Effects of whole body vibration on pain, stiffness and physical functions in patients with knee osteoarthritis: a systematic review and meta-analysis

Pu Wang1,2, Xiaotian Yang1,2, Yonghong Yang1,2, Lin Yang1,2, Yujing Zhou1,2, Chuan Liu1,2, Jan D Reinhardt3,4,5 and Chengqi He1,2

Abstract

Objective: To assess the effects of whole body vibration for pain, stiffness and physical functions in patients with knee osteoarthritis.

Data sources: We searched the Cochrane Central Register of Controlled Trials, MEDLINE, Physiotherapy Evidence Database (PEDro) and EMBASE (up to October 2014) to identify relevant randomized controlled trials. The outcome measures were pain, stiffness and physical functions.

Review methods: Two investigators identified eligible studies and extracted data independently. The PEDro score was used to evaluate the methodological quality of the selected studies. Standard mean differences (SMDs) and 95% confidence intervals (CIs) were calculated, and heterogeneity was assessed using the I² test.

Results: A total of five randomized controlled trials involving 170 patients with knee osteoarthritis met the inclusion criteria. Only four studies involving 144 patients were deemed to be good quality trials (PEDro score = 6–7). Meta-analysis revealed that whole body vibration has a significant treatment effect in Western Ontario and McMaster Universities index physical function score (SMD = −0.72 points, 95% CI = −1.14 to −0.30, \( P = 0.0008 \)), 12-weeks whole body vibration improved the 6-minute walk test (SMD = 1.15 m, 95% CI 0.50 to 1.80, \( P = 0.0006 \)) and balance (SMD = −0.78 points, 95% CI −1.40 to −0.16, \( P = 0.01 \)). Whole body vibration was not associated with a significant reduction in Western Ontario and McMaster Universities index pain and stiffness score.

Conclusion: Eight-week and 12-week whole body vibration is beneficial for improving physical functions in patients with knee osteoarthritis and could be included in rehabilitation programs.

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Introduction

Osteoarthritis is associated with advancing age and is characterized by the degradation and erosion of articular cartilage, inflammation of synovial membrane, sclerosis of subchondral bone and formation of osteophytes, which causes arthritic symptoms, such as joint pain, swelling, stiffness, deformation and loss of functions in middle-aged and the elderly. Optimal management of patients with knee osteoarthritis requires a combination of non-pharmacological with pharmacological treatments, even surgical interventions when needed. In non-pharmacological interventions, rehabilitation including exercise and physical therapies may be important alternatives for bridging the gap between the disease onset and final operative intervention. Whole body vibration training, defined as the human body on a vibrating platform with or without exercise, may improve neuromuscular performance in healthy individuals and provide benefits to patients with neurological disorders such as stroke, spinal cord injury, Parkinson disease, multiple sclerosis, as well as older patients whose exercise options are limited. Currently, researchers have started to explore the possibility that whole body vibration may offer benefits to patients with knee osteoarthritis. Whole body vibration may counteract reduced cartilage thickness potentially owing to modulation of skeletal tissue, increasing oscillation of chondrocytes and augmenting thickness of the chondrocyte layer. However, effects of whole body vibration in patients with knee osteoarthritis remain controversial. To address these discrepancies we conducted a meta-analysis to assess the effects of whole body vibration on pain, stiffness, balance ability and physical functions in patients with knee osteoarthritis.

Methods

Data sources and searches

We identified relevant studies by an electronic search consisting of four English-language databases: MEDLINE (1966 to October 2014), the Cochrane Central Register of Controlled Trials (up to the third quarter of 2014), Physiotherapy Evidence Database (PEDro) and EMBASE (1980 to October 2014). The keywords and search strategy include: (whole body vibration OR vibration OR vibratory exercise) AND (osteoarthritis OR osteoarthritis OR degenerative arthritis) AND knee. The Appendix (available online) shows the search strategy of MEDLINE (OVID). The reference list of each selected article was examined to identify other potentially applicable articles. Where possible, we contacted authors for additional information.

Inclusion criteria

Titles and abstracts obtained were screened to select relevant articles. The full texts of the remaining articles were then read in detail to identify their eligibility. The inclusion criteria were: (1) randomized controlled trials (RCTs) investigating the effects of whole body vibration on people diagnosed with knee osteoarthritis; (2) reported in English; (3) outcome measures included pain, stiffness and (or) physical functions. There were no restrictions on age, gender, ethnicity or type of setting. Studies were excluded if they were: (1) reports published as conference proceedings; (2) reports in books.

