

ORIGINAL ARTICLE

The effects of whole-body vibration on cognition: a systematic review

Ana Clara de Souza Freitas^b, Juliana Ferrari Gaspar^b, Giovanna Calixto Rossi Marques de Souza^a, José Hugo Inamonico^a, Cynthia Kallas Bachur^a, Ana Carolina Coelho-Oliveira^c, Danúbia da Cunha de Sá Caputo^c, Redha Taiar^e, Mario Bernardo Filho^c, Anelise Sonza^d, José Alexandre Bachur^a



^aUniversidade de Franca;

^bUniversidade do Estado do Rio de Janeiro;

^cUniversité de Reims Champagne-Ardenne;

^dUniversidade do Estado de Santa Catarina

Corresponding author
anasoitas@hotmail.com

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Abstract

Purpose: To systematically review the mechanisms by WBV improves the ability to learn, think, memorize and all other processes involving cognition.

Methods: The present study collected data from three databases using the keywords “whole-body-vibration” and “cognition”. Randomized clinical trials focusing on the association of WBV and cognition were considered. The study was registered in the database of systematic reviews protocols PROSPERO. All included studies used healthy patients, exposed to WBV. The included articles were obtained regarding the risk of bias according to the Cochrane Collaboration criteria, level of evidence and strength of recommendation following the GRADE and Oxford classification.

Results: Of the 89 articles published to the eligibility criteria, four were submitted to data extraction. Cognitive parameters were improved in relation to attention, memory or learning in almost all articles evaluated in this systematic review.

Conclusion: Intervention with WBV would positive effects on individuals’ cognitive ability, although further randomized investigations must be conducted. PROSPERO registration number: CRD42020203679

Keywords: exercise, learning, memory, attention, vibratory.

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Authors summary

Why was this study done?

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What do these findings mean?

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INTRODUCTION

The benefits of physical activity on the cardiovascular and musculoskeletal systems have solid evidence. More recently, this has been associated with improved cognitive functions, as well as the activation of areas of the central nervous system related to attention, memory, emotions and learning, such as the prefrontal cortex and amygdala¹. Both active physical exercises such as running, aerobic and sports in general, passive as for example as whole-body vibration (WBV) exercises have such effects².

Although the exposure of the organism to mechanical vibration (MV) can be harmful, it is estimated that the interventions with MV generated on vibrating platform have benefits both on process of physical rehabilitation and on improvement of physical performance, a fact that has been the objective of various studies³⁻⁵, but biomechanical and other parameters must be considered.

It is emphasized that the body's sensitivity to MV is linked to several structural and functional factors, such as posture and muscle tension, as well as the frequency, amplitude, direction of the MV and time of exposure⁵. When considering the fact that human organs naturally have a vibratory pattern that occurs in a frequency spectrum ranging from 5 to 20Hz, it is assumed that when the body is subjected to vibrations within this range, there may be a possibility of resonance and potential damage to the organs, being safer and possible to observe adaptive effects on different body structures in vibratory exposures in arange between 20 and 70 Hz. However, MV above 70 Hz, especially for prolonged periods, increases the risk of incidence of structural damage⁶.

The MV generated on vibrating platform, producing WBV exercise, can be considered stressful stimuli to the individual that is in contact with the device. In consequence, responses mediated by the nervous system, through neural structures, from the activation of the respective receptors, such as the muscle spindle, among others⁶. It was postulated that the physiological effects resulting from the vibration stimulation of the whole body should be categorized into the functions: cardiovascular, respiratory, endocrine and metabolic, motor, sensory and musculoskeletal⁵.

Based on the analysis of different studies, it was observed that subsequent to the therapeutic use of WBV in the elderly, there is an improvement in the functionality of these individuals, associated with improved balance, agility and quality of gait, in addition to increased muscle strength³, including that person with physical-functional sequel to a stroke⁷. In addition, an increase in mean blood flow associated with a reduction in peripheral vascular

resistance in lower limbs of healthy adults subjected to WBV, as well as an acute increase on plasma concentrations of testosterone and growth hormones, and a reduction in cortisol in males submitted to the same type of vibratory stress⁴. It was also found that this stimulation model causes improvement in the inspiratory capacity, in the respiratory strength and quality of life of the elderly⁸.

Whole Body Vibration Platform (WBV) models allow vibration to be applied vertically and laterally alternating or transmitting / transmitting vibration. Waves are defined according to their intensity, amplitude, waveform, whether sinusoidal or vertical, and frequency frequency (usually between 20-60Hz). During how the patient can remain standing, sitting, desired or still perform some type of dynamic activity, the number of combinations and the time of exposure to vibration may be variable⁹.

Considering the effects resulting from WBV in the organism, it allows inferring about the possibility that these effects may have an influence on the functioning of the central nervous system with a range of different functions, such as cognitive capacity, as indicated in some publications⁸.

