ISSN : 2350-0743

www.ijramr.com

International Journal of Recent Advances in Multidisciplinary Research
Vol. 06, Issue 09, pp.5234-5238, September, 2019

RESEARCH ARTICLE

EFFECT OF WHOLE-BODY VIBRATION ON BONE DENSITY IN CHILDREN WITH DOWN SYNDROME: A SYSTEMATIC REVIEW

Samia A. Abdel Rahman[1,*], Ahmed Mohamed Elnahhas[2] and Dina Ibrahim El-Sayed Ahmed[3]

[1]Professor of Pediatric Physical Therapy, Faculty of Physical Therapy, Cairo University,Egypt
[2]Lecturer of Pediatric Physical Therapy, Faculty of Physical Therapy, Cairo University, Egypt
[3]Physical Therapist at General Hospital, Mansoura, Dakahlia, Egypt

ARTICLE INFO

Article History:
Received 27th June, 2019
Received in revised form
29th July, 2019
Accepted 20th August, 2019
Published online 30st September, 2019

Keywords:
Down syndrome,
Trisomy 21,
Whole body vibration,
Bone mineral density,
Systematic review.

ABSTRACT

Background: Down syndrome is one of the most common genetic causes of developmental delays. Children with Down syndrome exhibit a reduction in bone mineral density. **Objective:** To systematically review the available studies on the effectiveness of whole-body vibration on bone density in children with Down syndrome. **Methods:** Four electronic databases; PubMed, Cochrane Library, Physiotherapy Evidence Database (PEDro), and Google Scholar were searched up to June 2019. Studies were selected if they were published full text randomized controlled trails in peer-reviewed journals in any language and focused on the effect of whole-body vibration for children with Down syndrome who aged one to 18 years. The outcome measure was bone mineral density. Two authors independently screened articles, extracted data and assessed the methodological quality using PEDro scale, with revision from the first author. Modified Sackett Scale was used to determine the level of evidence for the outcome. **Results:** Out of 540 articles screened, two studies with 55participants met the inclusion criteria. The duration of treatment ranged from 10 to 20 minutes, three times a week and for 12–20 weeks. One study has a fair quality, while the other has poor quality (with a mean Pedro score of 3.5 out of 10).The clinical homogeneity of studies makes meta-analysis appropriate. The mean difference across all studies is -0.43 (95% CI is -0.98- 0.11). According to Modified Sackett Scale, there is level 2 evidence to support using whole body vibration for increasing bone mineral density. **Conclusion:** In children with Down syndrome, there is poor-quality evidence that whole body vibration training improves bone mineral density. Therefore, high-quality studies are required.

INTRODUCTION

Down syndrome (DS) is one of the most common chromosomal abnormalities in humans. It occurs in about one per 691 babies born each yearcaused by presence of the three copies of chromosome 21 (Frank, 2015).It is associated with a characteristic phenotype in terms of physical appearance as well as with medical problems such as metabolic disorders dysmorphism, congenital heart disease, and thyroid dysfunction (Weijerman, 2010).Children with Down syndrome exhibit a delaying motor development due to hypotonia, ligamentous laxity, poor balance, and a lack of postural control that cause difficulties in adapting the gravity and the surrounding environment(Ulrich, 2008).Children and adults with Down syndrome exhibit a reduction in bone mineral density (BMD) and an imbalance between bone resorption and formation during remodeling lead to the high incidence of osteopenia and osteoporosis (Özçivici, 2013).

***Corresponding author:* Samia A. Abdel Rahman,**
Professor ofPediatric Physical Therapy, Faculty of Physical Therapy, Cairo University, Egypt. Email: m.samia@cu.edu.eg

Patient with DS has several environmental and hormonal factors that contribute to low BMD such as: hypotonia, low amounts of physical activity, poor calcium and vitamin D absorption and hypo-gonadism (McKelvey, 2013).Bone mineral density is a medical term normally referring to the amount of mineral matter per square centimeter of bones. Bone density (or BMD) is used in clinical medicine as an indirect indicator of osteoporosis and fracture risk (Cole, 2008).One common test used to measure bone mineral density is dual energy X-ray absorptiometry (DXA or DEXA). It focuses on two main areas - the hip and the spine. It can get also on forearm. These areas can give a good idea of whether fractures can occurs in other bones in the body (World health organization, 2003).The results of bone mineral density test are compared to the ideal or peak bone mineral density of a healthy 30-year-old adult giving a T-score. A score of zero means that the BMD is equal to the norm for a healthy young adult. Differences between the BMD and that of the healthy young adult norm are measured in units called standard deviations (Table 1). One standard deviation is equal to a 10-12% difference in bone mass (https://americanbonehealth.org/. (Accessed 29 April 2018). Vibration therapy or whole body vibration (WBV) also known as biomechanical stimulation (BMS), or biomechanical oscillation (BMO) is a training method employing low amplitude, low frequency mechanical stimulation to exercise musculoskeletal structures for the improvement of muscle strength, power, and flexibility. Vibration training has been advocated as a therapeutic method in the treatment of osteoporosis andsarcopenia (Al Basini, 2010). Its effects on the musculoskeletal system include improvement of muscle function and increasing of BMD (Lam, 2013). Whole body vibration training is characterized by an external stimulation inducing an oscillation vibration to a subject standing on a vibrating platform. Most platforms rely on one or both of the two most commonly used energy transfer systems but also vary by technical quality. One type of devices transfers vibration to both feet synchronously (also known as vertical vibration), while the other one uses a side alternating mode like standing on a seesaw (Gloeckl, 2015).