Data extraction

Potentially relevant studies were obtained and examined independently. Two investigators independently scanned the article’s title and abstract to exclude obviously irrelevant studies, then read full-text articles to decide whether the retrieved trials met the inclusion criteria or not. We recorded the first author, year of publication, sample size, intervention duration and frequency, intervention time, intervention in the controlled population, outcome measures time points and conclusions. Extracted data were entered into a standardized Excel file and...
checked by a third investigator. Any disagreements were resolved by discussions and consensus.

**Methodological quality assessment**

We used the PEDro tool (http://www.pedro.fhs.usyd.edu.au/scale_item.html) to assess methodological quality of individual RCTs. The PEDro scale consists of 10 quality ratings, each receiving either a yes or no. The maximum score a study could receive was 10. Scoring discrepancies were resolved through discussion. Studies scoring 9 to 10 were considered methodologically to be of “excellent” quality. Studies with PEDro scores ranging from 6 to 8 were considered to be of “good” quality, while studies scoring between 4 to 5 were of “fair” quality. Studies that scored below 4 were of “poor” quality.

**Statistical analyses**

All analyses were conducted using RevMan5.1 (http://ims.cochrane.org/revman). For continuous outcomes, a mean difference was calculated using the standard mean difference (SMD). The SMDs were estimated from each study with the associated 95% confidence intervals (CIs). If there were sufficient studies within each subcategory (e.g. gender and age of participants), subgroup analyses identified sources of heterogeneity and analyzed their influence on effect size. Heterogeneity was examined using $I^2$ statistic. Studies with an $I^2$ of 25% to 50% were considered to have low heterogeneity, $I^2$ of 50% to 75% were considered moderate heterogeneity and $I^2 > 75\%$ was considered high heterogeneity. Fixed-effect models were used to combine the studies if the $I^2$ test was not significant ($p > 0.05$). Otherwise, random-effect models would be used. If $I^2 > 50\%$, potential sources of heterogeneity were identified by sensitivity analyses conducted by omitting one study in each turn and investigating the influence of a single study on the overall pooled estimate. A subgroup analysis was conducted based on different durations; $P < 0.05$ was considered statistically significant.

**Results**

**Literature search**

Our initial search yielded a total of 44 relevant articles, of which 36 were excluded for duplicate studies and various reasons (reviews, non-randomized studies or not relevant to our analysis) on the basis of the titles and abstracts (Figure 1). Eight potentially relevant studies were identified for full-text analysis, but one study was excluded because of design type (a protocol article) and two studies were excluded because they were not RCTs. Finally, five RCTs met all eligibility criteria and were selected for systematic review. One of the five studies did not include measure of pain, stiffness and physical functions in the outcome, so it was not selected for meta-analysis. At last, only four RCTs were selected for this meta-analysis.

**Description of studies**

Descriptive data for the studies in this systematic review are in Table 1. Five eligible studies involved 170 participants with knee osteoarthritis whom were recruited from different settings. Two trials were from the clinical setting. One trials was from an outpatient clinic setting. Two trials were from the community. The five studies were published between 2009 and 2013. Clinical and radiographic criteria of the American College of Rheumatology were used as diagnostic criteria for knee osteoarthritis in all trials. Three different types of whole body vibration devices were used across the five RCTs. Three studies used vertical synchronous vibration, one study used side-alternating vibration and one study used multidirectional vibration. The frequency of the vibration used varied from 12 to 40 Hz. The frequency of vibration in one study increased from 12 to 14 Hz, the frequency of the vibration in one study increased from 25 to 30 Hz and three studies increased from 35 to 40 Hz across treatment duration. Three studies documented the amplitude of the vibration, 4 mm amplitude of the vibration in three studies, 2.5–5 mm amplitude of the vibration in one study and one study did not report the amplitude of the vibration. The frequency of treatment sessions varied between one to three sessions per week. The exposed time per treatment session used varied from 120 seconds to 600 seconds. Duration of two trials was eight weeks, duration of three trials was 12 weeks.
Methodological quality

Four studies were considered to be good quality trials, one study was considered to be fair. One of the studies was scores 5;16 two of the studies were scores 618,20; two of the studies were scores 717,19 (Table 2).