Cognition is defined as an act or process of acquiring knowledge, which involves sub or conscious mental aspects based on sensory experimentation, memory, learning and formulation of thoughts¹⁰. The study of cognitive and learning processes has both the psychopedagogical side and the neuroscience side. This second one tries to pragmatize and establish anatomophysiological correlations. The evolution of neuroimaging techniques has led to discoveries about the neural circuits and brain areas involved in the formation of thinking and the development of cognition¹¹.

Explaining cognition circuitally as a single process is extremely complex, so it is more illuminating to understand it as an integration of sensory perception, attention, memory and its efferences as language and executive functions^{11,12}. These integrated circuits have high adaptive capacities through neuronal cells, which, despite not undergoing mitosis throughout life, that are known as neuroplasticity and involve both neuro and synaptogenesis and angiogenesis processes, thus increasing the metabolic input and reinforcing a certain neural pathway in detriment of others¹².

Considering evidences of association between WBV therapy and its effects on the cognitive capacity, this systematic review aims to assess effect about this therapy available in the literature.

METHODS

This systematic review followed the recommendations proposed by PRISMA (Main Items for Reporting Systematic Reviews and Meta-analyses)¹³.

The decision for the theme of the persistent meeting was due to the importance of cognitive capacity in the development of the individual in society. Associated with this, the fact that the knowledge about the vibratory patterns of the body and the environment in which it is inserted, demonstrate that vibratory stimuli can be facilitators or not, of the corporal functioning.

Since the beginning of the process of designing this study, we have chosen to include only randomized studies, as we consider the best strategy for verifying the evidence regarding the influence of the WBV exercise on cognitive capacity, depending on the greater methodological rigor. Although, depending on the type of population to be studied, non-randomized clinical studies may also contribute significantly to the proper understanding of the facts related to the subject.

Search strategy: It is a study of systematic literature review, motivated and developed from a clinical question, structured based on the acronym PICO (Patient, Intervention, Comparison and Outcomes)¹⁴⁻¹⁷: what is the effect of whole-body vibration therapy in cognition? From which the scientific keywords were extracted, identified with the definer (DeCS) Terms (<http://decs.bvs.br/>) and definir (MeSH) Terms (<https://www.ncbi.nlm.nih.gov/mesh/>) systems as: “whole-body-vibration” AND “cognition”

Searches for scientific documents were carried out (July 2020) in the PubMed (Medline) (<https://www.ncbi.nlm.nih.gov/pubmed/>), Scopus (<http://www.scopus.com>) and EMBASE (<https://www-embase.ez67.periodicos.capes.gov.br/>) using the aforementioned keywords interspersed by the Boolean Operator ‘AND’.

Eligibility criteria and study selection: As eligibility criteria only randomized clinical trials with humans adults or elderly, with or without mental or neurological disorders were be included, considering the cognition related to the abilities to learn, think and memorize of these individuals. There was no language restrictions. However, animal studies, absence of approval by the ethics committee and use of other methodologies besides the vibrating platform (incorrect methodology), studies published before the year 2000, in addition to studies unrelated to the main objective was considered the reason for exclusion, as well as studies that do not allow the complete identification of the control group. The selection of the inclusion and exclusion criteria mentioned was carried out according to the principles proposed in the specialized literature^{17,18}, for the purpose of guidance and objectivity in the document screening process.

The identification of duplicates between the related documents in the different databases was carried out using the application Qatar Computing Research Institute (Rayyan QCRI) (<https://rayyan.qcri.org/welcome>)¹⁹. After performing the duplicate exclusion, the reviewers (JAB, ACSF, ACCO), individually performed the selection of the documents, based on the eligibility criteria described

above. Regarding those documents in which there was a discrepancy in selection between the reviewers, they were reevaluated and the decision on the selection was made by consensus, as recommended in the literature¹⁸.

Data related to primary or secondary variables, such as: types of study, participants and intervention, as well as the proposed examination methods, were selected and extracted independently among the examiners of the present study, in order to avoid bias during the process data extraction. In cases where there was a discrepancy between the reviewers, it was resolved by consensus between them^{16, 18}.

Grey literature (or gray literature) (materials, documents and research produced by organizations outside of the traditional commercial or academic publishing) were not considered in this review.

Registration data: At the end of the document selection process (October 2020), and prior to data extraction, this review study was registered with the database of systematic reviews protocols called Prospective Register of Ongoing Systematic Reviews (PROSPERO) (<https://www.crd.york.ac.uk/prospero>) with the number of registration CRD42020203679^{16, 18-21}.

