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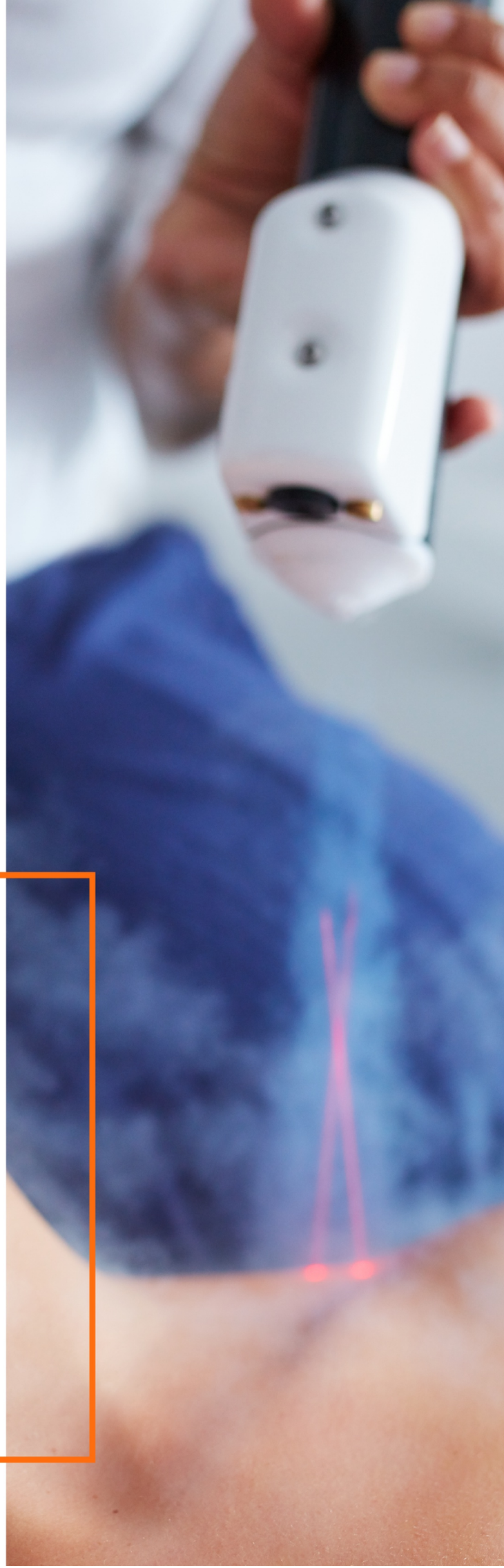

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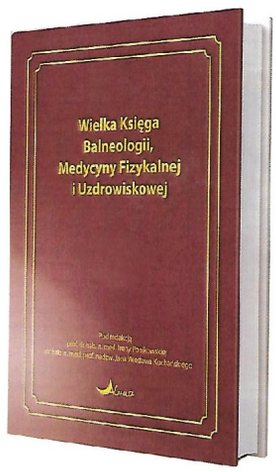

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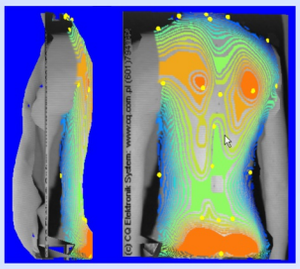

