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Effect of Whole-Body Vibration on Bone Mineral Density in Post-Menopausal Women Aged > 65 Years: A Meta-Analysis

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Abstract: **Constitutional exercising is regarded as an efficacious tactic, frequently endorsed in general practice, for the prevention and management of post-menopausal osteoporosis. Whole body vibration (WBV) is a contemporary type of exercise that has been repeatedly tested for its ability to prevent bone fractures and osteoporosis. The aim of the current meta-analysis is aimed towards understanding the influence of WBV treatments in leading to optimum BDM outcomes in healthy post-menopausal women aged >65. A literature search was conducted with the following key words such as "whole body vibration", "bone mineral density", "bone density", "postmenopausal", "elderly" from Cochrane Register of Controlled Trials (CENTRAL), MEDLINE and EMBASE database up to December 2017. Change of BMD of the femoral neck and lumbar spine were evaluated. Meta-analysis was made using Meta-Essentials. The analysis of the data showed that the WBV stimulation when related with healthy postmenopausal women aged >65 years did not produce a significant development in BMD values at the femoral neck and the lumbar spine.**

Keywords: **whole-body vibration, bone mineral density, post-menopausal, meta-analysis.**

1. INTRODUCTION

By virtue of the aging of the global population, the determent and treatment of chronic diseases in the elderly have become crucial health concerns. The numerical escalation of osteoporosis-induced fracture instances in the elderly is remarkable (Kanis JA et al., 2008). The World Health Organization has defined osteoporosis as a disease typified by "low bone density and microarchitectural deterioration of bone tissue with a consequent increase in bone fragility and susceptibility to fracture." (Totosy de Zepetnek JO, 2009). Bone fracture injury is one of the most common and costly health problem in the population, especially in post-menopausal women (Roudsari BS et al., 2005).

The foremost determinants of bone fractures are falls, bone fragility, loss of equilibrium and lower limb strength decline (Kannus P et al., 1995). Osteoporotic fractures commonly arise at the backbone, hip, distal forearm and proximal humerus (Johnell O and Kanis JA, 2006). A vast majority for treating bone loss are oriented towards diatery and pharmacological interventions (Hamdy RC et al., 2010). Nonetheless, drug remedies can have detrimental effects yet poor long-term adherence, in spite of their efficacy (Green J et al., 2010). Constitutional exercising is regarded as an efficacious tactic, frequently endorsed in general practice, for the prevention and management of post-menopausal osteoporosis (Shea B et al., 2004).

Vibration might be an applicable alternative in feeble people (Bautmans I et al., 2005). Whole body vibration (WBV) is a contemporary type of exercise that has been repeatedly tested for its ability to prevent bone fractures and osteoporosis. Studies have shown that whole body vibration (WBV) has remarkable impact on gait, body balance and motor capacity

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(Bruyere O et al., 2005). WBV is performed as individuals stand on an oscillation plate, then the device the device transmits vertical acceleration according to muscle then skeleton (Rauch F et al., 2010). WBV generated osteogenic outcomes by altering the flow of bone fluid via bone stimulation and mechano-transduction, conversely it can generate indirect bone through skeletal muscle activation by utilizing tone stretch reflex (Judex S and Rubin CT, 2010). WBV is a technique that includes the junction of different mechanical factors. Vibrations are transmitted through the kinematic chain of the body: the combination of frequency, amplitude of the stimulus, subject posture and vibration delivery design can dramatically alter the actual stimulus at the targeted area (Fratini A et al., 2014).

The aim of the current meta-analysis is aimed towards understanding the influence of WBV treatments in leading to optimum BDM outcomes in healthy post-menopausal women aged >65.

2. METHODS

Inclusion criteria:

Studies that examined the effect of WBV on BMD in healthy postmenopausal women aged >65 years were selected. The included papers were randomized clinical trials (RCTs) and controlled clinical trials (CCTs) studies with control arms. Control groups included traditional exercise training or light/absent physical activity. No restrictions on vibration delivery design, frequency, magnitude and cumulative dose (total stimulus delivered to the patients) were considered.

