inconsistency	no serious indirectness	no serious imprecision	none	32	30	–	MD 0.17 higher (0.68 lower to 0.33 higher)	⊕⊕⊕○ MODERATE	CRITICAL
Social function outcome in elderly (follow-up 6 to 12 weeks; Measured with: Short Form Health Survey (SF36); Range of score: 0-100; Better indicated by higher values)												
2	randomised trials	serious[3, 4, 5, 6]	no serious inconsistency	no serious indirectness	no serious imprecision	none	32	30	–	MD 0.73 higher (0.21 to 1.25 higher)	⊕⊕⊕○ MODERATE	CRITICAL
Role physical outcome in elderly (follow-up 6 to 12 weeks; Measured with: Short Form Health Survey (SF36); Range of score: 0-100; Better indicated by higher values)												
2	randomised trials	serious[3, 4, 5, 6]	no serious inconsistency	no serious indirectness	no serious imprecision	none	32	30	–	MD 0.84 higher (0.31 to 1.36 higher)	⊕⊕⊕○ MODERATE	CRITICAL
Role emotional outcome in elderly (follow-up 6 to 12 weeks; Measured with: Short Form Health Survey (SF36); Range of score: 0-100; Better indicated by higher values)												
2	randomised trials	serious[3, 4, 5, 6]	no serious inconsistency	no serious indirectness	no serious imprecision	none	32	30	–	MD 0.79 higher (0.27 to 0.31 higher)	⊕⊕⊕○ MODERATE	CRITICAL
Mental health outcome in elderly (follow-up 6 to 12 weeks; Measured with: Short Form Health Survey (SF36); Range of score: 0-100; Better indicated by higher values)												
2	randomised trials	serious[2, 3, 4, 5, 6]	no serious inconsistency	no serious indirectness	no serious imprecision	none	32	30	–	MD 0.41 higher (0.1 lower to 0.91 higher)	⊕⊕⊕○ MODERATE	CRITICAL
Vitality outcome in elderly (follow-up 6 to 12 weeks; Measured with: Short Form Health Survey (SF36); Range of score: 0-100; Better indicated by higher values)												
2	randomised trials	serious[3, 4, 5, 6]	no serious inconsistency	no serious indirectness	no serious imprecision	none	32	30	–	MD 0.78 higher (0.26 lower to 1.29 higher)	⊕⊕⊕○ MODERATE	CRITICAL
Pain outcome in elderly (follow-up 6 to 12 weeks; Measured with: Short Form Health Survey (SF36); Range of score: 0-100; Better indicated by higher values)												
2	randomised trials	serious[2, 3, 4, 5, 6]	no serious inconsistency	no serious indirectness	no serious imprecision	none	32	30	–	MD 0.12 higher (0.4 lower to 0.64 higher)	⊕⊕⊕○ MODERATE	CRITICAL
General health outcome in elderly (follow-up 6 to 12 weeks; Measured with: Short Form Health Survey (SF36); Range of score: 0-100; Better indicated by higher values)												
2	randomised trials	serious[2, 3, 4, 5, 6]	no serious inconsistency	no serious indirectness	no serious imprecision	none	32	30	–	MD 0.29 higher (0.21 lower to 0.79 higher)	⊕⊕⊕○ MODERATE	CRITICAL

[1] Among the 09 studies, 04 were randomized with method description, 04 were called randomized but with no description and 01 was considered quasi-randomized

[2] All confidence intervals touch the nullity line

[3] The two selected studies were classified as contrlled and randomized, although none of them have described the allocation method

[4] It was not randon sequence generations

[5] There was no blinding of participants, personnal, outcome assessment

[6] Incomplet outcome data

Figure 2 - GRADE of the studies.

Besides the strength outcome, the studies analyzed other variables such as functional capacity (24 - 27), cardiopulmonary function (4), frequency of falls (20), muscle power (21 - 23) and hip bone mineral density (23).

None of the studies reported adaptation difficulties or adverse effects related to WBV. The dropouts were due to external causes such as holidays or address change, liver cancer, breast surgery or placing of knee prosthesis. Most of the studies had a pre-treatment series for demonstration and adaptation to the WBV.