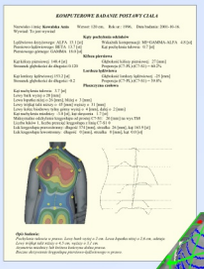

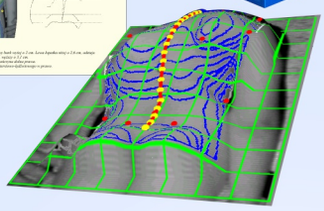

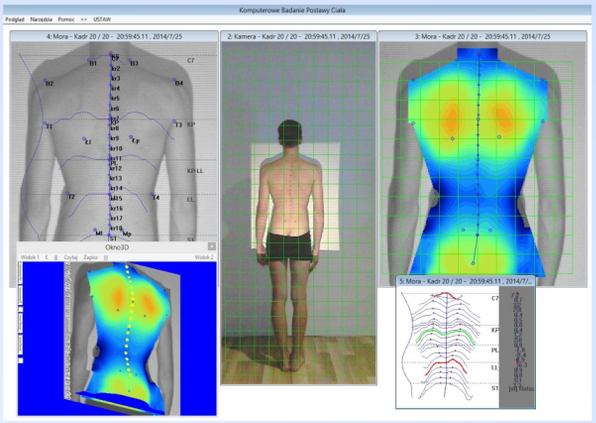

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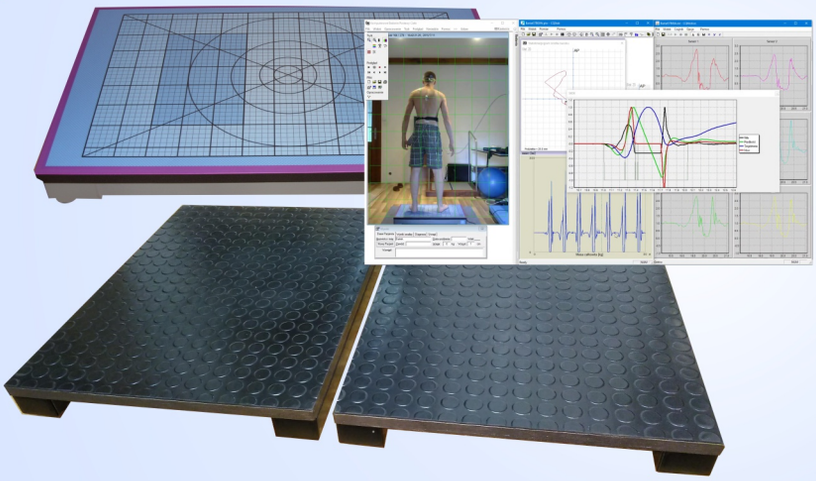

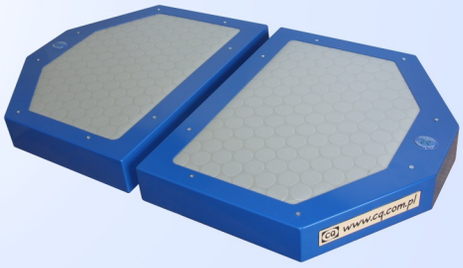

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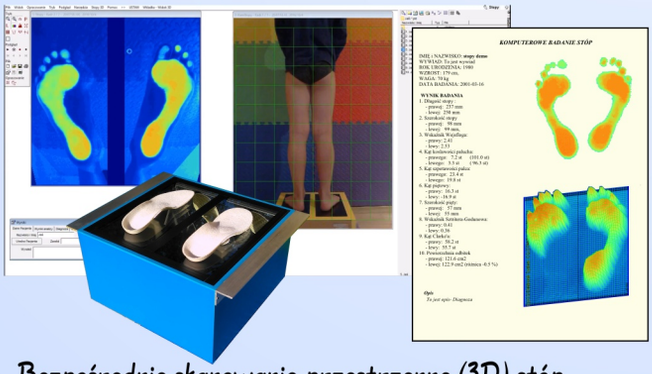

