Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2015;96:1525-32

REVIEW ARTICLE (META-ANALYSIS)

Therapeutic Effects of Whole-Body Vibration Training in Knee Osteoarthritis: A Systematic Review and Meta-Analysis

Hamayun Zafar, PhD, PT,[a,b] Ahmad Alghadir, MS, PhD, PT,[c] Shahnawaz Anwer, MPT,[c,d] Einas Al-Eisa, PhD, PT[c]

From the [a]Department of Rehabilitation Sciences, College of Applied Medical Sciences King Saud University, Riyadh, Saudi Arabia; [b]Department of Odontology, Clinical Oral Physiology, Umea University, Umea, Sweden; [c]Rehabilitation Research Chair, Department of Rehabilitation Sciences, College of Applied Medical Sciences, King Saud University, Riyadh, Saudi Arabia; and [d]Padmashree Dr. D. Y. Patil College of Physiotherapy, Dr. D. Y. Patil Vidyapeeth, Pune, India.

Abstract

Objective: To examine the current evidence regarding the effects of whole-body vibration (WBV) training in individuals with knee osteoarthritis (OA).

Data Sources: We searched PubMed, CINAHL, Embase, Scopus, Physiotherapy Evidence Database (PEDro), and Science Citation Index for research articles published prior to January 2015 using the keywords whole body vibration, vibration training, and vibratory exercise in combination with the Medical Subject Heading osteoarthritis knee.

Study Selection: This meta-analysis was restricted to randomized controlled trials published in the English language. The quality of the selected studies was assessed by the PEDro Scale. The risk of bias was assessed using the Cochrane collaboration's tool in the domain-based evaluation. We also evaluated the quality of each study based on the criteria given by the International Society of Musculoskeletal and Neuronal Interactions for reporting WBV intervention studies, consisting of 13 factors.

Data Extraction: Descriptive data regarding subjects, design, intervention, WBV parameters, outcomes, and conclusions were collected from each study by 2 independent evaluators. The mean and SD of the baseline and final endpoint scores for pain, stiffness, and function were extracted from the included studies.

Data Synthesis: A total of 83 studies were found in the search. Of these, 5 studies met the inclusion criteria and were further analyzed. Four of these 5 studies reached high methodologic quality on the PEDro Scale. Overall, studies demonstrated mixed results in favor of additive effects of WBV for reducing pain and improving function in knee OA. There was considerable variation in the parameters of the WBV included in this systematic review.

Conclusions: WBV training reduces pain and improves function in individuals with knee OA.

Archives of Physical Medicine and Rehabilitation 2015;96:1525-32

Knee osteoarthritis (OA) is the most common form of degenerative joint disease affecting both men and women.[1,2] In addition to pain, knee OA causes joint stiffness and decreased quadriceps strength resulting in physical disability.[3] The target of any treatment approach in the management of knee OA includes reduction of pain, disability, and improvement in quadriceps muscle strength. Currently accepted nonpharmacologic treatment options for OA recommended by the Osteoarthritis Research Society International include patient education, weight loss, physical rehabilitation, exercise, change in activities of daily living, and coping strategies.[4]

Recently, the use of whole-body vibration (WBV) has been recommended as an efficient and alternative option for improving muscle strength in individuals with knee OA.[5-8] Other studies demonstrated improvement in the function and self-reported disease status in individuals with knee OA after a 12-week training program of squatting exercise combined with WBV.[9,10] However, Trans et al[6] reported no improvement in self-reported knee pain and function, which shows that there is no consistent finding on this issue.

Supported by the King Saud University, Vice Deanship of Research Chairs, Rehabilitation Research Chair.

Disclosures: none.

0003-9993/15/$36 - see front matter © 2015 by the American Congress of Rehabilitation Medicine
http://dx.doi.org/10.1016/j.apmr.2015.03.010

WBV training is the exercise program performed with the body on a platform that generates vibrations.[11] These vibrations are transmitted to the body and stimulate the primary endings of the muscle spindles, thereby activating α-motor neurons, which cause muscle contractions similar to the tonic vibration reflex.[6] WBV training can be given via 2 types of machines, the rotational vibration and vertical vibration machines.[12] Rotational vibration machines can vibrate in 2 dimensions (right and left), whereas vertical vibration machines can vibrate in all 3 spatial dimensions. The study suggests that it is easier to maintain the correct training posture on a vertical vibration machine than a rotational vibration machine.[12]

Recently, Wang et al[13] published a systematic review and meta-analysis to investigate the effects of WBV on pain, stiffness, and physical functions in individuals with knee OA. They reported that the WBV training program significantly improves physical functions, but there is no evidence that WBV can reduce pain and stiffness in individuals with knee OA. However, because this review compared posttest data, there is a possibility that the group variations in the baseline data can affect the results. Therefore, the comparison of mean differences between groups would give more reliable results. In addition, the use of the International Society of Musculoskeletal and Neuronal Interactions (ISMNI)−recommended criteria would improve the quality of reports about WBV treatment studies.