Extraction data: The data (October 2020) chosen to be extracted considered aspects subdivided into: sociodemographic data (average age of the participants, sample space²², proportionality between genders and comorbidities),

Data extracted regarding technical aspects of WBV exercise application were determined from Reporting Guidelines for Whole Body Vibration Studies in Humans, Animals and Cell Cultures: A Consensus Statement by an International Expert Group⁸ (patterned of the vibratory stimulus, body positioning during the vibration, vibration protocol (intensity and duration), periodicity of stimulation and operational devices.

The outcome data (cognition assessment tool, cognitive framework (memory, attention, learning and / or others, positive, adverse and other effects).

Bias risk assessment: The evaluation of the risk of bias of documents (figure 2) was carried by the electronic system developed by a Microsoft Excel spreadsheet editor, based on the criteria of the Cochrane Collaboration for the Development of Systematic Intervention Reviews, version 5.1 with free online access through the website (<http://www.cochrane-handbook.org/>). The analysis of the risk of bias in clinical trials was carried out based on the evaluations of the domains of selection, performance, detection, follow-up, reporting and others. Considering the variation in the bias classification as: high, uncertain and low²³.

Evidence level and recommendation strength evaluation: The evaluation of level of evidence and strength recommendation of this articles was made by using the Oxford and Grade scales. It divides the studies into eight levels (1a, 1b, 1c, 2a, 2b, 2c, 3a, 3b, 4 and 5) according to five parameters therapy, prevention

and aetiology, harm, prognosis, diagnosis, differential diagnosis or symptom prevalence study and economic and decision analyzes²². On Grade scale there are four levels of evidence: very low, low, moderate and high. Evidence from randomized controlled trials begins with high quality and, due to residual confusion, evidence that includes observational data is inserted as a low level of evidence, for example²⁴.

RESULTS

Literature search results: From the identification of documents in the databases (PubMed, Scopus and EMBASE) to the exclusion step, the process of selection, inclusion and exclusion of the documents to be analyzed is described in the flowchart (figure 1).

A total of 89 articles were retrieved from the electronic databases. After removing 35 duplicates, and from the 54 left articles, 5 randomized clinical trials has been included. The main reasons for exclusion has been wrong population (studies with animals), not related to the main objective, not randomized clinical trials and wrong methodology.

Description of the included studies: The extraction of data from the included studies is available in table 1, 2 and 3, subdivided into sociodemographic data, intervention data and the outcomes of each of them.

Study population: two hundred and thirteen individuals participated in the studies of the selected publications distributed in Paddan (2012)²⁵ with a sample of 20 participants (50% female and 50% male), Regterschot (2014)²⁶ with a total sample of 145 (20% male and 80% female), Amonette (2015)²⁷ with 12 obligations (66.6% male and 33.3% female) and Boerema (2018)²⁸ with 36 participants, all healthy, without comorbidities, they are a history of gastrointestinal, musculoskeletal disorders, color blindness or neuropsychiatric diseases.

Intervention and outcomes: Paddan's study (2012), in which the vibration pattern was vertical, with frequencies ranging from 2 to 20Hz, with the individual seated (where) and the back in varying degrees of inclination, exposed to sessions of about 30-40 minutes (3 minutes being vibration), revealed that there was no