Exclusion criteria:

Studies on male subjects or athletes, with limited clinical information or inaccurate number of cases, single-arm studies, literature reviews, case reports, were excluded.

Interventions:

Whole-body vibration (via vibrating platforms) either with or without combined exercise training.

Measurement index:

Change of BMD of the femoral neck and lumbar spine were evaluated.

Retrieval method:

A literature search was conducted with the following key words such as “whole body vibration”, “bone mineral density”, “bone density”, “postmenopausal”, “elderly” from Cochrane Register of Controlled Trials (CENTRAL), MEDLINE and EMBASE database up to December 2017. Searching language is limited to English.

Study screening and data extraction:

Collected information mainly consisted of first author, dates of accrual, study design, study sample size, participant characteristics, study arms, study intervention, median follow-up time, and outcome (pre-post change in BMD).

Quality evaluation:

Quality evaluation was done according to the quality evaluation standard recommended by Cochrane handbook 5.0: (1) whether the randomized method is correct or not; (2) whether allocation concealment method is used or not; (3) whether blinding or not is adopted; (4) whether there is bias caused by data deficiency or not; (5) whether there is bias caused by selective report or not; (6) whether there are other types of bias or not. Each quality standard will be divided into “yes”, “no” and “not clear” (Higgins JPT and Green S, 2011).

Statistical treatment:

Meta-analysis was made using Meta-Essentials (Suurmond R et al., 2017). They were calculated mean difference and 95% confidence intervals (CIs) for continues variables (BMD pre- and post-value). When each document used the same measurement and unit to one index, measurement data counted weighed mean difference. A random effect model was used because when studies are gathered from researchers operating independently, the random-effects model is more easily justified than the fixed-effect model. Heterogeneity across trials was assessed using the Cochrane Q-statistic (p<0.05 was

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considered significant) and I^2-statistic. I^2 describes the percentage of total variation across studies; that is, due to heterogeneity rather than chance. A value of 0 % indicates no heterogeneity, and larger values indicate increased heterogeneity. Publication bias was visually estimated by assessing funnel plots and two tests (Begg's test and Egger's test). All statistical evaluations were made assuming a two-sided test with a significance level of 0.05. (Ellis and Paul D, 2010)

3. RESULTS

Search results:

2519 articles were identified by title and abstract. Articles that did not meet the necessary requirements (inclusion and exclusion criteria) were excluded. Finally, 3 studies have been selected and included in the present work (Leung KS et al., 2014; von Stengel S et al., 2011-a; von Stengel S et al., 2011-b).

Quality evaluation and general characteristics of the included studies:

The quality evaluation of 3 articles is shown in Figure 1, and their general characteristics are shown in Table 1. All the three finally selected studies consist of randomized studies. A total number of 768 participants (intervention arm=366, control arm=402) was examined.

Meta-analysis:

BMD femoral neck:

All three articles described the mean difference (MD) for overall bone mineral density of femoral neck. Random-effect mode was used, and no heterogeneity was estimated between the studies (p_q=0.98, I^2=0%). Comparing the two methods (Whole-body vibration vs Control) we found that there was no significant difference between them (MD=-0.01, 95%CI: -0.32 to 0.30, Z=-0.13, p=0.89). Does not exist publication bias from the Begg-Mazumdar test (p=0.117) and Egger test (p=0.577). The forest plot for the BMD change of the femoral neck between the WBV and Control group, is shown in Figure 2.

BMD lumbar spine:

All three articles described the mean difference (MD) for overall bone mineral density of lumbar spine. Random-effect mode was used, and no heterogeneity was estimated between the studies (p_q=0.15, I^2=48.07%). Comparing the two methods (Whole-body vibration vs Control) we found that there was no significant difference between them (MD=-0.18, 95%CI: -0.46 to 0.16, Z=-1.23, p=0.22). Does not exist publication bias from the Begg-Mazumdar test (p=0.602) and Egger test (p=0.674). The forest plot for the BMD change of the lumbar spine between the WBV and Control group, is shown in Figure 3.