Therefore, the objective of this systematic review is to provide an overview of current available evidence regarding the therapeutic effects of WBV training in individuals with knee OA.

Methods

Data sources

The search for published studies was conducted using PubMed, CINAHL, Embase, Scopus, Physiotherapy Evidence Database (PEDro), and Science Citation Index using a combination of the keywords whole body vibration, vibration therapy, and vibratory exercise with osteoarthritis knee and the Medical Subject Headings osteoarthritis, knee combined with whole body vibration or vibration. The bibliographic search was restricted to randomized controlled trials (RCTs) published in the English language prior to January 2015. Hand searching of the identified studies was used to find other appropriate studies. Two independent evaluators (S.A., H.Z.) selected the studies based on titles and abstract, excluding those articles not related to the objectives of this review.

Study selection

The meta-analysis was restricted to RCTs published in the English language prior to January 2015. Trials were required to compare exercise with and without WBV or compare exercise with WBV and a control. Studies that did not include WBV therapy in their interventions were excluded. The outcome measures of interest were pain, stiffness, and function in individuals with knee OA. RCTs were excluded if the publication was in abstract form only.

Assessment of methodologic quality

Two independent reviewers (S.A., H.Z.) assessed the quality of the included studies using the PEDro Scale.[14] The scale consists of 11 questions to assess the quality of RCTs on 2 aspects, including internal validity (criteria 2−9) and sufficient statistical information to make it interpretable (criteria 10 and 11). Each question is scored according to its presence or absence in the assessed study. The sum of all positive responses gives the final score.

The studies with a score ≥5 (50%) were considered high quality, as reported by Moseley et al.[15] Therefore, in the present review, all randomized studies with scores ≥5 (5/10) were considered to be of high methodologic quality. Two evaluators independently assessed methodologic quality using the PEDro Scale.

The risk of bias was assessed using the Cochrane collaboration's tool in the domain-based evaluation. The assessed domains were sequence generation, allocation concealment, blinding, completeness of outcome data, and absence of selective outcome reporting. Risk of bias was classified as low, unclear, and high in each domain.[16]

In addition, we also evaluated the quality of each study based on the criteria given by the ISMNI for reporting WBV intervention studies, consisting of 13 factors.[17] We evaluated whether each article adequately described the 13 questions inquiring about the WBV parameters (eg, frequency, amplitude, acceleration) and participants' position (eg, holding on to a railing, exercise position, footwear condition). Each of these factors was scored with yes, no, or unclear, based on the descriptions. If the displacement was not described as peak-to-peak, the vibration amplitude was scored as unclear. If figures in the articles show participants holding onto a railing and footwear conditions, we scored these with a yes.

Data analysis

The selected studies were screened by 2 independent evaluators (S.A., H.Z.). The analysis of included studies was performed according to a structured script using the following parameters: author/year, subjects, design, intervention, WBV parameters, outcomes, and conclusions. Disagreements between the evaluators were resolved by discussion to reach consensus. The unweighted κ was used to determine the agreement between the 2 evaluators.

The outcome measures of interest were pain, stiffness, and function. The mean and SD of the baseline and final endpoint scores for pain, stiffness, and function were extracted from the included studies. The mean change score (final score − baseline score) for each outcome measure was calculated for each intervention. The standardized mean difference for the outcomes (pain, stiffness, function) was computed using Hedges (adjusted) g ($g = M1 - M2/S_{pooled}$, where M1 and M2 are the mean change scores of groups 1 and 2, respectively, and S_{pooled} is the estimate of the population SD).[18]

The magnitude of the effect size was categorized using the Cohen categories, with $g<0.5$ as a small effect size; $g\geq 0.5$ and ≤ 0.8 as a medium effect size; and $g>0.8$ as a large effect size. The random effects meta-analysis was conducted to determine the overall effect size of WBV. Then 95% confidence intervals (CIs)

List of abbreviations:

CI	**confidence interval**
ISMNI	**International Society of Musculoskeletal and Neuronal Interactions**
OA	**osteoarthritis**
PEDro	**Physiotherapy Evidence Database**
RCT	**randomized controlled trial**
WBV	**whole-body vibration**
WOMAC	**Western Ontario and McMaster Universities Osteoarthritis Index**