All studies reported adequate sequence generation and four studies reported adequate concealment of allocation.16,17,19,20 One study provided insufficient detail on the concealment.18 No study was described as subjects-blind and therapists-blind. Two studies were presented as assessor-blind.17,19 Four studies reported adequate follow-up,17–20 and one study reported inadequate follow-up.16 All studies reported between-group comparisons and point estimates. One study used intention-to-treat analysis.18

Quantitative analysis of effects

Pain

Four studies used the WOMAC pain-subscale as an outcome measure to evaluate the effects of whole body vibration on self-reported pain.17–20 The aggregated results of these studies suggest that whole body vibration did not significantly reduce pain (SMD = −0.24 points, 95% CI = −0.66 to 0.17, p = 0.25, P for heterogeneity = 0.07, I² = 58%) (Figure 2(A)). Subgroup analyses were conducted
### Table 1. Characteristics of included studies.

<table>
<thead>
<tr>
<th>Investigators (first author and year reference)</th>
<th>Methods</th>
<th>Participants</th>
<th>Intervention (parameter of WBV and control)</th>
<th>Outcome and time points</th>
<th>Main conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trans 2009&lt;sup&gt;17&lt;/sup&gt;</td>
<td>Subject: Patients from outpatient clinic Study design: RCT Trial duration: 8 weeks</td>
<td>Sample size: N= 52 Diagnosis criteria: Knee OA according to the ACR clinical criteria; KL grade: 3 ±1 Treatment groups (Sample size): Experimental group 1 (N=17): Was performed on a conventional stable WBV-platform (VibM); Experimental group 2 (N=18): Was performed on a balance board with a built-in vibration device (VibF); Control group (N=17): did not participate in any training Age (Mean ±SD): VibM group: 61.5 ±9.2; VibF group: 58.7 ±11.0; control group: 61.1 ±8.5 Gender (female (n%)): Female (100%)</td>
<td>F: 25 Hz (pre-4 weeks), 30 Hz (post-4 weeks); A1: No documented; A2: No documented; POS: Stand with bent knees and hips; FRQ: Began at 30 s × 6 r and progressed to 70 s × 9 r (increasing the number of repetitions per 1 session), 2 sessions a week for 8 weeks; R: equal to exercise time. Device: VibM: VibM, Xendon, Sweden; VibF: Vibrosfäre, ProMedVi, Sweden Control: The control group did not participate in any training</td>
<td>Knee muscle strength of extension Knee muscle strength of flexion TDPM WOMAC Time points of assessment: baseline, 8 weeks</td>
<td>VibM could improve muscle strength; VibF could improve TDPM</td>
</tr>
<tr>
<td>Avelar 2011&lt;sup&gt;18&lt;/sup&gt;</td>
<td>Subjects: Patients from clinical setting Study design: RCT Trial duration: 12 weeks</td>
<td>Sample size: N= 21 Diagnosis criteria: Knee OA according to the ACR clinical criteria; KL grade: 2–3 Treatment groups (Sample size): Experimental group (N=11): Performed squatting exercise on a WBV-platform; Control group (N=10): Perform squatting exercise without vibration Age (Mean ±SD): WBV group:75 ±5; exercise group: 71 ±4 Gender (female (n%)): WBV group: 82%; exercise group: 90%</td>
<td>F: 35 Hz (pre-6 weeks), 40 Hz (post-6 weeks); A1: 4 mm; A2: 2.78g–3.26g; POS: Squatting exercise while vibration; FRQ: Began at 20 s × 6 r and progressed to 40 s × 8 r per session, 1 session a week for 12 weeks; R: 20–40 s; Device: FitVibe, GymnagUniphy NV, Bilzen, Belgium Control: 3 s of isometric flexion of the quadriceps to 60° and 3 s of isometric flexion of the quadriceps to 10°</td>
<td>BBS, TUG, CST, 6MWT, WOMAC Time points of assessment: Baseline, 12 weeks</td>
<td>WBV associated with squat training did not improve WOMAC; WBV could improve the functionality and WOMAC</td>
</tr>
</tbody>
</table>
Table 1. (Continued)