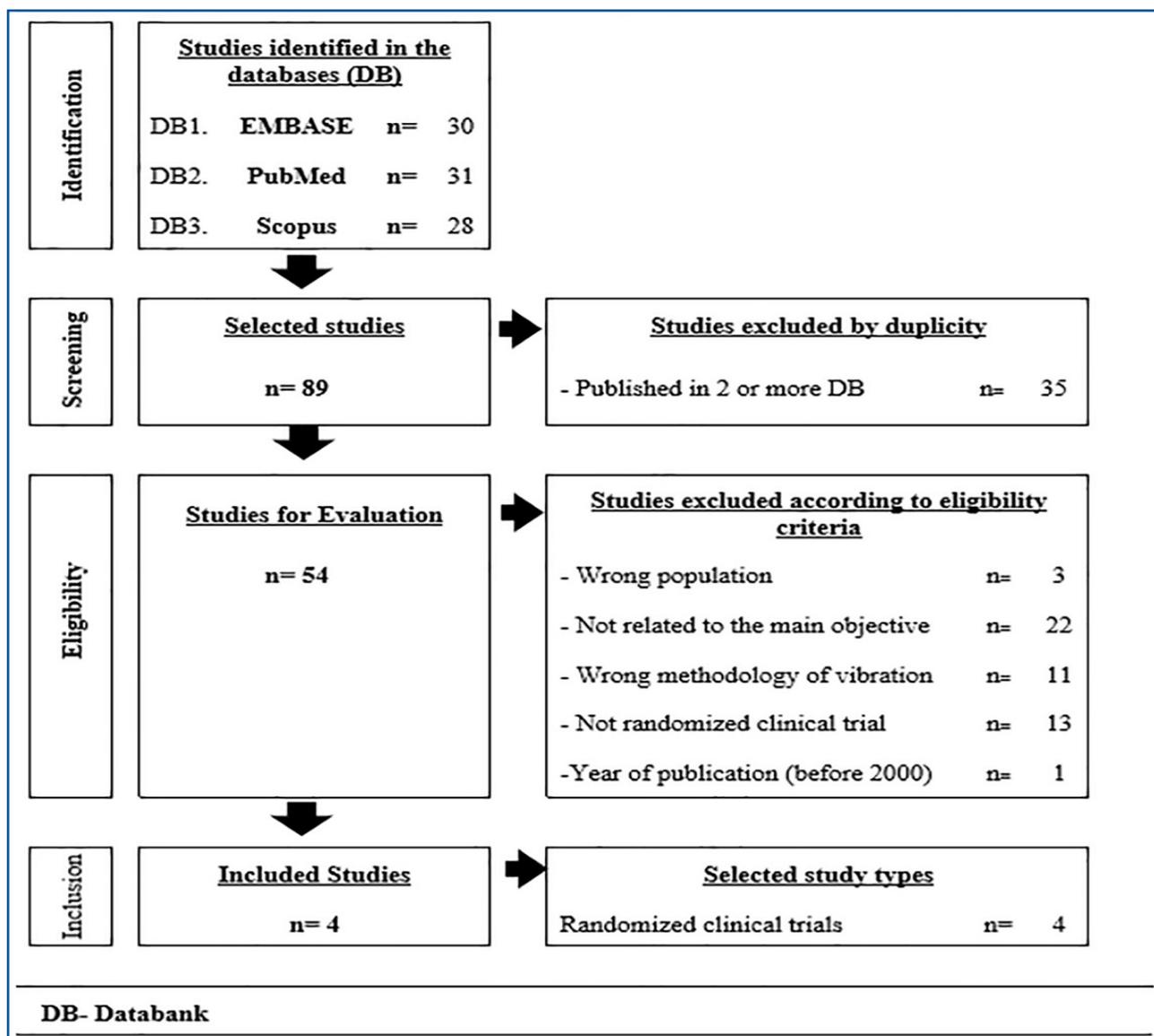


Figure 1: Flowchart of the selection and inclusion process of scientific documents for analysis

impairment in cognitive performance in the most diverse situations of exposure to vibration when compared to the control and even participants exposed to 45 ° inclination and 14-20Hz vibration had better performance. Despite this, vibration proved to be a hindrance to the performance of visual control activities and manual tasks²⁵.

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Tabel 1: Sociodemographic Data

		Average age of participants, in Years	Sample number (N)	Sex/ Proportion	Considerations about the presence of comorbidities
A1	Paddan GS et al, (2012)	F: 33.8 + 8,5 M: 29.0 +10.2	20	F: 50% (10) M: 50% (10)	Good health. No history of back or gastrointestinal disorders
A2	Regterschot GR et al, (2014)	Epi: 22.8 + 1.5 EPr: 20.5 + 2.2	Epi: 12 EPr: 133	Epi: F=4 M=8 EPr: F=112 M=21	No history of color blindness, neurological or psychiatric illness
A3	Amonette WE et al, (2015)	28.2 (+/- 6.4) Years	12	F: 4 M: 8	Healthy, active
A4	Boerema AS et al, (2018)	Experimental group:65.8 years (42-99) Control:66.0 years with (45-90)	34	F: 61.1%	Healthy, >40 years without cognitive impairments

Female (F); Male (M); Pilot Study (Epi); Main Study (EPr).

(2014)²⁵ with a total sample of 145 (20% male and 80% female), Amonette (2015)²⁶ with 12 obligations (66.6% male and 33.3% female) and Boerema (2018)²⁷ with 36 participants, all healthy, without comorbidities, they are a history of gastrointestinal, musculoskeletal disorders, color blindness or neuropsychiatric diseases, as described in table 1.

In Regterschot (2014), in which the vibratory pattern was vertical and sinusoidal, with a frequency of 30Hz and the participants were placed in a sitting position

and exposed for 2 minutes, varying only the sequence of the cognition tests, it was concluded that the vibration has an effect positive in executive functions, but for a short period after exposure, thus raising a possible applicability of passive vibration in the therapy of individuals with cognitive deficits and unable to perform physical exercises²⁶.

Tabel 2: Intervention Data

	Vibrating Stimulus Pattern	Body positioning during vibration	Vibration Protocol - Intensity and Duration	Stimulation Periodicity	Operating devices
A1	Vertical vibration	Seated with seat back angles at 90° (vertical), 67° 45°, 22° and 0° (bench press).	4 test stimuli: Frequency: 0 Hz (without vibration), 2–8 Hz; 8–14 Hz and 14–20 Hz, Vibration magnitude of 2.0 m / s ² Duration: each session 18 minutes Total session duration: 30-40min	Once a day Duration 6 days 1st Day: pre-test training and familiarization 5 Days: 5 experimental sessions where participants were exposed to all four vibration frequencies.	Servotest man-rated vibration device Endevco Q-Flex QA-116-15 accelerometer. LCD display 255X190 mm high, approximately 600 mm away from the participant's eyes, angle of approximately 0.28.