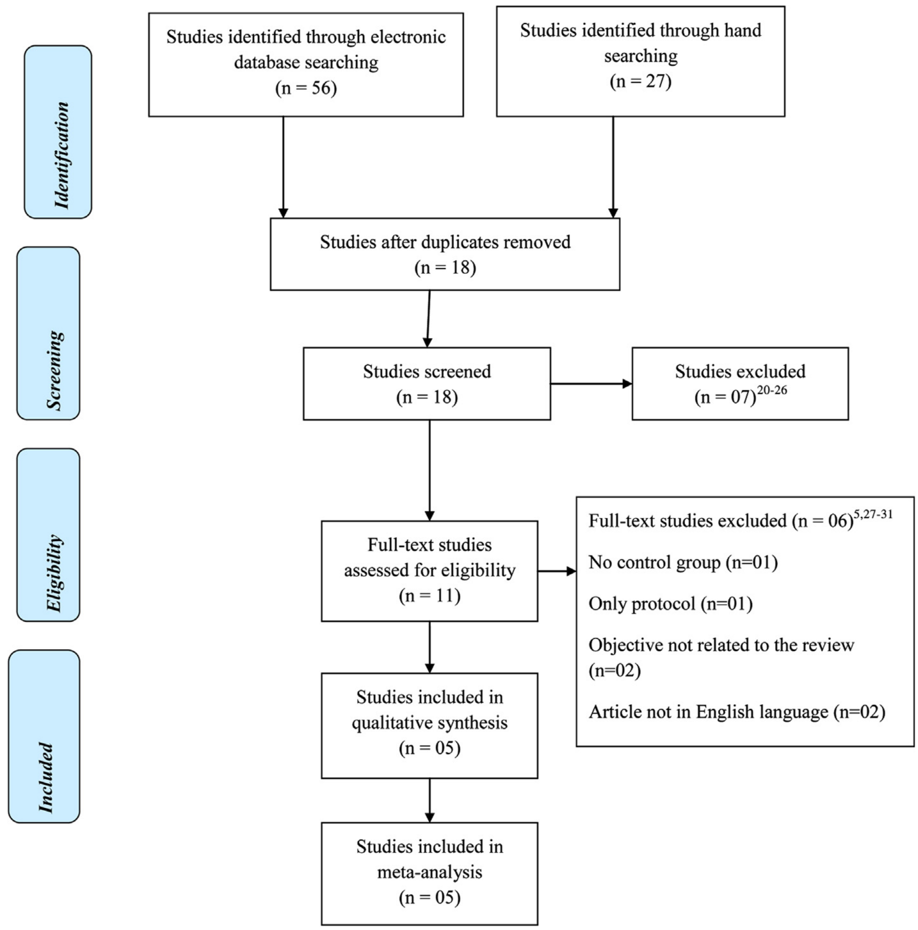


Fig 1 Flow diagram of the study procedure.

were calculated for effect sizes based on a generic inverse variance outcome model. The significance of the overall effect was tested using the *z* statistic. The Cochran Q statistic and Higgins I^2 statistic were used to determine statistical heterogeneity between studies.[18] A low *P* value (≤.10) for the Q statistic was considered evidence of heterogeneity of treatment effects. All statistics were computed using Comprehensive Meta-Analysis software.[19,a]

Results

Identified studies

The initial search resulted in 83 research studies. A total of 65 studies that appeared in >1 database or did not meet predetermined inclusion criteria were excluded. A total of 18 studies

Table 1 Methodologic classification assessed by the PEDro Scale

Criteria	Simão et al[9]	Trans et al[6]	Avelar et al[10]	Tsuji et al[7]	Park et al[8]	Cumulative Score*
Random allocation	Yes	Yes	Yes	No	Yes	4
Concealed allocation	Yes	Yes	No	No	No	2
Baseline comparability	Yes	Yes	Yes	Yes	Yes	5
Blind participants	No	No	No	Yes	No	1
Blind therapists	No	No	No	No	No	0
Blind assessors	Yes	Yes	No	No	No	2
Follow-up	Yes	No	Yes	No	No	2
Intention-to-treat analysis	No	Yes	No	Yes	No	2
Group comparisons	Yes	Yes	Yes	Yes	Yes	5
Point and variability measures	Yes	Yes	Yes	Yes	Yes	5
Cumulative score	7	7	5	5	4	5.6†

* Out of the 5 total studies.
† Maximum score of 10.

Table 2 Risk of bias of included studies

Citations	Adequate Sequence Generation	Allocation Concealment	Blinding	Incomplete Outcome Data Addressed	Free of Selective Reporting	Conclusions
Simão et al[9]	Yes	Yes	Yes	Yes	Yes	Low risk of bias
Trans et al[6]	Yes	Yes	Unclear	Yes	Yes	Unclear risk of bias
Avelar et al[10]	No	No	Unclear	Yes	Yes	High risk of bias
Tsuji et al[7]	No	No	Unclear	Yes	Yes	High risk of bias
Park et al[8]	Yes	No	No	Yes	Yes	High risk of bias

Abbreviations: No, high risk of bias; Yes, low risk of bias.

were assessed for eligibility. Thirteen studies were eliminated because they did not match the inclusion criteria or were not available in full text (fig 1).[5,20-31] The final selection, made by consensus, resulted in the inclusion of 5 studies in the quality assessment phase.