How vibration therapy increases bone density is not well understood. One hypothesis suggests that vibration signals transmit and amplify into bone tissue, directly activating mechano-sensors in bone cells. Another hypothesis suggests that whole-body vibration, like other weight-bearing exercise, improves muscle strength and power by increasing neuromuscular activation. Others have shown whole-body vibration therapy to improve muscle and bone circulation, increasing the supply of nutrients needed to build bones (Von Stengel, 2011). The aim of this study was to review the effects of WBV on BMD in children with Down syndrome.

MATERIALS AND METHODS

Search strategy: The databases PubMed, Cochrane Library, Physiotherapy Evidence Database (PEDro) and Google Scholar were searched for randomized controlled trials without restrictions regarding language or year of publication. The following keywords were used: whole body vibration, mechanical load, Down syndrome, trisomy 21, bone mineral density and mongolism. All databases were searched from inception until June 2019. The articles were assessed against the eligibility criteria. Studies were included in this review if they met the following criteria: full text randomized controlled trails published in peer-reviewed journals, studying the effect of WBV on BMD in children with Down syndrome, age of participants ranged from one to 18 years and the outcome measures related to BMD.Two authors independently evaluated each title and abstract identified in the search against the eligibility criteria. The full text was obtained for complete analysis. Two authors independently extracted data from the included studies and assessed its methodological quality. The whole process was revised by the first author.

Data Extraction: Data from all the included studies were summarized in the format sheets demonstrated in tables according to AACPDM which demonstrate the general information about the studies and participant characteristics as well as intervention, procedures, outcome measures, main findings and author conclusion. The following data were extracted: name of the primary author and year of the publication of article, design of the study, information about the subjects in the included study (number, diagnosis, gender and age), inclusion and exclusion criteria, description of the intervention as well as the main results and author conclusion of the included studies (Table 2 and 3).

Quality Assessment: The following classification was used for rating the methodological quality using Physical therapy evidence database (PEDro) scale: a PEDro score of <4 indicated poor quality; score of 4–5 indicated fair quality; score of 6–8 indicated good quality; and score of 9–10 indicated excellent quality (Valkenet, 2011).

Levels of Evidence: For interpretation of results, modified Sackett Scale was used to determine the level of evidence for each outcome (Straus, 2015).

RESULTS

The search strategy identified 540 studies till June 2019. After screening titles and abstracts, 12 full papers were retrieved. After assessing articles against the eligibility criteria, two papers were included in the review (Figure 1). Across all studies 55 children participated, all diagnosed with Down syndrome. Their ages ranged from 4 years to 18 years.Results of the quality assessment of the included studies by PEDro scale are presented in Table (4).One study has a fair quality (16), while the other has poor quality (Zaky, 2013) (with a mean PEDro score of 3.5 out of 10).According to this table, the scores of both studies are < 6. Accordingly, the evidence is grade two according to Modified Sackett scale. By refereeing to Tables (2) &(3), that there is a clinical homogeneity between the included studies making the meta-analysis an appropriate choice.

Zaky and Elbagalaty (2013) evaluated BMD before and after 3 months of treatment by dual energy x-ray absorptiometry. For treatment, the control group received selected physiotherapy program included facilitation of equilibrium and protective reactions, stimulatory techniques and muscle strength and endurance. The children in the study group received the same selected physical therapy program in addition to WBV.In Matute-Llorente *et al*. (Matute-Llorente, 2015), X-ray absorptiometry (DXA) was used to measure bone geometry and bone strength. Peripheral quantitative computed tomography (pQCT) was used for measuring bone strength and volumetric BMD (vBMD), plus other measures such as bone strength indexes. For treatment: A synchronous vibration platform (Power Plate®) was used (3/week, 10 repetitions (30–60 s) 1-min rest, frequency of 25–30 Hz, and peak-to-peak displacement of 2 mm (peak acceleration 2.5– 3.6 g).The total number of subjects included into analysis was 29 in experimental groups and 26 in control groups. The meta-analysis revealed that Matute-Llorente *et al*. study (Matute-Llorente, 2015) showed a statistically non-significant effect of WBV on BMD in Down syndrome children while Zaky and Elbagalaty study (15) showed a statistically significant effect of WBV on BMD in children with Down syndrome. Furthermore, the mean difference across all studies was -0.43, 95%CI of the mean difference = -0.98, 0.11 (Figure 2).