Continuation - Tabel 2: Intervention Data

	Vibrating Stimulus Pattern	Body positioning during vibration	Vibration Protocol - Intensity and Duration	Stimulation Periodicity	Operating devices
A2	Vertical and sinusoidal vibration	Sitting on the chair, with his arms on the armrests and feet on the wooden board.	Frequency: 30 Hz, Amplitude: approximately 0.5 mm Duration: 2 minutes CBT + CWIT + DSBT before starting the experiment AFTER WBV or control followed by CBT, CWIT and DSBT AFTER 3 sessions of WBV + 3 control followed by CBT and CWIT before DSBT AFTER 3 sessions of WBV + 3 control followed by DSBT before CBT and CWIT	6 passive WBV sessions and 6 control sessions Duration 12 sessions	Vibration device (Vibe 300 from Tonic Vibe, Nantes, France), Accelerometers (tri-axial accelerometers, model 3093B, Dytran Instruments Inc, Chatsworth, CA, USA)
A3	Vertical and alternating vibration	Static squat (feet 20.6 cm apart, with 45° knee flexion)	Frequency: 30 Hz Peak to peak displacement: 4 mm 5 series Duration: 2 minutes each series Interval: 1 minute Total duration WBV: 10 min	4 different days with 4-13 days interval	VV: Power Plate vibration platform (Power Plate North America, LLC, Culver City, CA, USA) RV: Galileo 2000 vibration platform (Orthometrix, Inc., White Plains, NY, USA).
A4	Vertical	Sitting on the chair with their back against the back back of the chair, their arms on the rests, and their feet (without shoes) on the surface of the platform	Frequency: 30Hz Amplitude: 0,5-1mm 4 minutes per session	4 sessions per week, during 5 weeks	Developed by Pactive Motion (type Rolstoelpod)

Hertz (Hz); Whole-body vibration (WBV); troop Color-Block Test (CBT); Stroop Color-Word Interference Test (CWIT); Stroop Difference Score(SDS); Digit Span Backward task (DSBT); Rotational Vibration (RV); Vertical vibration (VV).

Table 3: Outcomes Data

	Cognitive Referential	Assessment Tool: Memory (1), Attention (2), Learning (3) and / or others (4)	Positive Effects	Adverse Effects	Other Effects
A1	Mental demand using NASA-TLX subscales	2 and 4	The angle of the seat back under various conditions of vibration of the whole body does not negatively affect cognitive performance 45 ° + 14-20Hz = better performance - In the Control + 90 ° situation = better performance	2–8 Hz, had a detrimental effect on both overall performance tracking and reaction times for the cognitive task. 22° seat backrest produces worse performance of the psychomotor task (tracking) than the other backrest angles under all 4 conditions.	The vibration made the tasks more difficult to perform, which was probably due to the increased difficulty in the visual control and hand-arm / manual task elements.
A2	Color Block Test (CBT), Color-Word Interference Test (CWIT), Stroop difference score (SDS), Digit span backward task (DSBT).	1,2,3 and 4	Passive vibration has a positive short-term effect on executive functions (attention and inhibition) in healthy young adults with a high level of cognitive functioning.	-	Passive WBV can be a relevant therapy for populations with cognitive disabilities unable to perform active forms of exercise. Cognitive performance immediately after WBV and control session: CWIT and SDS improved after WBV When preceded by another cognitive test, there were no significant changes in the tests
A3	Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT)	1,2,3 and 4	Vibration under these conditions is probably safe for healthy populations in environments of strength, conditioning and rehabilitation.	-	They suggest that the head accelerations resulting from this WBV protocol are not sufficient to cause acute injury.
A4	Stroop test, Digit Memory Span forward/backward, and the	1 and 2	WBV with 30 Hz versus pWBV with 1 Hz improved the performance on the Stroop Color-Word test but not on other conditions of the Stroop test	5-weeks WBV intervention is a safe intervention to improve brain functioning, although the subtle effects suggest that the protocol is as yet suboptimal.	No beneficial or detrimental effects were found for the TMT test and the Digit Span tests If the cholinergic activity was also enhanced in humans by WBV as we found in mice, it could explain the improvement in the Stroop Color-Word test

Hertz (Hz); Whole-body vibration (WBV); troop Color-Block Test (CBT); Stroop Color-Word Interference Test (CWIT); Stroop Difference Score(SDS); Digit Span Backward task (DSBT); Trailmaking Test (TMT); Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT)

The volunteers in Amonette (2015) did 5 series of static squats for 2 minutes each on the platform in vertical vibration and alternated at a frequency of 30Hz and after each session it was noted that the processing and speed of motor response were improved after vertical vibration, although verbal, visual memory and reaction time are not affected when compared to the control group²⁷.