Quality assessment of study

The 5 included studies had an average PEDro score of 5.6 out of 10, as illustrated in table 1. These scores represent multiple sources of bias that may skew the results. The most common shortcomings were lack of blinding (patient, therapist, assessor),[6-10] follow-up,[6-8] intention-to-treat analysis,[8-10] and concealed allocation.[7,8,10] The most adhered to items on the PEDro Scale were random allocation, baseline comparability, measurements of variability, and between-group comparison, which were evident in almost all of the trials. Most studies seemed to suggest a favorable additive benefit after WBV with exercise for pain and function compared with the control.

Agreement between evaluators was excellent (unweighted κ=.88) in assessing risk of bias across studies. Table 2 details the risk of bias assessment of the included studies. The overall risk of bias assessment indicated that the risk of bias was low in 1 study,[9] high in 3 studies,[7,8,10] and unclear in 1 study.[6]

The quality score of each study followed by the ISMNI recommendation is shown in table 3. The overall mean score was 6.8±0.84 (range, 6−8) of 13 points. All included studies gave the brand name and type of vibration device used. None of the included studies clearly described that the given amplitude was peak to peak.

Characteristics of the study populations

The participant characteristics are given in table 4. The sample size ranged from 23 to 47, with the mean age varying from 60 to 75 years. Most of the studies included only women participants with knee OA.[6-8] Most of the studies used clinical and radiographic criteria of the American College of Rheumotology to diagnose knee OA.[6,8-10] One study used the Kellgren and Lawrence scale to assess severity of knee OA.[7]

Training protocol

The training protocols are summarized in table 4. Three studies[6,8,9] used vertical vibration, whereas others[7,10] did not specify the type of vibration used. Four studies had a frequency of 3 sessions per week,[7-10] whereas 1 study had 2 sessions per week.[6] Three studies had 8 weeks duration of treatment,[6-8] whereas 2 studies had 12 weeks of treatment.[9,10] The frequency and amplitude of the vibration signals used varied from 12 to 40Hz and 2 to 5mm, respectively. The frequency of vibration was increased from 35 to 40Hz in 2 studies,[9,10] 30 to 40Hz in 1 study,[7] 25 to 30Hz in 1 study,[6] and 12 to 14Hz in 1 study[8] during treatment duration. One study did not specify the amplitude used.[6] The number of vibration bouts delivered per sessions varied from 1 to 9 for a period that lasted for 20 seconds to 10 minutes for each. Two studies had vibration bouts of 6 to 8 repetitions for 20 to 40 seconds for each.[9,10] One study had vibration bouts of 1 to 2 repetitions for 30 to 60 seconds for each,[7] 1 study had 6 to 9 repetitions for 30 to 70 seconds,[6] and 1 study had 2 repetitions for 10 minutes for each.[8]

Outcome measures

The outcome measures of interest were pain, stiffness, and function in individuals with knee OA. Three studies used the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) pain score,[6,9,10] 1 study used the numerical rating scale,[8] and 1 study used the Japanese Knee Osteoarthritis Measure pain score[7] for measuring pain. One study used the Japanese Knee Osteoarthritis Measure,[7] 1 study used the Korean WOMAC,[8] and others used the WOMAC for measuring stiffness and function.

Table 3 Methodologic assessment by the recommendations of the ISMNI

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Quality Score
Simão et al[9]	Yes	Yes	Yes	Unclear	Yes	Yes	Unclear	Unclear	Yes	Unclear	No	Yes	Yes	8
Trans et al[6]	Yes	Yes	Yes	No	No	Unclear	Unclear	Unclear	No	Unclear	Yes	Yes	Yes	6
Avelar et al[10]	Yes	Unclear	Yes	Unclear	Yes	Yes	Unclear	Unclear	Yes	Unclear	No	Yes	Yes	7
Tsuji et al[7]	Yes	Unclear	Yes	Unclear	No	Yes	Unclear	No	Yes	Unclear	Yes	Yes	Yes	7
Park et al[8]	Yes	Unclear	Yes	Unclear	No	Unclear	Unclear	Unclear	Unclear	Yes	Yes	Yes	Yes	6

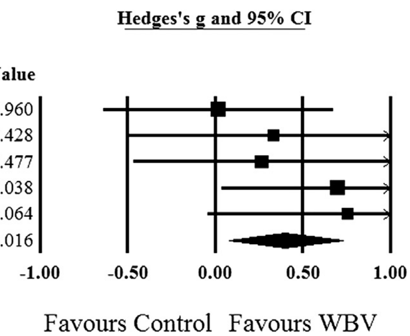
Abbreviations: Q1, brand name of vibration platform; Q2, type of vibration; Q3, vibration frequency; Q4, vibration amplitude; Q5, peak acceleration; Q6, accuracy of vibration parameter; Q7, evaluation of skidding of the feet; Q8, changes of vibration parameters; Q9, rationale for choosing vibration parameters; Q10, support devices during vibration exposure; Q11, type of footwear; Q12, body position; Q13, description of exercise.