Quality of Life Outcome

The two selected studies were classified as controlled and randomized, although none of them have described the allocation method. The studies were performed in Belgium (28) and Australia (29). Both studies had male and female participants. The first lasted for 06 weeks and had 42 individuals (28), while the second lasted for 12 weeks and had 73 individuals (29).

The WBV protocol varied in the studies regarding the frequency dosage. In the first study (28), both groups performed exercises for stretching, gait and balance, transfer, and resistance for the lower limbs. In addition, the treatment group performed WBV three times a week, with four series alternating one minute of vibration and 90 seconds of rest. In the first and third series, the frequency was 10 Hz with amplitude of 03 mm. In the second and fourth series, the frequency was 26 HZ with amplitude of 07 mm. In the second study (29), the subjects were randomized for performing zero, one, two or three weekly sessions in a WBV prototype constructed by the researchers, with amplitude of 0,5 mm and frequency of 15 to 25Hz.

In both studies, the quality of life assessment was performed with The Short Form Health Survey (SF 36), which works with eight domains: vitality, physical functioning, bodily pain, general health perceptions, physical role functioning, emotional role functioning, social role functioning and mental health. Bruyere et al. (28) shows gains in the eight health domains, compared with the control group and besides evaluate balance with the Tinetti Test and motor ability with the Timed Up & Go Test. Furness and Maschette (29) compares the scale values to the control group, presenting improvement in vitality and emotional role functioning with WBV three times a week, and increased physical functioning with WBV once a week. It also assesses neuromuscular performance with the same tests and with the 5-Chair Stands Test.

None of the studies reported incompatibility or adverse effects directly related to vibration. However, two subjects quit treatment in the WBV group due to a tingling sensation in the lower limbs (28). Series of WBV adaptation or demonstration are not reported.

Table 1 - Methodological assessment of studies selected for the strength and quality of life outcomes according to Cochrane Collaboration Reviewer's Handbook, 5.1.0

LABEL
- + Low risk of bias
- ? Unclear risk of bias
- − High risk of bias

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Control group (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment: patient reported outcome (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)
Bautmans et al, 2005	+	+	+	+	−	?	+
Bogaerts et al, 2009	?	−	+	−	−	?	+
Stengel et al, 2012	?	−	+	?	−	?	+
Machado et al, 2010	?	−	+	?	−	?	+
Raimundo et al, 2009	+	−	+	−	−	+	+
Rees et al, 2008	+	−	+	−	−	?	+

(To be continued)

(Conclusion)

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Roelants et al, 2004	?	−	+	−	−	?	+
Silva et al, 2009	?	−	+	−	−	−	+
Verschueren et al, 2004	+	+	+	−	−	−	+
Bruyere et al, 2005	?	?	+	−	−	?	+
Furness, TP; Maschette, WE, 2009	?	?	+	−	−	?	+

Quantitative Synthesis

Strength Outcome

The results present clinical homogeneity, similar patients, identical investigation question, the same intervention and result measurement, with heterogeneity verified by Chi^2 = 3,09, which is considered methodological heterogeneity. Therefore, it was done a meta-analysis in order to verify the strength effect. The selection criterion for meta-analysis was training chronicity. Previous reviews mention as chronic training periods of three or more months (14, 15), and only such studies were included in the meta-analysis. These studies included 324 individuals, 157 using WBV as treatment and 167 participating actively or as control (Figure 3).

Muscle Strenght outcome

Study or Subgroup	Treatment Mean	Treatment SD	Treatment Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Fixed, 95% CI
Bogaerts, 2007	177.3	66.8	31	165.2	6.7	36	4.7%	12.10 [-11.52, 35.72]
Kemmler, 2009	72.6	17.5	39	70.1	20	47	41.6%	2.50 [-5.43, 10.43]
Raimundo, 2009	46.8	10.8	14	43.6	14.6	13	27.5%	3.20 [-6.55, 12.95]
Roelants, 2004	161	48	24	150	30	25	5.2%	11.00 [-11.52, 33.52]
Silva, 2009	88.2	60.4	24	86	31	23	3.5%	2.20 [-25.08, 2948]
Vershueren, 2004	128	22	25	114.3	21.1	23	17.6%	13.70 [1.50, 25.90]
Total (95% CI)			**157**			**167**	**100.0%**	**5.54 [0.43, -10.65]**