<table>
<thead>
<tr>
<th>Investigators (first author and yearreference)</th>
<th>Methods</th>
<th>Participants</th>
<th>Intervention (parameter of WBV and control)</th>
<th>Outcome and time points</th>
<th>Main conclusion</th>
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</thead>
<tbody>
<tr>
<td>Simão 2012</td>
<td>Subjects: Patients from clinical setting Study design: RCT Trial duration: 12 weeks</td>
<td>Sample size: N = 35 Diagnosis: Knee OA according to the ACR clinical criteria; KL grade: 1–4 Treatment groups (sample size): Experimental group (N = 12): Received WBV and squatting exercise Control group 1 (N = 12): Received squatting exercise Control group 2 (N = 11): Did not participate in any training Age: Experimental group: 75 ±7.4; Control group 1: 71 ±5.3; Control group 2: 69 ±3.7 Gender (female (n%)): Female (89%)</td>
<td>F: 35 Hz (pre-6 weeks), 40 Hz (post 6 weeks); A1: 4 mm; A2: 2.78 to 3.26 g; POS: Squatting exercise while vibration; FRQ: Began at 20 s × 6 r and progressed to 40 s × 8 r per session, 3 sessions a week for 12 weeks; R: 20–40 s; Device: FitVibe, GymnA Uniphy NV, Bilzen, Belgium Control 1: The squat group performed squat exercise without vibration 3 session per week for 12 weeks Control 2: The control group did not participate in any training</td>
<td>The soluble receptors of TNF-α1 The soluble receptors of TNF-α2 WOMAC, 6MWT, BBS, gait speed Time points of assessment: Baseline, 12 weeks</td>
<td>Whole body vibration training improves self-perception of pain, balance, gait quality and inflammatory markers in elderly subjects with knee OA</td>
</tr>
<tr>
<td>Park 2013</td>
<td>Subjects: Patients from community Study design: RCT Trial duration: 8 weeks</td>
<td>Sample size: N = 36 Diagnosis criteria: Knee OA according to the ACR clinical criteria; KL grade: 2–3 Treatment groups (sample size): Experimental group (N = 17): Received WBV associated with home-based exercise; Control group (N = 19): Performed home-based exercise without vibration Age (Mean ±SD): WBV group: 60.0 ±5.7; Control group: 62.5 ±6.2 Gender (female (n%)): Female (100%)</td>
<td>WBV: F: 12–14 Hz; A1: 2.5–5 mm; A2: No documented; POS: Stand with a slight knee flexion while vibration; FRQ: 10 min × 2 per session, 3 sessions a week for 8 weeks; R: 5 min; Device: TurboSonic, TS Korea Co., Ltd, Seoul, Korea Control: Active range-of-motion exercises, muscle strengthening and muscle stretching, 3 sessions a week for 8 weeks</td>
<td>NRS, WOMAC, LSS, isokinetic torque, isometric torque Time points of assessment: Baseline, 4 weeks, 8 weeks</td>
<td>In comparison with the home-based exercise program, WBV was superior only in pain reduction and similarly effective in strengthening of the quadriceps muscle and balance improvement</td>
</tr>
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Tossige-Gomes 2012

<table>
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<tr>
<th>Investigators (first author and year)</th>
<th>Methods</th>
<th>Participants</th>
<th>Intervention (parameter of WBV and control)</th>
<th>Outcome and time points</th>
<th>Main conclusion</th>
</tr>
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<tbody>
<tr>
<td>Tossige-Gomes 2012</td>
<td>Subjects: Patients from community setting Study design: RCT Trial duration: 12 weeks</td>
<td>Sample size: N=26 Diagnosis criteria: Knee OA according to the ACR clinical criteria; KL grade: 2–4 Treatment groups (sample size): Experimental group 1 (N=8): Squatting exercise with vertical synchronous vibration; Experimental group 2 (N=10): Squatting exercise without WBV; Control group (N=8): did not participate in any training Age (Mean ±SD): group 1: 75 ±7; Group 2: 71 ±4; Control group: 72 ±6; Gender (female (n%)): No document</td>
<td>WBV: F: 35–40 Hz; A1: 4 mm; A2: No documented; POS: 10°of knee flexion and continuing until 60°of knee flexion while vibration; FRQ: During the 12-week intervention by increasing the time and number of sets (6 sets × 20 s to 8 sets × 40 s) and reducing the resting time (40 to 25 s) Device: FitVibe, GymnaUniphy NV, Belgium Grope 2: the same as grope1, without WBV; Control: Did not receive training and were instructed not to change their lifestyle during the study or engage in any new type of physical activity</td>
<td>The proliferation of TCD4+ and TCD8+ cell; Time points of assessment: Baseline, 12 weeks</td>
<td>The addition of WBV to squat exercise training might modulate T-cell-mediated immunity, minimizing or slowing disease progression in elderly patients with OA of the knee</td>
</tr>
</tbody>
</table>