Table 4 Overview of selected WBV studies in knee OA

Study	Subjects	Mean Age, y (male/female, %)	Design	Group	WBV Parameters	Duration	Outcomes	Conclusions
Simão et al[9]	Knee OA based on clinical and radiographic criteria of ACR	Group 1: 75 (18/82) Group 2: 71 (9/91)	RCT	1: Squat-WBV (n=12) 2: Control (n=12)	Frequency (Hz): 35, 40 Amplitude (mm): 4 Acceleration (*g*):2–2.61	3 times a week, 12wk	WOMAC	The addition of vibration training to squat exercise reduces the self-perception of pain. No significant differences between groups were observed on functional scores.
Trans et al[6]	Knee OA based on clinical and radiographic criteria of ACR	Group 1: 61.5 (0/100) Group 2: 61.1 (0/100)	RCT	1: WBV-exercise on stable platform (n=17) 2: Control (n=18)	Frequency (Hz): 25, 30 Amplitude (mm): NR Acceleration (*g*): NR Time/repetition: 30s/6–70s/9	2 times a week, 8wk	WOMAC	No significant differences between groups were observed on pain and functional scores.
Avelar et al[10]	Knee OA based on clinical and radiographic criteria of ACR	Group 1: 75 (18/82) Group 2: 71 (10/90)	RCT	1: Squat-WBV (n=12) 2: Squat (n=11)	Frequency (Hz): 35, 40 Amplitude (mm): 4 Acceleration (*g*): 2.78–3.26	3 times a week, 12wk	WOMAC	The addition of vibration training to squat exercise does not reduce pain and improve function beyond that of squat exercise without WBV.
Tsuji et al[7]	Postmenopausal women with knee pain in the age group of 50–75y Knee OA based on KL scale (0–4)	Group 1: 62.1 (0/100) Group 2: 60.9 (0/100)	RCT	1: Accelerated training: WBV (n=32) 2: Control: home exercise (n=15)	Frequency (Hz): 30, 40 Amplitude (mm): 2.5 Acceleration (*g*): NR	3 times a week, 8wk	JKOM	The accelerated training program consisting of strength and flexibility training with WBV-reported improvement in function. No significant differences between groups were observed on the pain score.
Park et al[8]	Knee OA based on clinical and radiographic criteria of ACR	Group 1: 62.5 (0/100) Group 2: 60 (0/100)	RCT	1: WBV and home exercise (n=17) 2: Control: home exercise (n=19)	Frequency (Hz): 12, 14 Amplitude (mm): 2.5–5 Acceleration (*g*): NR	3 times a week, 8wk	NRS KWOMAC	The WBV with home exercise group reported significant reduction in pain compared with home exercise alone. No significant differences between groups were observed on function.

Abbreviations: ACR, American College of Rheumatology; JKOM, Japanese Knee Osteoarthritis Measure; KL, Kellgren and Lawrence; KWOMAC, Korean Western Ontario and McMaster Universities Osteoarthritis Index; NR, not reported; NRS, numerical rating scale.

Study name	Hedges's g	Lower limit	Upper limit	Z-Value	p-Value
Trans T et al. 2009	0.017	-0.639	0.673	0.051	0.960
Avelar NCP et al. 2011	0.335	-0.493	1.164	0.793	0.428
Tsuji T et al. 2014	0.267	-0.468	1.001	0.711	0.477
Park YG et al. 2013	0.697	0.037	1.357	2.071	0.038
Simao AP et al. 2012	0.757	-0.044	1.559	1.852	0.064
	0.401	0.076	0.726	2.420	0.016



Heterogeneity: Q- value, 3.00 (p=0.558); I-squared, 0%

Fig 2 Effect of WBV training on pain.

Effect of WBV on pain

Meta-analysis of 5 trials showed that most studies displayed an insignificant effect size point estimate to favor WBV compared with the control; however, the test for an overall effect across the 5 included studies was significant ($P=.016$), with an overall small effect size point estimate of .40 (95% CI, .08−.73) based on a fixed-effects model that favored WBV compared with the control. Therefore, WBV was effective in reducing pain (fig 2). No significant heterogeneity was found ($I^2=0\%$, $P=.558$).

Effect of WBV on stiffness

Meta-analysis of 5 trials showed that all studies displayed an insignificant effect size point estimate to favor WBV compared with the control; the test for an overall effect across the 5 included studies was insignificant ($P=.193$), with an overall small effect size point estimate of .21 (95% CI, −.11 to .54) based on a fixed-effects model. Therefore, WBV compared with the control was not effective at reducing stiffness (fig 3). No significant heterogeneity was found ($I^2=0\%$, $P=.809$).