In Boerema (2018), in which the vibratory pattern was vertical, with a frequency of 30Hz and the participants

were placed in a sitting position and exposed during 4 minutes, 4 times per week per 5 weeks, the memory was evaluated by three, concluded that the vibration has improved the performance on the Stroop Color-Word test but not on other conditions of the Stroop test and WBV intervention is a safe intervention to improve brain functioning²⁸.

In the four articles included in this review, the respective authors reported that did not have financial support for research, authorship or publication.

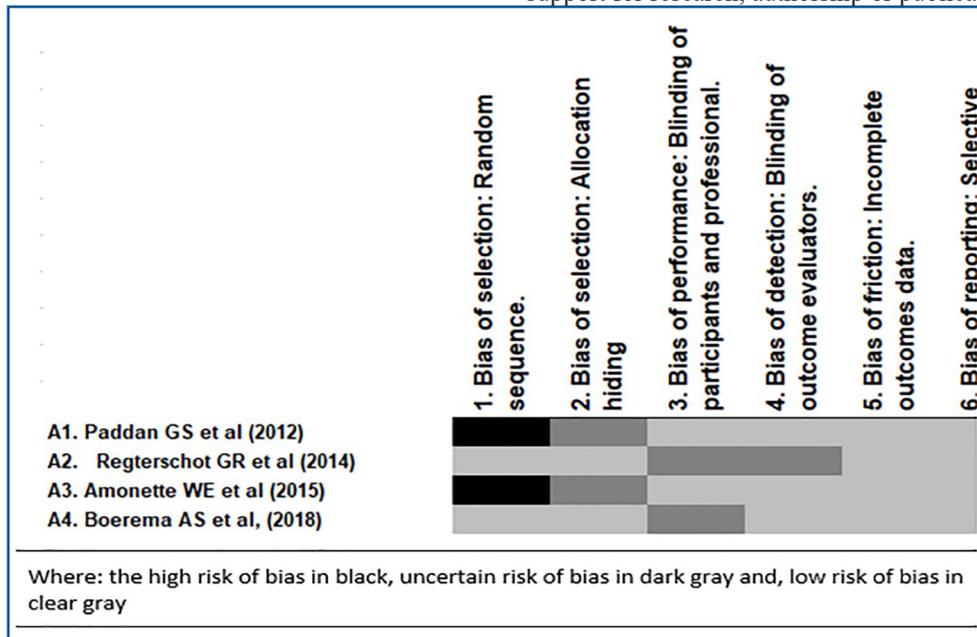


Figure 2: Evaluation of the risk of bias of documents

Bias risk assessment: As described in figure 2, the high level of bias was perceived in two of the studies and only in risk criterion 1, which concerns the randomization sequence. All studies presented a low risk for criteria 5 and 6, that is, they present a low risk for friction biases. Criterion 7 (other risks) was uncertain in the three included studies.

When analyzing quantitatively the incidence of the levels (high, uncertain and low) of risks of the different types of bias in each included article, we can, through the data in Figure 3, that articles 1 and 3 have the same percentage values, while in article 2 and 4, no high risk of bias was attributed to any of the parameters evaluated, thus