6MWT: 6-Minute Walk Test; A1: amplitude; A2: acceleration; ACR: the American College of Rheumatology; BBS: Berg Balance Scale; CST: Chair Stand Test; F: frequency of vibration; FRQ: frequency of training; KL: ; LSS: Lysholm Scoring Scale; N: number; NRS: numeric rating scale; OA: osteoarthritis; POS: initial position; R: rest time; RCT: randomized controlled trial; TDPM: threshold for detection of passive movement; TUG: Timed Up and Go Test; VibF: ; VibM: ; WBV: whole body vibration; WOMAC: the Western Ontario and McMaster Universities OA Index. TDPM= Threshold for detection of passive movement; BSS= Biodex Stability System; NRS= Numeric Rating Scale; LSS= Lysholm Scoring Scale.
based on different duration (eight weeks and 12 weeks). For eight weeks, whole body vibration did not significantly reduce pain (SMD = −0.41 points, 95% CI = −0.96 to 0.15, \(P = 0.15\), \(P\) for heterogeneity = 0.48, \(I^2 = 0\%\)) (Figure 3(A)); for 12 weeks, whole body vibration did not reduce pain (SMD = −0.74 points, 95% CI = −3.71 to 2.22, \(P = 0.62\), \(P\) for heterogeneity = 0.00, \(I^2 = 95\%\)) (Figure 4(A)).

**Stiffness**

Four studies used the WOMAC stiffness subscale as an outcome measure to assess the effects of whole body vibration on stiffness.\(^{17-20}\) The aggregated results of these studies suggest that whole body vibration did not significantly reduce stiffness (SMD = 0.02 points, 95% CI = −0.39 to 0.42, \(P = 0.94\), \(P\) for heterogeneity = 0.32, \(I^2 = 14\%\)) (Figure 2(B)). In the subgroup analyses, whole body vibration did not reduce stiffness for the eight-week duration (SMD = −0.01 points, 95% CI = −0.56 to 0.54, \(P = 0.98\), \(P\) for heterogeneity = 0.29, \(I^2 = 11\%\)) (Figure 3(B)); for 12 weeks, whole body vibration did not reduce stiffness (SMD = 0.04 points, 95% CI = −0.56 to 0.65, \(P = 0.89\), \(P\) for heterogeneity = 0.13, \(I^2 = 57\%\)) (Figure 4(B)).

**Physical function**

Three scales as follows were used to test the physical function change.

**WOMAC physical function subscale.** Four studies used the WOMAC physical function subscale as an outcome measure to assess the effects of whole body vibration on physical function.\(^{17-20}\) The aggregated results of these studies suggest that whole body vibration is associated with significantly reduced disability in physical function (SMD = −0.72 points, 95% CI = −1.14 to −0.30, \(P = 0.0008\), \(P\) for heterogeneity = 0.42, \(I^2 = 0\%\)) (Figure 2(C)). In the subgroup analyses, whole body vibration could reduce disability in physical function for the 8-week duration (SMD = −0.57 points, 95% CI = −1.14 to −0.01, \(P = 0.05\), \(P\) for heterogeneity = 0.41, \(I^2 = 0\%\)) (Figure 3(C)); for the 12-week duration, whole body vibration could reduce disability in physical function (SMD = −0.90 points, 95% CI = −1.69 to −0.11, \(P = 0.03\), \(P\) for heterogeneity = 0.21, \(I^2 = 38\%\)) (Figure 4(C)).

**6-minute walk test.** Two studies used the 6-minute walk test as an outcome measure to assess the effects of whole body vibration on functional mobility.\(^{18,19}\) The meta-analysis revealed that whole body vibration has a significant treatment effect in improving walking compared with control groups for 12 weeks (SMD = 1.15 points, 95% CI = 0.50 to 1.80, \(P = 0.0006\), \(P\) for heterogeneity = 0.37, \(I^2 = 0\%\)) (Figure 5(A)).