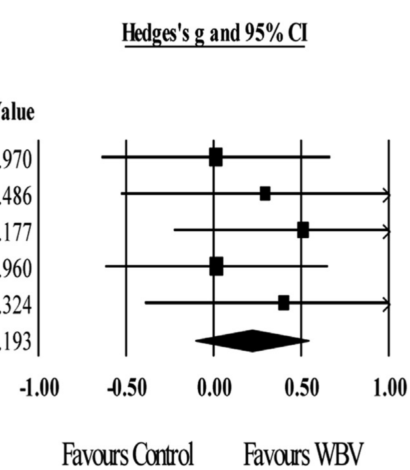
Effect of WBV on function

Meta-analysis of 5 trials showed that most studies displayed an insignificant effect size point estimate to favor WBV compared with the control; however, the test for an overall effect across the 5 included studies was significant ($P=.024$), with an overall small effect size point estimate of .37 (95% CI, .05−.70) based on a fixed-effects model. Therefore, WBV compared with the control was effective at improving function (fig 4). No significant heterogeneity was found ($I^2=52.22\%$, $P=.079$).

Discussion

The present review evaluated 5 RCTs including a total of 165 participants to examine evidence regarding the therapeutic effect of WBV in the management of knee OA. Among the 5 studies evaluated using the PEDro Scale,[14] 4 were considered of high methodologic quality. Of the 5 included studies, 3 studies would be regarded as high risk of bias because they failed to fulfill the required criteria.[7,8,10] Our evaluation showed that more than half of the studies performed adequate random sequence generation;

Study name	Hedges's g	Lower limit	Upper limit	Z-Value	p-Value
Trans T et al. 2009	0.013	-0.644	0.669	0.038	0.970
Avelar NCP et al. 2011	0.294	-0.533	1.121	0.697	0.486
Tsuji T et al. 2014	0.511	-0.230	1.252	1.351	0.177
Park YG et al. 2013	0.016	-0.623	0.656	0.051	0.960
Simao AP et al. 2012	0.401	-0.396	1.198	0.985	0.324
	0.214	-0.108	0.537	1.302	0.193



Heterogeneity: Q- value, 1.598 (p=0.809); I-squared, 0%

Fig 3 Effect of WBV training on knee stiffness.

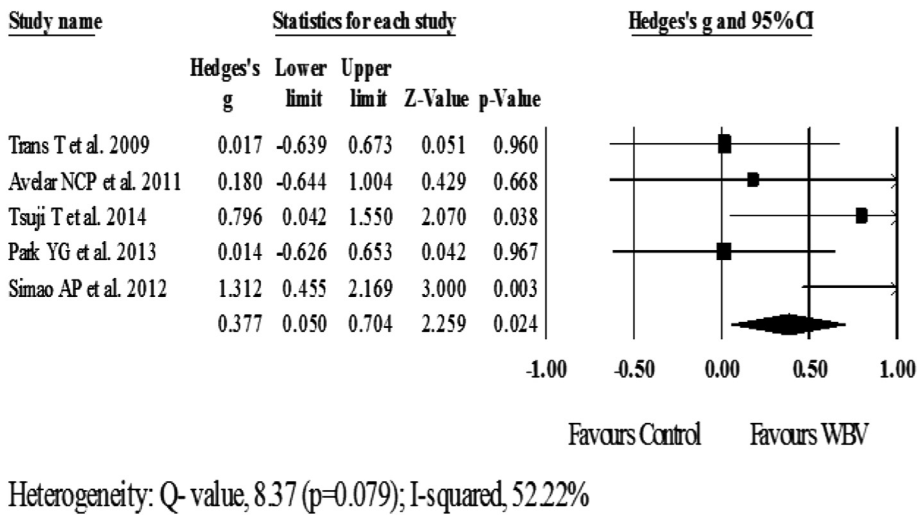


Fig 4 Effect of WBV training on function.

however, blinding of the outcome assessment was unclear (see table 2).

Per the guidelines given by the ISMNI recommendations,[17] some factors related to the acceleration were not sufficiently documented in the included studies. Only 2 studies measured the actual acceleration of the WBV platform and described the method used to ensure consistent targeting amplitude of the WBV.[9,10] The acceleration generated by the WBV platform is one of the most salient factors in WBV studies; therefore, future studies should strictly adhere to these guidelines.[32]

The methodology and procedures of the intervention of the evaluated studies were properly prepared and described, allowing for clinical reproducibility. The use of the ISMNI recommended criteria and the Cochrane collaboration's tool to assess the risk of bias gives additional strength and improves the quality of this review about WBV treatment studies.