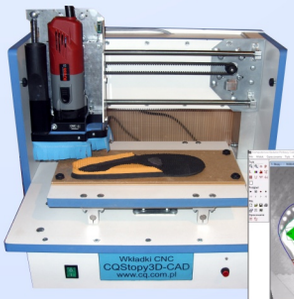

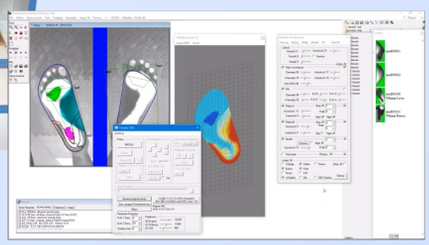

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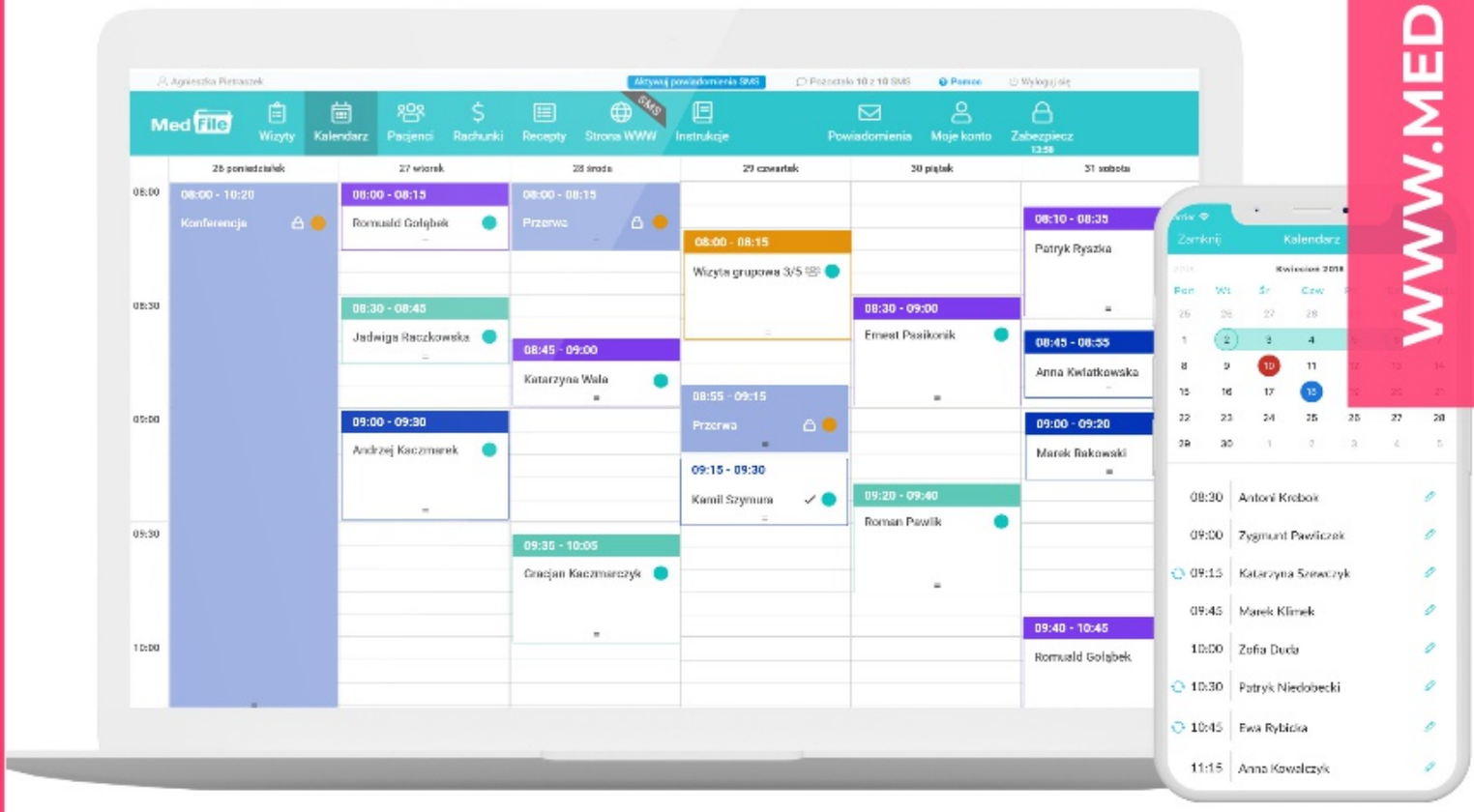