**Balance.** Two studies assessed the effects of whole body vibration on balance. The two studies

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**Table 2.** Assessment of the methodological quality using the PEDro scale.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Tossige-Gomes(^{16})</th>
<th>Trans(^{17})</th>
<th>Avelar(^{18})</th>
<th>Simão(^{19})</th>
<th>Park(^{20})</th>
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<tbody>
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<td>Yes</td>
<td>Yes</td>
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<td>0</td>
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<td>Blind assessors</td>
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<td>Adequate follow-up</td>
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<td>7</td>
<td>6</td>
<td>7</td>
<td>6</td>
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</table>
used the Berg Balance Scale as an outcome measure.\textsuperscript{18,19} The meta-analysis revealed that whole body vibration has a significant treatment effect in improving the Berg Balance Scales total score compared with control groups for 12 weeks (SMD = −0.78 points, 95% CI = −1.40 to −0.16, \( P = 0.01 \), P for heterogeneity = 0.54, \( I^2 = 0\% \)) (Figure 5(B)).

**Discussion**

Our meta-analysis suggests that whole body vibration training can significantly improve physical functions, and there is no evidence that whole body vibration can reduce pain and stiffness in people with knee osteoarthritis. This is verified by four high- or moderate-quality studies.
In our study, subgroup analyses suggested that eight weeks and 12 weeks whole body vibration training can significantly improve physical functions, according to measurement by the WOMAC physical function subscale, 6-minute walk test and Berg Balance Scale. The possible mechanisms may be mechanical stimuli transmitted to the body to stimulate the primary endings of the muscle spindles and polysynaptic pathways, which in turn activate alpha motor neurons, resulting in muscle contractions comparable with the tonic vibration reflex.22,23 The performance improvement is probably also related to an increase in sensitivity of the stretch reflex, which initiates muscle. Whole body vibration also induced a more efficient use of the positive proprioceptive feedback loop.24 Taken together, the above mechanism showed that the principle of whole body vibration could increase muscle strength and proprioception. Increased muscle strength and proprioception of low extremity in patients with knee osteoarthritis may be responsible for the improved physical functions.25,26 However, we found no significant effects of eight weeks and 12 weeks whole body vibration on pain and stiffness. The explanations for the finding may relate to heterogeneity of the intervention parameters.

We consider that pain and stiffness may be related to physical exercise. It is important to set another experimental group to test the influence in the research. Participants in this group should perform on a balance board and just do the same exercise without vibration. Besides, platforms
using vertical-, horizontal- or pivot-based vibration have been shown to have varying effects. It is possible that alternative vibration parameters (frequency, amplitude, duration and direction) could produce different results. Finally, we found no significant side-effects or adverse events associated with whole body vibration, and participants had relatively high compliance in most studies, indicating that whole body vibration may be a safe intervention.

The present meta-analysis also has several limitations that should be taken into account. First, our analysis is based on four RCTs, all of which had a small sample size. Overestimation of treatment effect is more likely in smaller compared with larger trials. Second, a major limitation of our subgroup analyses is that the eight weeks and 12 weeks effect are based only on two studies; thus, the conclusions about the duration of whole body vibration exercise should be interpreted with caution. Third, we consider that the response to different modes of whole body vibration is different, since three different methods of whole body vibration were found in our study. We should perform the meta-analysis on each of the vibration exercises separately, however, this is not possible given the few studies there are. Moreover, adopted whole body vibration protocols differed. These factors may have a potential impact on our results. Finally, the exclusion of non-English language studies and some missing and unpublished data may result in bias.

Figure 4. A forest plot of the subgroup analyses of RCTs comparing the 12-week whole body vibration group with control group for change in pain, stiffness and physical function. Each block represents a study and the area of each block is proportional to the precision of the mean treatment effect in that study. The horizontal line represents each study’s 95% CI for the treatment effect. The center of the diamond is average treatment effect across studies, and the width of the diamond denotes its 95% CI. (A) The aggregated results of WOMAC pain-subscale of four studies. (B) The aggregated results of WOMAC stiffness subscale of four studies. (C) The aggregated results of WOMAC physical function subscale of four studies.
In summary, the positive finding of this study suggests that eight weeks and 12 weeks whole body vibration training have beneficial effects on improving physical functions, including walking and balance. As a novel, effective, safe and alternative approach, whole body vibration training may be available in rehabilitation programs for management of knee osteoarthritis. However, given the heterogeneity among study designs and small RCTs, additional larger-scale and high-quality RCTs are needed to substantiate the current findings and investigate more effects of whole body vibration in patients with knee osteoarthritis.

Clinical messages
- Whole body vibration may improve physical function in patients with knee osteoarthritis.
- Whole body vibration training does not reduce pain for patients with knee osteoarthritis.

Conflict of interest
The authors declare that there is no conflict of interest.

Funding
This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References