On the basis of the present review, WBV along with exercises compared with the control has shown a greater reduction of pain and improvement in function. However, the present review did not find any additional effect of WBV on stiffness compared with the control. Similarly, Yoon et al[30] reported significant improvement of function after WBV training in middle-aged and older Japanese women with knee OA and knee pain. Another study reported that WBV training yields similar results to traditional strength training for reduction of pain in individuals with knee OA.[31]

Recently in a systematic review and meta-analysis, Wang[13] reported that the WBV training program significantly improved physical functions, but in contrast with the present study, there was no evidence that WBV can reduce pain in individuals with knee OA. These differences in the results may be caused by the methodologic differences we adopted in this review. In the present review, the mean change score (final score minus baseline score) for each outcome measure was compared; however, Wang compared posttest data, and there is a possibility that the group variations in the baseline data can affect the results. In addition, the present review included 1 more trial, which could have caused this result.[7]

Most studies reported a priori sample size calculation to determine the minimum number of subjects necessary for each group for adequate power. Although there was some variation in the methods and interventions used in these studies, overall the studies demonstrated mixed results in favor of additive effects of WBV for reducing pain and improving function in knee OA. There was variation in the content and duration of the exercise programs included in our systematic review. The length of intervention ranged from 8 to 12 weeks, with a frequency of intervention ranging from 2 to 3 times per week. There was considerable variation in the parameters of the WBV included in our systematic review. Variations among the 5 studies included duration of intervention; type of control groups; and vibration parameters, including frequency, amplitude, and acceleration.

Study limitations

There are several limitations in the present review. Three out of the 5 studies included only participants who were women. Additionally, in this review, no study assessed the isolated effect of WBV on outcome. For example, it is undetermined whether isolated WBV would yield similar or better effects than when using WBV in combination with another intervention. This would be an important area of research to determine the clinical effectiveness of WBV. Moreover, different vibration platforms have different technical characteristics and may induce different therapeutic effects. None of the selected studies attempted to compare the effects of different vibration platforms. Furthermore, none of the selected studies evaluated long-term follow-up effects of WBV on outcome. In addition, the present study did not suggest optimal vibration parameters because of variations in the methodologies.

Conclusions

WBV has demonstrated limited but beneficial therapeutic effects in individuals with knee OA. WBV training reduces pain and improves function in individuals with knee OA. In the present review there is a variation in the vibration protocol, training dose, and reported results. Therefore, more robust, well-designed studies are required for conclusive evidence of the beneficial therapeutic effects of WBV training in individuals with knee OA.

Supplier

a. Comprehensive Meta-Analysis; Biostat.

Keywords

Knee; Osteoarthritis; Pain; Rehabilitation; Vibration

Corresponding author

Shahnawaz Anwer, MPT, Researcher, Rehabilitation Research Chair, College of Applied Medical Sciences, King Saud University, Riyadh, Saudi Arabia. *E-mail address:* anwer_shahnawazphysio@rediffmail.com.