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The effects of Whole body vibration energy on bone mineral density in post-menopausal women: A systematic Review

全身振动能量对绝经后妇女的骨矿物质密度的影响：系统评价

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[1]Physical and Occupational Therapy Department, the Hashemite University, Jordan
[2]Physical Therapy Department, al-Isra university, Jordan
[3]Rehabilitation Medicine Department, Jordan University

Abstract

Aging increases the incidence of bone fractures due to the loss of bone mass especially with postmenopausal women Purpose. The aim of this systematic review is to re-evaluate the clinical trials done on the efficacy of WBV treatment of osteoporosis in postmenopausal women.
Approach. Data search and studies selection: The following databases Pub-Med, Medline, Science Direct and Google Scholar have been searched. The searches were conducted using the following key words: "Whole Body Vibration (WBV)", "Osteoporosis," "Post-Menopausal Woman," "Bone Mineral Density (BMD)." Data Extraction: we extracted sample size, age, Study design, outcomes at baseline, whole body vibration details and the main findings.
Results. some studies showed that WBV increased bone mineral density, most studies showed that it hasn't significantly increases bone mineral density in post-menopausal women.
Conclusion. we concluded that there is no consensus on the effects of WBV technique on bone mineral density.

Key words:
Osteoporosis, Aging, Fracture, Osteopenia

摘要

老年人因骨质流失而使骨折的发生率增加，尤其是停经后的妇女。该系统评价的目的在重新评估以 WBV 治疗绝经后妇女骨质疏松症的临床试验疗效。
方法。数据搜索和研究选择：已搜索下列数据库：Pub-Med、Medline、Science Direct 和 Google Scholar，搜索时使用下列关键词："全身振动（WBV）"、"骨质疏松症"、"绝经后妇女"、"骨矿物质密度（BMD）"等。数据提取：我们提取样本大小、年龄、研究设计、基线结果、全身振动细节和主要发现。
结果。部分研究显示 WBV 可增加骨矿物质密度，然而大部分研究均显示它并未使绝经后妇女的骨矿物质密度显著增加。
结论。我们得出结论是在 WBV 技术对骨矿物质密度的影响上尚未无共识。

关键词：
骨质疏松症、老化、骨折、骨质减少

Introduction

Aging increases the incidence of bone fracturesdue to the loss of bone mass (osteoporosis) [1]. Particularlyin postmenopausal women [2]. One of the most serious problems which face post-menopausal women is osteoporosis. The World Health Organization has defined osteoporosis as a disease characterized by "low bone density and microarchitectural deterioration of bone tissue with a consequent increase in bone fragility and susceptibility to fracture" [3]. More than 200 million postmenopausal women around the world suffer from osteoporosis.[4] In the United States, osteoporosis affects 2% of men and 10% of women aged 50 years and above. In addition, 49% of older women and 30% of older men have osteopenia [5]. In Taiwan, 1.63% of men aged 50 years and above suffer from osteoporosis, and 11.35% of women suffer from it [6]. Osteoporosis and falls are related to fractures, which can lead to increased morbidity and mortality, as well as decreased functional ability. The mortality of patients with hip fractures within 1 year is 20%, and only one-third of the patients have recovered their pre injury level of function [7].

Most strategies for treating bone loss have focused on dietary and pharmacologic interventions [8], but also non-pharmacologic interventions have been suggested for treating osteoporosis in postmenopausal women and great part of evidence is in favor for exercise interventions as a countermeasure for the prevention and treatment of osteoporosis in women [9]. Despite the great importance of exercise and physical activity for the treatment of osteoporosis in postmenopausal women, it is difficult to force elderly women to continue intense or vigorous exercise, and the popular walking or jogging forms of exercising are sometimes potentially harmful for people with impaired balance and flexibility [10].