Heterogeneity: Chi^2 = 3.09, df = 5 (P = 0.69); I^2 = 0%
Test overall effct: Z = 2.12 (P = 0.03)

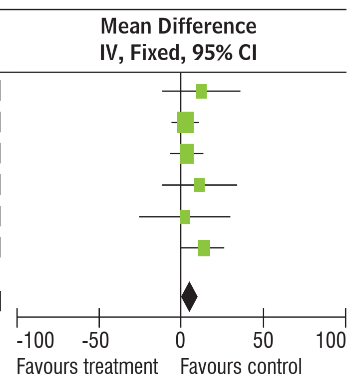


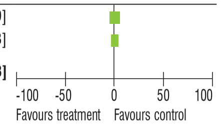
Figure 3 - Forest Plot studies of meta-analysis for muscle strength outcome.

Quality of Life Outcome

Both studies presented the same intervention, in the same group, with result measurement done in identical form, using the SF 36 for measuring quality of life. In the quantitative evaluation, 30 individuals were evaluated for the control group and 32 for the WBV group. As the questionnaire outcomes are eight, eight evaluations were performed (Figure 4).

Study or Subgroup	Treatment Mean	Treatment SD	Treatment Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Fixed, 95% CI
Bruyere 2005	18.5	13.9	22	24	11.6	20	67.6%	-0.42 [-1.03, 0.19]
Furness & Maschette 2009	71	21	10	64	18	10	32.4%	0.34 [-0.54, 1.23]
Total (95% CI)			**32**			**30**	**100.0%**	**-0.17 [-0.68, 0.33]**

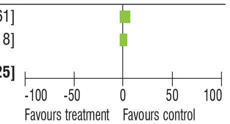
Heterogeneity: Chi² = 1.93, df = 1 (P = 0.16); I² = 48%
Test overall effct: Z = 0.67 (P = 0.50)



FUNCTION CAPACITY OUTCOME

Study or Subgroup	Treatment Mean	Treatment SD	Treatment Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Fixed, 95% CI
Bruyere 2005	19.9	17.6	22	2.6	17.5	20	65.3%	0.97 [0.32, 1.61]
Furness & Maschette 2009	86	21	10	79	24	10	34.7%	0.30 [-0.59, 1.18]
Total (95% CI)			**32**			**30**	**100.0%**	**0.73 [0.21, 1.25]**

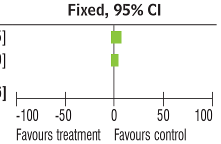
Heterogeneity: Chi² = 1.44, df = 1 (P = 0.23); I² = 31%
Test overall effct: Z = 2.77 (P = 0.006)



SOCIAL FUNCTION OUTCOME

Study or Subgroup	Treatment Mean	Treatment SD	Treatment Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Fixed, 95% CI
Bruyere 2005	36.3	30.9	22	5.2	29.6	20	65.7%	1.01 [0.36, 1.65]
Furness & Maschette 2009	83	24	10	70	25	10	34.3%	0.51 [-0.39, 1.40]
Total (95% CI)			**32**			**30**	**100.0%**	**0.84 [0.31, 1.36]**

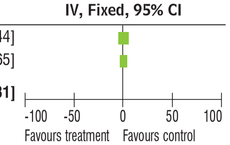
Heterogeneity: Chi² = 0.79, df = 1 (P = 0.38); I² = 0%
Test overall effct: Z = 3.13 (P = 0.002)



ROLE PYHYSICAL OUTCOME

Study or Subgroup	Treatment Mean	Treatment SD	Treatment Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Fixed, 95% CI
Bruyere 2005	31.7	38.2	22	1.7	34.2	20	67.6%	0.81 [0.18, 1.44]
Furness & Maschette 2009	89	22	10	66	36	10	32.4%	0.74 [-0.17, 1.65]
Total (95% CI)			**32**			**30**	**100.0%**	**0.79 [0.27, 1.31]**