References

1. Michael JW, Schluter-Brust KU, Eysel P. The epidemiology, etiology, diagnosis, and treatment of osteoarthritis of the knee. Dtsch Arztebl Int 2010;107:152-62.
2. Cho HJ, Chang CB, Kim KW, et al. Gender and prevalence of knee osteoarthritis types in elderly Koreans. J Arthroplasty 2011;26:994-9.
3. Dawson J, Linsell L, Zondervan K, et al. Epidemiology of hip and knee pain and its impact on overall health status in older adults. Rheumatology 2004;43:497-504.
4. Zhang W, Moskowitz RW, Nuki G, et al. OARSI recommendations for the management of hip and knee osteoarthritis, Part II: OARSI evidence based, expert consensus guidelines. Osteoarthritis Cartilage 2008;16:137-62.
5. Segal NA, Glass NA, Shakoor N, Wallace R. Vibration platform training in women at risk for symptomatic knee osteoarthritis. PM R 2013;5:201-9.
6. Trans T, Aaboe J, Henriksen M, Christensen R, Bliddal H, Lund H. Effect of whole body vibration exercise on muscle strength and proprioception in females with knee osteoarthritis. Knee 2009;16:256-61.
7. Tsuji T, Yoon J, Aiba T, Kanamori A, Okura T, Tanaka K. Effects of whole-body vibration exercise on muscular strength and power, functional mobility and self-reported knee function in middle-aged and older Japanese women with knee pain. Knee 2014;21:1088-95.
8. Park YG, Kwon BS, Park JW, et al. Therapeutic effect of whole body vibration on chronic knee osteoarthritis. Ann Rehabil Med 2013;37:505-15.
9. Simão AP, Avelar NC, Tossige-Gomes R, et al. Functional performance and inflammatory cytokines after squat exercises and whole-body vibration in elderly individuals with knee osteoarthritis. Arch Phys Med Rehabil 2012;93:1692-700.
10. Avelar NC, Simão AP, Tossige-Gomes R, et al. The effect of adding whole-body vibration to squat training on the functional performance and self-report of disease status in elderly patients with knee osteoarthritis: a randomized, controlled clinical study. J Altern Complement Med 2011;17:1149-55.
11. Cardinale M, Bosco C. The use of vibration as an exercise intervention. Exerc Sport Sci Rev 2003;31:3-7.
12. Merriman H, Jackson K. The effects of whole-body vibration training in aging adults: a systematic review. J Geriatr Phys Ther 2009;32:134-45.
13. Wang P, Yang X, Yang Y, et al. Effects of whole body vibration on pain, stiffness and physical functions in patients with knee osteoarthritis: A systematic review and meta-analysis. Clin Rehabil 2014 Dec 18. [Epub ahead of print].
14. Maher CG, Sherrington C, Herbert RD, Moseley AM, Elkins M. Reliability of the PEDro Scale for rating quality of randomized controlled trials. Phys Ther 2003;83:713-21.
15. Moseley AM, Herbert RD, Sherrington C, Maher CG. Evidence for physiotherapy practice: a survey of the Physiotherapy Evidence Database (PEDro). Aust J Physiother 2002;48:43-9.
16. Higgins JPT, Altman DG, Sterne JA, editors. Chapter 8: Assessing risk of bias in included studies. In: Higgins JPT, Green S, editors. Cochrane handbook for systematic reviews of interventions version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available at: www.cochrane-handbook.org. Accessed September 25, 2014.
17. Rauch F, Sievanen H, Boonen S, et al. Reporting whole body vibration intervention studies: recommendations of the International Society of Musculoskeletal and Neuronal Interactions. J Musculoskelet Neuronal Interact 2010;10:193-8.
18. Higgins J, Green S. Cochrane handbook for systematic reviews of interventions version 5.0.0. Chichester: The Cochrane Collaboration; 2008.
19. Borenstein M, Hedges L, Higgins J, Rothstein H. Comprehensive Meta-Analysis version 2.0. Englewood: Biostat; 2014.
20. Kitay GS, Koren MJ, Helfet DL, Parides MK, Markenson JA. Efficacy of combined local mechanical vibrations, continuous passive motion and thermotherapy in the management of osteoarthritis of the knee. Osteoarthritis Cartilage 2009;17:1269-74.
21. Osugi T, Iwamoto J, Yamazaki M, Takakuwa M. Effect of a combination of whole body vibration exercise and squat training on body balance, muscle power, and walking ability in the elderly. Ther Clin Risk Manag 2014;10:131-8.
22. Blackburn JT, Pamukoff DN, Sakr M, Vaughan AJ, Berkoff DJ. Whole body and local muscle vibration reduce artificially induced quadriceps arthrogenic inhibition. Arch Phys Med Rehabil 2014;95:2021-8.
23. Mikhael M, Orr R, Amsen F, Greene D, Singh MA. Effect of standing posture during whole body vibration training on muscle morphology and function in older adults: a randomised controlled trial. BMC Geriatr 2010;10:74.
24. Sitjà-Rabert M, Martínez-Zapata MJ, Fort-Vanmeerhaeghe A, Rey-Abella F, Romero-Rodríguez D, Bonfill X. Whole body vibration for older persons: an open randomized, multicentre, parallel, clinical trial. BMC Geriatr 2011;11:89.
25. Bogaerts AC, Delecluse C, Claessens AL, Troosters T, Boonen S, Verschueren SM. Effects of whole body vibration training on cardiorespiratory fitness and muscle strength in older individuals (a 1-year randomised controlled trial). Age Ageing 2009;38:448-54.
26. Bogaerts A, Delecluse C, Claessens AL, Coudyzer W, Boonen S, Verschueren SM. Impact of whole-body vibration training versus fitness training on muscle strength and muscle mass in older men: a 1-year randomized controlled trial. J Gerontol A Biol Sci Med Sci 2007;62:630-5.
27. Salmon JR, Roper JA, Tillman MD. Does acute whole-body vibration training improve the physical performance of people with knee osteoarthritis? J Strength Cond Res 2012;26:2983-9.
28. Stein G, Knoell P, Faymonville C, et al. Whole body vibration compared to conventional physiotherapy in patients with gonarthrosis: a protocol for a randomized, controlled study. BMC Musculoskelet Disord 2010;11:128.
29. Tossige-Gomes R, Avelar NC, Simão AP, et al. Whole-body vibration decreases the proliferativeb response of TCD4(+) cells in elderly individuals with knee osteoarthritis. Braz J Med Biol Res 2012;45:1262-8.
30. Yoon J, Tsuji T, Kanamori A, Tanaka K, Okura T. [The effects of whole-body vibration training on knee function and physical performance of middle-aged and elderly woman with knee osteoarthritis and chronic knee pain] [Japanese]. Japanese Journal of Physical Fitness and Sports Medicine 2014;63:371-82.
31. Rapp W, Boeer J, Albrich C, Heitkamp HC. [Efficiency of vibration or strength training for knee stability in osteoarthritis of the knee] [German]. Aktuelle Rheumatologie 2009;34:240-5.
32. Rittweger J. Vibration as an exercise modality: how it may work, and what its potential might be. Eur J Appl Physiol 2010;108:877-904.