Whole body vibration (WBV) is a popular exercise where individuals stand on an oscillating plate, and the motor transmits vertical accele-

ration to muscle and bone [11]. WBV can produce osteogenic effects by changing the flow of bone fluid through direct bone stimulation and mechanotransduction, or it can generate indirect bone stimulation through skeletal muscle activation by means of tone stretch reflex [12]. WBV can operate in a number of planes; small rotational oscillations around a central axis, up and down in the vertical plane, or side-to-side in the lateral plane [13]. The effect of whole body vibration energy on bone mineral density in postmenopausal women is yet conflicting as many systematic reviews have shown that the effects WBV treatments in the clinical trials have managed maintenance in BMD rather than increasing bone density [14] .

The aim of this systematic review is to re-evaluate the clinical trials done on the efficacy of WBV treatment of osteoporosis in postmenopausal women, with a focus on sample size and the protocols used for WBV treatments.

Material and Methods

This review has been reported as recommended in preferred reporting items for systematic review.

Eligibility criteria: Type of studies: Clinical trials that have pre-post design and published between 2003 and 2016. The included articles were in English language.

Type of intervention: Whole body vibration.

Type of participants: post-menopausal women with osteoporosis.

Type of outcomes: Bone mineral density.

Data search and studies selection: The following databases PubMed, Medline, Science Direct and Google Scholar have been searched. The searches were conducted using the following key words: “Whole Body Vibration (WBV)”, “Osteoporosis”, “Post-Menopausal woman”, “ Bone Mineral Density (BMD)”.

Data Extraction: we extracted sample size, age, Study design, outcomes at baseline, whole body vibration details and the main findings.

Results

Study selection: A total of 5 articles were included. Database and hand search provided 70 publications. After adjusting the duplication, 20 had been removed. Based on the title and abstract, 23 were excluded; 15 were non randomized clinical trial, and 8 applied vibration interventions other than whole body vibration. Of the remaining 27, 22 articles did not meet the inclusion criteria. Finally, 5 trials were met the inclusion criteria (Figure 1).