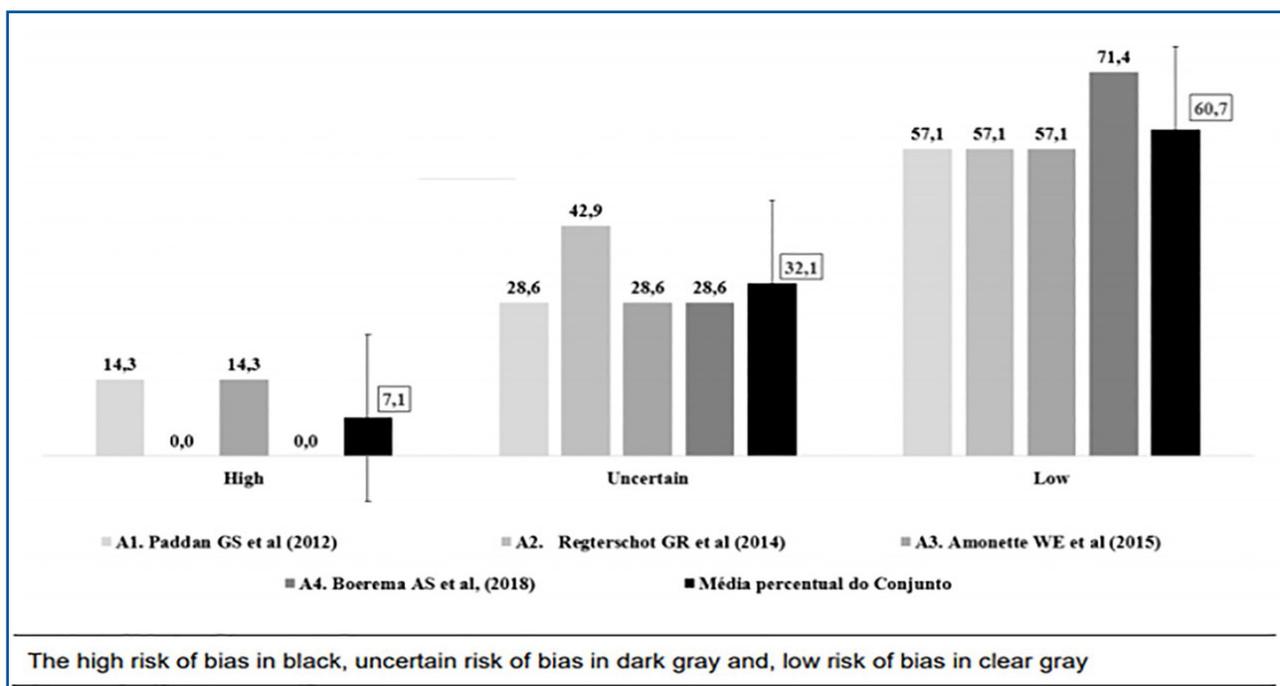


Figure 3: Comparative analysis of the average percentages indices of risk of bias.

suggesting possible better scientific evidence.

Still, based on the global observation of the data resulting from the paired analysis on the risks of bias in the attached documents, the average prevalence of the high

level was 7.1%, while the average of the uncertain and low levels were, respectively, 32.1 and 60.7 percentages, according to the data indicated in figure 3.

Evidence level and recommendation strength evaluation: When evaluating the levels of evidence

Table 4: Level of evidence and strength recommendation

	Oxford Scale		Grade Scale	
	Level of evidence	Strength recommendation	Level of evidence	Strength recommendation
A1. Paddan GS et al (2012)	1B	A	Moderate	Strong
A2. Regterschot GR et al. (2014)	1B	A	High	Strong
A3. Amonette WE et al (2015)	1B	A	Moderate	Strong
A4. Boerema AS et al (2018)	1B	A	High	Strong

according to the Oxford scale, all studies showed evidence level 1B and strength of recommendation A. Following the classification of Grade Paddan and Amonette, they had a moderate level of evidence and a strong degree of recommendation, while Regterschot and Boerema showed a high level of evidence, as described in table 4.

DISCUSSION

Knowing that cognition comprises the processes of attention, learning and memory and includes all the internal and external stimuli that surround them, this review was designed to understand the effects of body vibration on it¹².

Attention, within the cognitive process, is the ability of the human being to filter, among the various stimuli to which he is constantly exposed, the one on which he will discover greater focus and concentration, making the brain able to select what it wants to interpret and what will you ignore²⁹.

An excess of sensorimotor stimulation leads to fragmentation of perception, and attention within the learning process is essential. Such a process is raised by the ability to retain certain content or process that is taught, copied or conditioned³⁰.

Thus, memory, within the cognition process, would be the end, what remains from learning, that is, what can be taken to life and evoked in the most opportune future moment. Therefore, it is extremely important for the development of daily activities and for the construction of new perceptions based on what is already known²⁹. Therefore, establishing strategies to improve cognitive capacity in healthy individuals or even treating patients with conditions in which such aspects are compromised, such as dementias or ADHD, is of clinical and scientific interest to the community.

The NASA- Task Load Index (NASA-TLX) questionnaire used in Paddan's study helps to understand the workload by addressing aspects such as mental, physical and temporal demand, performance, effort and level of frustration. Such aspects can be understood as cognition, mainly because they are difficult to maintain attention and its consequent implication on learning³¹.

Amonette, on the other hand, used the ImpAct test, which is a questionnaire developed initially to assess post-concussion patients. It also has the "ImpAct baseline Test" version that can be used for healthy patients, being the most ideal for application in clinical trials to assess

cognition against applied therapies^{32, 33}.

There are still no specific protocols in the literature on the best form of WBV aimed at improving cognition, however the protocols are intended for physical improvements, such as weight loss, bone mass gain or improved stability and balance^{21, 34}. Studies demonstrate that the effectiveness of WBV therapy is greater with the use of multiple sessions when compared to a single exposure to vibration³⁴. Of the selected studies, all were exposed to multiple sessions, however, in Regterschot they were assessed cognitively after each of the vibration sessions, which may have influenced the results of the study.