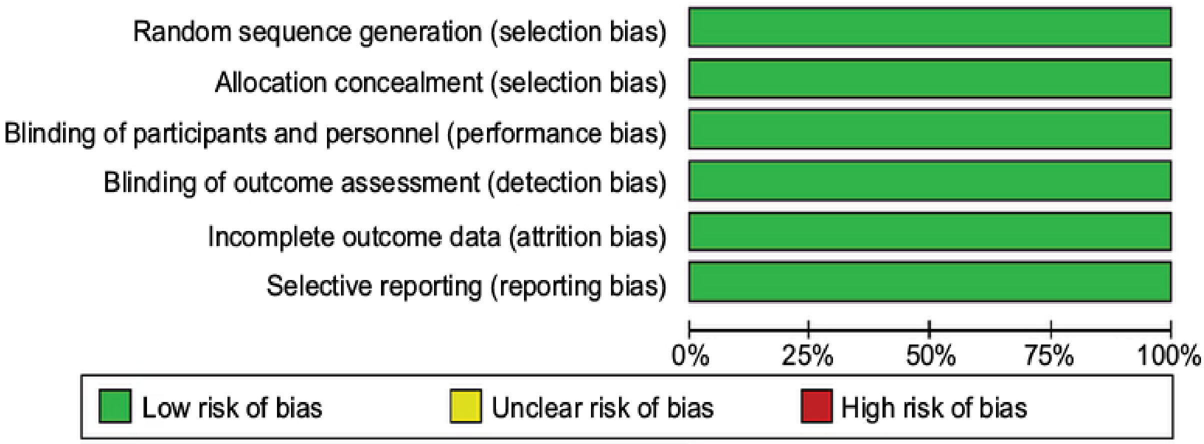

Figure 1. Risk of bias graph

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Table 1. General characteristics of studies

Author and year publication	Study design	Study sample size	Mean age (stanard deviation)	Control intervention	Mean follow-up (months)
Leung KS et al., 2014	RCT	72 (intervention arm=36, control arm=36)	73 (sd=7)	No treatment	18
von Stengel S et al., 2011-a	RCT	100 (intervention arm=50, control arm=50)	65.8 (sd=3.5)	Sham vibration	12
von Stengel S et al., 2011-b	RCT	596 (intervention arm=366, control arm=402)	68.5 (sd=3.1)	Conventional training group	18

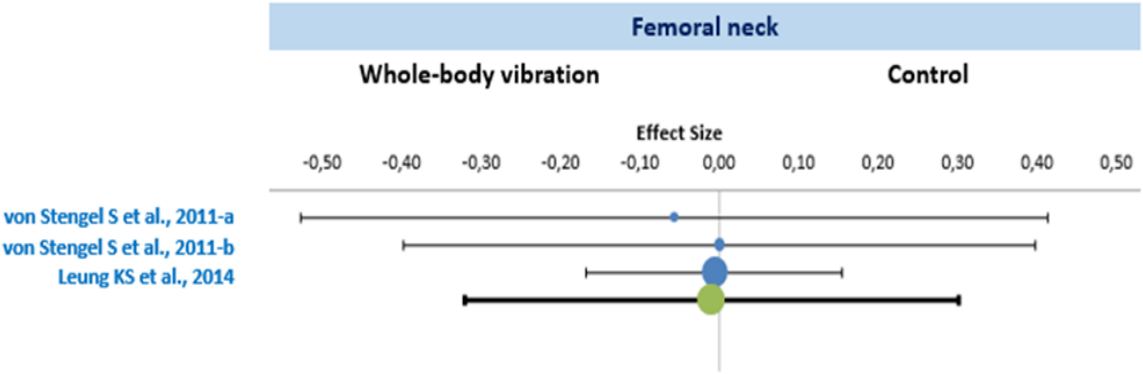

Figure 2. Forest plot for the BMD change of the femoral neck between the WBV and Control group