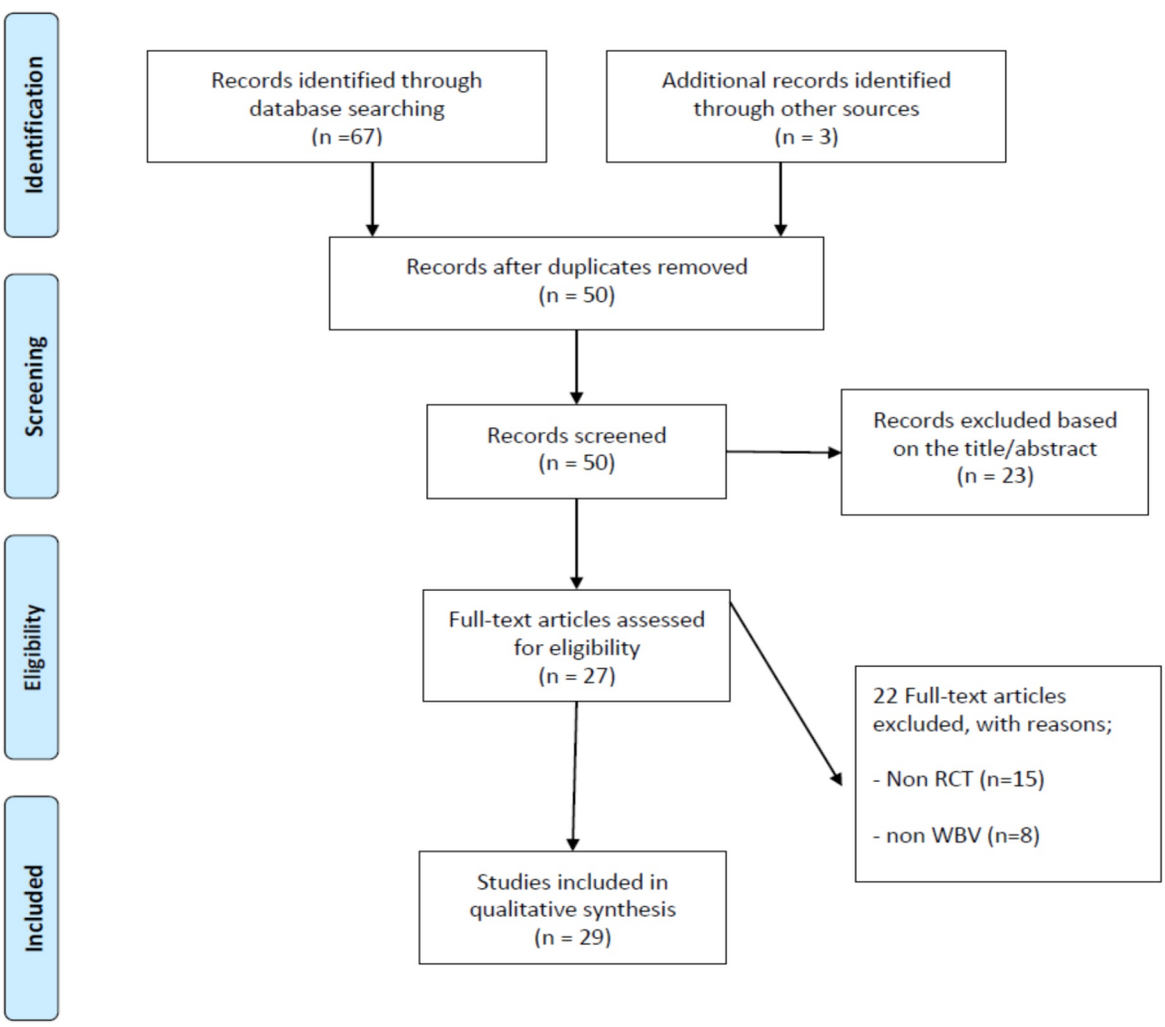

Figure 1. PRISMA flowchart of studies and selection

The quality of included articles revealed good scores as showed in (Table 1). All included studies design was Randomized controlled trial (RCT) with high quality assessment (Table 2). Some studies showed that WBV increased bone mineral density; most studies showed that it hasn't significantly increases bone mineral density in post-menopausal women (Table 3).

Table 1. Quality of included articles, Methodological quality: WWW.pedro.org.au

Study / Item	Verchuren 2014	Lai 2013	Mediros 2015	Lwamoto 2005	Gusi 2015
Eligibility Criteria	Yes	Yes	Yes	Yes	Yes
Random Allocation	Yes	Yes	Yes	Yes	Yes
Concealed Allocation	No	No	No	No	No
Baseline Comparability	Yes	Yes	Yes	Yes	Yes
Blind Subjects	No	No	No	No	No
Blind Therapists	No	No	No	No	No
Blind Assessors	Yes	No	No	No	No
Adequate follow-up	Yes	Yes	Yes	Yes	No
Attention to treat analysis	Yes	Yes	Yes	Yes	Yes
Point estimate variability	Yes	Yes	Yes	Yes	Yes
Between groups comparison	Yes	Yes	Yes	Yes	Yes
Overall Score	7	6	6	6	5

Table 2. Quality assessment of the included articles

Study	Sample size	Age	Study design	Quality assessment
Sabine MP Verschueren, 2003	70	58-74	RCT	7
Jun lwamoto, 2005	50	55-88	RCT	6
Narcís Gusi, 2006	28	-	RCT	5
Chung-Liang Lai, 2013	28	-	RCT	6
Fernanda Santin-Medeiros, 2015	37	82.4	RCT	6