As for the vibration frequency of the platform, the best performances occurred with an exposure between 30-35Hz, oscillating with an amplitude of 2mm (low amplitude and high frequency)^{21,34}. In this context, Regterschot, Amonette and Boerema used such vibratory patterns in their studies, however Paddan used lower frequencies, which may have had a negative impact on the study participants' motor response.

The whole-body vibration platforms can be of the vertical, sinusoidal or alternating type^{34,35}. According to protocols of WBV, the sinusoidal stimulus (multidirectional) would be the most effective for improving balance, weight loss and cardiovascular improvement³¹. In the studies of this review, both the sinusoidal and vertical patterns were positive about cognition. Thus, new clinical studies could be conducted to elucidate the influence of such a parameter within the protocols or even if it has no influence on training patterns to improve cognition.

When it was used to improve physical fitness, both protocols with dynamic and static exercises showed effectiveness²¹. When assessing the studies above, body positioning (sitting or doing static squats) showed good results.

It was observed that, within the cognition parameters evaluated, whether they are memory (Amonette and Boerema), attention, learning and / or others (Amonette, Paddan and Regterschot), there was some improvement in performance or at least there was no loss, as expected by Paddan. Despite the good results obtained, Boerema concludes that the protocols are still suboptimal, that is, they must continue with further investigations to reach an effective and applicable clinical protocol on a large scale.

In the three selected studies, the authors attribute

the improvement in attention and memory to the vibration of the whole body, since this was the only intervention imposed on the sample. In addition, the parameters of the vibration protocols are not a consensus among the four articles reinforces that possibly such vibration really positively affects cognitive aspects.

The improvement of cognitive functions associated with physical exercise has already been demonstrated by several scholars and it is assumed that it is closely linked to the repression of the decline in cardiovascular function, increasing the oxygenation of the central nervous system and greater nutritional supply, since such tissue is responsible increased consumption of oxygen and nutrients in the human body^{36,37}. Thus, the theory that the WBV positively influences these aspects is reinforced by the present review.

This review, despite noting the positive and non-harmful effects and their possible therapeutic applications of WBV on cognition, also reveals the lack of randomized studies with a large sample space on the subject.

Studies with a larger number of participants and with greater methodological rigor should be carried out in order to draw conclusions regarding the use of such therapy in patients with neurological disorders such as dementia or attention deficit hyperactivity disorder (ADHD) and / or psychiatric disorders such as schizophrenia or depression.

Another interesting fact about the effects of stimulation by WBV is the observation of a significant improvement in the cognitive pattern and in the activation of the electroencephalogram in elderly women suspected of

having mild dementia, after being subjected to a period of eight weeks therapeutic intervention by means of WBV³⁸.

Despite the methodological quality and the subsequent clinical significance of its scientific evidence. The limitation of the current review is mainly due to the absence of selected studies with patients with cognitive comorbidities in the sample spaces, since the three included clinical trials have healthy individuals without any comorbidity as participants.

The strength of this review is to indicate innovation related to the use of the WBV improves cognitive responses and to present potential application in some clinical situations with an important perspective to be used worldwide. Despite the methodological quality and the subsequent clinical significance of its scientific evidence, we consider that the number of studies that can be included can be considered as a fragility factor of the present literature review.

■ CONCLUSION

The use of whole-body vibration therapy, regardless of the vibration pattern, has a high potential for positive interference in improving thinking, learning and memorizing in cognitive ability in healthy individuals.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Resumo

Objetivo: Revisar sistematicamente os mecanismos pelos quais a vibração de corpo inteiro (VCI) melhora a capacidade de aprender, pensar, memorizar e todos os outros processos que envolvem a cognição.

Método: O presente estudo coletou dados de três bancos de dados usando as palavras-chave “vibração de corpo inteiro” e “cognição”. Ensaios clínicos randomizados com foco na associação de WBV e cognição foram considerados. O estudo foi registrado no banco de dados de protocolos de revisões sistemáticas PROSPERO. Todos os estudos incluídos usaram pacientes saudáveis, expostos à VCI. Os artigos incluídos foram avaliados quanto ao risco de viés de acordo com os critérios da Colaboração Cochrane, nível de evidência e força de recomendação segundo a classificação GRADE e Oxford.

Discussão e Resultados: Dos 89 artigos publicados, de acordo com os critérios de elegibilidade, quatro foram submetidos à extração de dados. Os parâmetros cognitivos, atenção, memória e aprendizagem demonstraram melhora em quase todos os artigos avaliados nesta revisão sistemática.

Conclusão: A intervenção com VCI teria efeitos positivos na capacidade cognitiva dos indivíduos, embora mais ensaios clínicos randomizadas devam ser realizados para avaliação de tais parâmetros.

Número de registro PROSPERO: CRD42020203679

Palavras-chave: exercício, aprendizagem, memória, atenção, vibração.

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