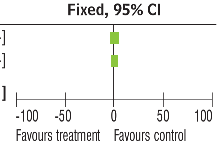
Heterogeneity: Chi² = 0.02, df = 1 (P = 0.90); I² = 0%
Test overall effct: Z = 2.97 (P = 0.003)



ROLE EMOTIONAL OUTCOME

Study or Subgroup	Treatment Mean	Treatment SD	Treatment Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Fixed, 95% CI
Bruyere 2005	10.1	17.1	22	2.5	17.8	20	67.6%	0.43 [-0.19, 1.04]
Furness & Maschette 2009	79	16	10	73	16	10	32.4%	0.36 [-0.53, 1.24]
Total (95% CI)			**32**			**30**	**100.0%**	**0.41 [-0.10, 0.91]**

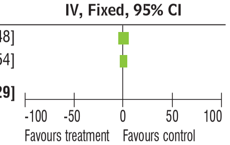
Heterogeneity: Chi² = 0.02, df = 1 (P = 0.90); I² = 0%
Test overall effct: Z = 1.58 (P = 0.11)



MENTAL HEALTH OUTCOME

Study or Subgroup	Treatment Mean	Treatment SD	Treatment Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Fixed, 95% CI
Bruyere 2005	15	15.7	22	3.6	9.9	20	67.0%	0.84 [0.21, 1.48]
Furness & Maschette 2009	70	16	10	60	14	10	33.0%	0.64 [-0.27, 1.54]
Total (95% CI)			**32**			**30**	**100.0%**	**0.78 [0.26, 1.29]**

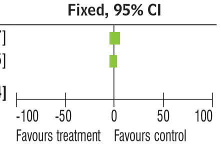
Heterogeneity: Chi² = 0.13, df = 1 (P = 0.71); I² = 0%
Test overall effct: Z = 2.93 (P = 0.003)



VITALITY OUTCOME

Study or Subgroup	Treatment Mean	Treatment SD	Treatment Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Fixed, 95% CI
Bruyere 2005	15.2	22.5	22	3.6	9.9	20	70.3%	0.64 [0.02, 1.27]
Furness & Maschette 2009	70	19	10	88	11	10	29.7%	-1.11 [-2.07, -0.15]
Total (95% CI)			**32**			**30**	**100.0%**	**0.12 [-0.40, 0.64]**

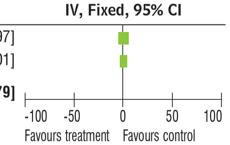
Heterogeneity: Chi² = 9.07, df = 1 (P = 0.003); I² = 89%
Test overall effct: Z = 0.46 (P = 0.65)



PAIN OUTCOME

Study or Subgroup	Treatment Mean	Treatment SD	Treatment Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Fixed, 95% CI
Bruyere 2005	7.5	25.7	22	0	11.8	20	67.4%	0.36 [-0.25, 0.97]
Furness & Maschette 2009	68	15	10	66	14	20	32.6%	0.13 [-0.75, 1.01]
Total (95% CI)			**32**			**30**	**100.0%**	**0.29 [-0.21, 0.79]**

Heterogeneity: Chi² = 0.18, df = 1 (P = 0.67); I² = 0%
Test overall effct: Z = 1.12 (P = 0.26)



GENERAL HEALTH OUTCOME

Figure 4 - Forest Plot studies of meta-analysis for quality of life outcome, eight domains.

Discussion

Despite the low methodological quality of the studies, the quantitative analysis suggests that WBV training is effective for the improvement of strength in the elderly, with good statistic power, with chances of being an alternative for resistance training. Some methodological considerations should be recognized. This study is the sum of single results of randomized and quasi-randomized clinical trials and reflects their quality. In this sense, it should be noted the low methodological quality of the selected clinical trials, most of them lacking sample size calculation, concealment description or randomization method or blinding method in the outcome analysis.