Table 3. The main finding of the included articles

Study	Outcomes at baseline	WBV details	Main findings
Sabine MP Verschueren, 2003	* BMD whole body (g/cm2): 1.02 ± 0.09 in WBV group. 1.01 ± 0.08 in RES group. 1.03 ± 0.06 in CON group. P Value = 0.84. * BMD proximal femur (g/cm2) 0.88 ± 0.14in WBV group. 0.84 ± 0.09in RES group. 0.84 ± 0.11in CON group. P Value = 0.64 * BMD lumbar spine (g/cm2) 0.90 ± 0.14in WBV group. 0.90 ± 0.14in RES group. 0.93 ± 0.14in CON group. P Value =0.71	35–40 Hz, 2.28 –5.09g. Three times weekly for 24 weeks	Total hip BMD increased over time inthe WBV training group (+0.93%; 95% CI, 0.13–1.71; p = 0.03), whereas no changes in hip BMD were observed in women participating in resistance training or age-matched controls (-0.51%; 95% CI, -1.13 to -0.11; p _ 0.41 and -0.62%; 95% CI, -1.30–0.07; p _ 0.16, respectively). Compared with the RES group, the 6-month vibration interventionresulted in a significant 1.51% net benefit in total hip BMD (p < 0.05). A similar net benefit (1.53%, p < 0.01) was observed incomparison with the CON group.
Jun lwamoto, 2005	Lumbar BMD (g/cm2): ALN = 0.569 ± 0.107. ALN+WBV= 0.563 ± 0.114	20 Hz. Once a week, 4 minutes every session for 12 months	After 6 months: Lumbar BMD (g/cm2): ALN= 0.591 ± 0.103. ALN+WBV= 0.584 ± 0.120. After 12 months: ALN= 0.611± 0.095 ALN+WBV= 0.614 ± 0.102
Narcís Gusi, 2006		12.6 Hz Three sessions for 8 months.	
Chung-Liang Lai, 2013	The average BMD of the lumbar spine was 0.818 ± 0.088 g/cm2 (0.684–0.984 g/cm2).	(30 Hz) and high-magnitude (3.2 g). 5 minutes, three times per week for Six months.	The BMD of the WBV group and the CON group after 6 months was 0.835 ± 0.098 g/cm2 (compared to the pretest, P = 0.047) and 0.815 ± 0.076 (compared to the pre-test, P = 0.188), respectively. There was a significant increase in the BMD of the lumbar spine of the WBV group, while there was a decrease in that of the CON group. The BMD of the lumbar spine in the WBV group increased by 2.032% ± 3.332%, while that of the CON group decreased by 0.046% ± 1.245%.
Fernanda Santin-Medeiros, 2015	BMD in all the hip regions at baseline F(0, 0) = 0.61; p= 0.44	(20 Hz and 2 mm). Twicea week for 8 months, with at least one day ofrest betweensessions.	No statistically significant differences between CON and WBV groupsfor BMD in all the hip regions. No statistically significant changes in the totalBMD were found within groups [F(0, 1) = 1.04; p = 0.68, and F(0, 1) = 2.14; p = 0.15 for pre-post values in the CONand WBV groups respectively

Discussion

Whole body vibration (WBV) has been proposed to be a therapeutic technique used to improve bone density. Given how much bone density is affected in post-menopausal women, WBV has been examined to understand its effect in this population. After a prolonged, in depth research we were able to come across 5 studies that matched our inclusion criteria that discussed the effects of WBV in postmenopausal women. The main objective of this review was to examine the evidence provided by those studies to find out whether or not using WBV is a viable technique that can help post-menopausal women with decreased bone density.