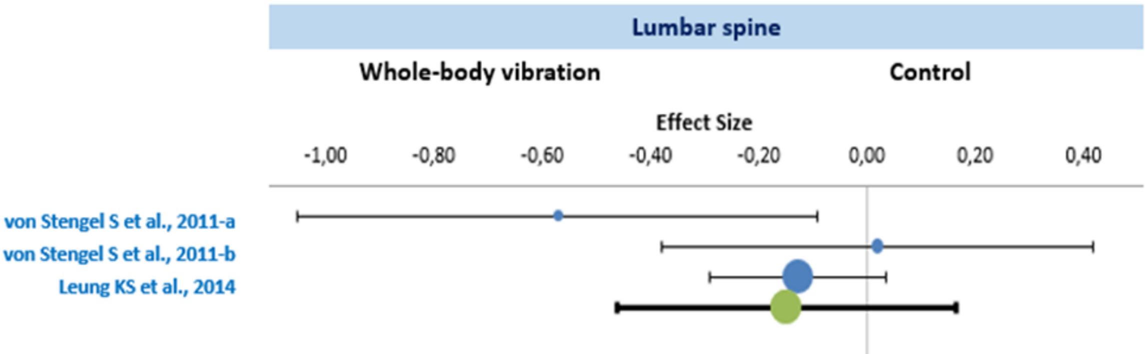

Figure 3. Forest plot for the BMD change of the lumbar spine between the WBV and Control group

4. DISCUSSION

Physical exercises are considered to be able to decrease bone loss and fall rate (Granacher U et al., 2011). Nonetheless, the consistence of long-term physical exercises is poor, and sporadically, it might increase the danger of injures and particularly in elderly individuals (Kallinen M and Markku A, 1995). With better conformity and assurance to elderly women, WBV is observed as a new potential anti-osteoporotic treatment. After all, its beneficial outcome on bone quality improvement and fall prevention has not been proved yet. The most frequent direct reason of osteoporotic fracture is fall with poor bone condition in postmenopausal women. Falls can edge to functional deterioration and fragility of bone (Laird RD et al., 2001). To the best of found knowledge present analysis is a systematic review to appraise the hazard of fall after WBV treatment in healthy postmenopausal women aged >65 years.

On account of, some barriers in this meta-analysis the results are affected by deformation of the control group of the included studies. One study contributed not providing treatment to patients in the control group (Leung KS et al., 2014). Sham vibration was used in one included trial (von Stengel S et al., 2011). Moreover, except whole-body vibration therapy, anti-osteoporosis drugs were used such calcium, vitamin D, and alendronate. In spite of anti-osteoporosis drug use, it is possible that anti-osteoporosis drug therapy plus WBV treatment remain a greater than addictive effect. All combined trials contributed to follow-up data of no longer than 18 months, and no complication were reported. Nonetheless, the long-term effect of WBV still ought to be evaluated. In addition, there is a reduction of systematic undivided fall risk assessment. To the best of our understanding, there's no such an evaluation that can be used to assess the fall risk. Different assessment or test was used in included studies, which makes it unsuitable to do a meta-analysis. So, a systematic assessment should be developed to evaluate the fall risk in postmenopausal women. Such assessment should compose the data of strength of lower limbs, results of balance test, BMD, etc. and appear to a score as a conclusion.

5. CONCLUSION

WBV stimulation when related with healthy postmenopausal women aged >65 years did not produce a significant development in BMD values at the femoral neck and the lumbar spine. Thus, protocol data was used for meta-analysis and only three RCTs were accessible, which would weaken the level of evidence. More evidence based is needed to better understand the benefits of WBV treatment in healthy postmenopausal women aged >65 years.

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