For the strength outcome, the evaluation was performed with isokinetic dynamometry, considered an evaluation method that generates objective data, high sensibility, reproducibility and specificity for the strength and balance measurement of muscle groups. Furthermore, it is a low cost and fast implementation method (30 - 32). The isokinetic strength evaluation is considered the best method for determining the functional pattern of muscle strength and balance, that way the subject performs maximal or submaximal contraction, which adapts itself to the device resistance (33 - 35).

The estimate following the statistic combination of the clinical trials pointed to the presence of benefits for the strength outcome, according to the graph, although in all studies the confidence interval has touched the no effect line (Figure 3).

In a quantitative analysis, a couple of studies (24, 27) do not show increase in strength outcome with p_{value} < 0,05. Despite having the best methodological quality, Bautmans's study (24) was performed in the shortest time, just 1.5 months, while the others ranged from 02 to 12 months. The WBV is an unspecific training operating in a mechanism that includes slow physiological adaptations, which is the case of strength improvement. Therefore, for an effective outcome, it should last slightly more than the specific training, which occurs around 1.5 to 2 months. As a specific protocol for WBV is not available yet, studies with any training time, acute or chronic, were included, but only the latter ones were part of the meta-analysis, assuming that the strength outcome, if present, would occur only after a chronic period of training.

Another possible variant in this study outcome may have occurred due to pre-existing differences between the intervention and control groups. The strength outcome varies widely, being the WBV group initial strength 270.0 ± 203.8 Newtons, against 375.2 ± 253.8 Newtons in the control group. Even considering the standard deviation values, there is a big difference in the basal values, what could explain the final difference in the outcomes of the two groups.

Raimundo et al. (27) also does not increase of strength in the groups (vibration/walks) according to the isokinetic dynamometry, although it notes significant positive values when measuring stand up speed, 4 meter walking speed and vertical jump height in relation to the pre-test. This means that although the gains have not been identified in numerical terms, functional capacity has improved. Besides, exercises like walks and low frequency vibration result in electromyographic activity of low to moderate amplitude, what can justify the lack of results in the isokinetic strength, once it requires high electromyographic activity (36 - 38).

Still in this study (27), comparing the walking and WBV groups, it was observed an improvement in the muscle strength associated to daily activities (walk, sit or climb stairs) essential for postural stability (33), while the WBV program improved the jump explosive strength associated to a fast muscle contraction, important to fall prevention in the elderly.

The other studies (4, 20, 21, 22, 23, 25, 26) present an increase in the strength outcome. These findings reinforce the theory that WBV is an option which produces adaptive results similar to resistance training (3, 6) leading to improvement of strength. In theory, the WBV improves neuromuscular efficiency by fast activation of response circuits to changes in muscle position and promotion of direct action upon contraction, in such a way that it would increase voluntary movement efficiency (39 - 41).

In quality of life, although the means have shown significant increases, at least in functional capacity, the graphs for each outcome do not make these results clear. In Bruyere's study (28) the differences between the means and standard deviations are big, what interferes in the final graph result. In the second study, Furness and Maschette (29) results had smaller standard deviations, however, their sample had only ten subjects training three times a week. The small number of individuals and the big standard deviation do not permit the diamond visualization in the meta-analysis (Figure 4).

Vibration proved to be an exercise well accepted by the elderly and with no adverse effects. The low to moderate frequency vibration safety is normatized by ISO 2631-1, 1997 (18). Although a training protocol has not been created yet, all studies were performed according to safety parameters concerning exposition time and frequency of the device.

Conclusion

Despite the low methodological quality of the studies, the quantitative analysis suggests that WBV training is effective for the improvement of strength in the elderly, with good statistic power, with chances of being an alternative for resistance training, once there is no need of active contraction. Its use is technically easy and shows positive and fast results, being one more alternative to the therapeutic arsenal that can slow down the decrease of strength in the elderly. Regarding quality of life, the WBV was effective only in improving physical functioning. The recommendation is that there is evidence for WBV application in the studied outcomes, although further studies are needed to evaluate other effects such as cardiopulmonary and hormonal functions, because being a global training, could promote changes in the physiology of several systems.

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