The first study was by Verschueren et al (2003) where they conducted a randomized controlled pilot study with 70 subjects. Subjects were allocated randomly into one of three groups; a whole body vibration group (n=25), a resistance training group (n=22), and a control group (n=23). Both experimental groups trained three times a week for 24 weeks. The WBV group performed static and dynamic knee extensor exercises on a vibrating platform, while the resisted training group performed knee extension by dynamic leg press and leg extension exercises. The control group reported no training of any kind. Their results suggest that both vibrations training and resistance training improved static and dynamic muscle strength. However total hip bone mineral density was significantly improved only in the WBV group. Improvement in bone mineral density was not significantly correlated with muscle strength improvement. Despite the good design on the study, it still had a number of li-

mitations which should be taken into consideration when interpreting the results. First of all, there were no physiological explanations for the improvement in bone mineral density and whether other protocols might have different effects or not. Also, all subjects in this study were healthy, which places a major limitation on generalizing those results to diseased population. Nonetheless, the authors have addressed both those limitations in the discussion section.

The second study was by Iwamoto et al (2004) where they examined 50 post-menopausal women with osteoporosis and followed them up for 12 months. Subjects were allocated randomly into one of two groups; one group taking alendronate (n=25) and one taking alendronate and WBV (n=25). The alendronate group took 5mg/day, while the exercise group took the medication in addition to a once a week session lasting 4 minutes. Results from this study showed that the increase in bone mineral density was not statistically different between both groups, yet the exercise group showed less chronic low back pain scores. Their conclusion was that WBV could be used as a method to reduce chronic low back pain levels in post-menopausal osteoporotic women. A major limitation to this study is the lack of a true control group that did not receive any medication, which makes comprehending those results more intricate.

Gusi et al (2006) had the third publication in this field where they examined 28 postmenopausal women and followed them up for 8 months. Subjects were assigned into either a WBV program (n=14) or to a walking program (n=14). The vibration session included 6 bouts of 1 minute with 1-minute rest in between bouts, while the walking program included a 1-hour walk including a 5-minute stretching break 3 times a week. Their results showed a significant increase in femoral neck bone mineral density in the WBV group as compared to the walking group. Yet lumbar spine bone mineral density showed no differences in between groups. The biggest limitation of this study is the small sample size, in addition to including only healthy subjects while excluding subjects with osteoporosis.

Eight years later, Lai et al (2006) published an article where they examined the effects of WBV for 6 months on postmenopausal women. 28 subjects were allocated randomly into either a WBV group (n=14) or a control group (n=14). The WBV group received treatment for 5 minutes, 3 times a week. After 6 months of exercising, the exercise group showed significant improvement in lumbar spine bone mineral density. Again, a huge limitation in this study is the small sample size.

The most recent article that was published in this specific arena was by Santin-Medeiros et al (2015). In this study 37 postmenopausal women were randomly assigned into either a WBV group (n=19) or a control group (n=18). The WBV group performed vibration training for twice a week for 8 months, while the control group had no training. Their results showed that after 8 months of WBV there were no differences in bone mineral density in all hip regions. Yet, the small sample size and the age range that was selected (age mean was 82 years) would be considered as limitation to this study.

As aforementioned, there is a huge inconsistency in the literature regarding the effects of WBV on bone mineral density. This inconsistency can be attributed to a number of reasons. First, the sample size of most studies is considered relatively small which would make generalizing the results and their accuracy very challenging. Second, the type of WBV protocol that was used in those studies was not similar, in terms of the device used, the frequency of vibration, the duration of the exercise, and the frequency of training session. Finally inclusion and exclusion criteria for the studies varied significantly, with the major difference being whether or not subjects with osteoporosis have been recruited for the study. Due to all these variances in study protocols, designs, and methodology, finding a consensus on the effect of WBV remains unclear.

Conclusion and recommendations

We concluded that there is no consensus on the effects of WBV technique on bone mineral density, although some studies showed that WBV increased bone mineral density, most studies showed that it hasn't significantly increases bone mineral density in post-menopausal women. We need to domore studies about using WBV in post-menopausal women but with large sample size of patients, and same protocol to get more precise and significant results.

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