DISCUSSION

The search of this systematic review revealed only two randomized control studies that investigated the effect of WBV on BMD in children with Down syndrome. According to this analysis, there is non- significant positive effect of whole body vibration on total bone mineral density. This meta- analysis extracted data from two studies, the first one (Zaky and Elbagalaty, 2013) showed significant effect of WBV on whole body bone density.

Table 1Value of bone mineral density

Level	Definition*
Normal	Bone density is within 1 SD (+1 or −1) of the young adult mean.
Low bone mass	Bone density is between 1 and 2.5 SD below the young adult mean (−1 to −2.5 SD).
Osteoporosis	Bone density is 2.5 SD or more below the young adult mean (−2.5 SD or lower).
Severe (established) osteoporosis	Bone density is more than 2.5 SD below the young adult mean, and there have been one or more osteoporotic fractures.

*World Health Organization Definitions Based on Bone Density Levels (American Bone Health, 2017).

Tables 2. Participant characteristics of the included studies

Author & Year	Sample size	Patient characteristics	Inclusion Criteria	Exclusion Criteria
Zaky and Elbagalaty (2013) (15)	30 (15 study+ 15 control)	Children with DS From both genders divided into two equal groups between (4-7 year)	DS children able to stand for 10 min. without handheld support	-Presence of seizure disorder -Vision problems -Any other medical condition that affect participation in the vibration intervention
Matute-Llorente et al. (2015) (16)	25 (11 study+ 14 control)	Adolescents with Down syndrome from both gender (between 12-18 years).	Down syndrome adolescent examined by an experienced cardiologist to give them permission to participate in the study.	Cardiac problems

Table 3. Intervention, procedures, outcome measure, main results and author conclusion of the included studies

Author (year)	Intervention versus control	Procedure	Outcome	Main results	Author conclusion
Zaky and Elbagalaty (2013) (15)	Study group: WBV+ traditional physical therapy program Control group: traditional physical therapy program	squatting on the platform in sets for a total duration of 10 min 3 days per week for a total of 12 weeks	-The mean± SD of BMD post treatment for control group was 0.75± 0.03 and for study group was 0.79± 0.03 the mean difference between both groups was-0.04 -The mean± SD of lean content for control group 6.42± 0.3 and for study group 6.67± 0.25	There was significant difference between control and study group in BMD post treatment. Also, Significant improvement in the two groups when comparing pre and post Treatment results.	Mechanical vibration Seems to improve BMD and muscular content in DS children making treatment of osteoporosis possible.
Matute-Llorente et al. (2015) (16)	Study group WBV Control group normal daily life	squatting position (bent knees at 90°) (15-20 min) exercised three times per week for 20 weeks supervised by a researcher	WBV group improved subtotal area 2.8 %, 95 % CI (3.4, 2.1), BMC 4.8 %, 95 % CI (6.5,3.1) and BMD 2.0%, 95% CI (2.8, 1.1) and total BMD of lumbar spine 3.3 %, 95 % CI (4.9, 1.7) (all p <0.05) CON group also improved total area of the lumbar spine 2.2 %, 95 % CI (3.4, 1.0), total area of the hip 4.6 %,95 % CI (7.0, 2.2) and total hip BMC 8.4 %, 95 % CI (12.8,4.8) (all p <0.05)	WBV and CON groups showed statistical increments in whole body total BMC 2.8 and 1.9 %, 95 % CIs (3.5, 2.1), and (2.9, 0.9), respectively, and lumbar spine BMC 6.6 and 4.0 %, 95 % CIs (8.6, 4.7), and (6.1, 1.9) respectively (all p <0.05)	20-week WBV training might be useful to improve subtotal BMC and BMD in Children and adolescents with DS.

Table 4. Methodology assessment of studies according to the Physiotherapy Evidence Database (PEDro) scale

Criteria	Zaky and Elbagalaty (2015)	Matute-Llorente et al., (2016)
Specified eligibility criteria	Yes	Yes
Random allocation of participants	Yes	Yes
Concealed allocation	No	No
Similar prognosis at baseline	No	Yes
Blinded participant	No	No
Blinded therapists	No	No
Blinded assessors	No	No
More than 85% follow-up for at least one key outcome	No	No
‘Intention to treat' analysis	No	No
Between group statistical analysis for at least one key outcome	Yes	Yes
Point estimates of variability for at least one key out come	Yes	Yes
PEDro score	3	4

The second one (Matute-Llorente *et al*., 2015) had non-significant effect on total bone density but has significant effect on sub-total bone density. The improvement in BMD by WBV may be attributed to that it could produce osteogenic effects by changing the flow of bone fluid through direct bone stimulation and mechano- transduction, or it could generate indirect bone stimulation through skeletal muscle activation by means of tonic stretch reflex(Cardinale, 2006).The growing skeleton of children and adolescents may be more sensitive to WBV training than other populations as there was significant improvement in trabecular volumetric BMD at both the tibia and the spine following WBV training.

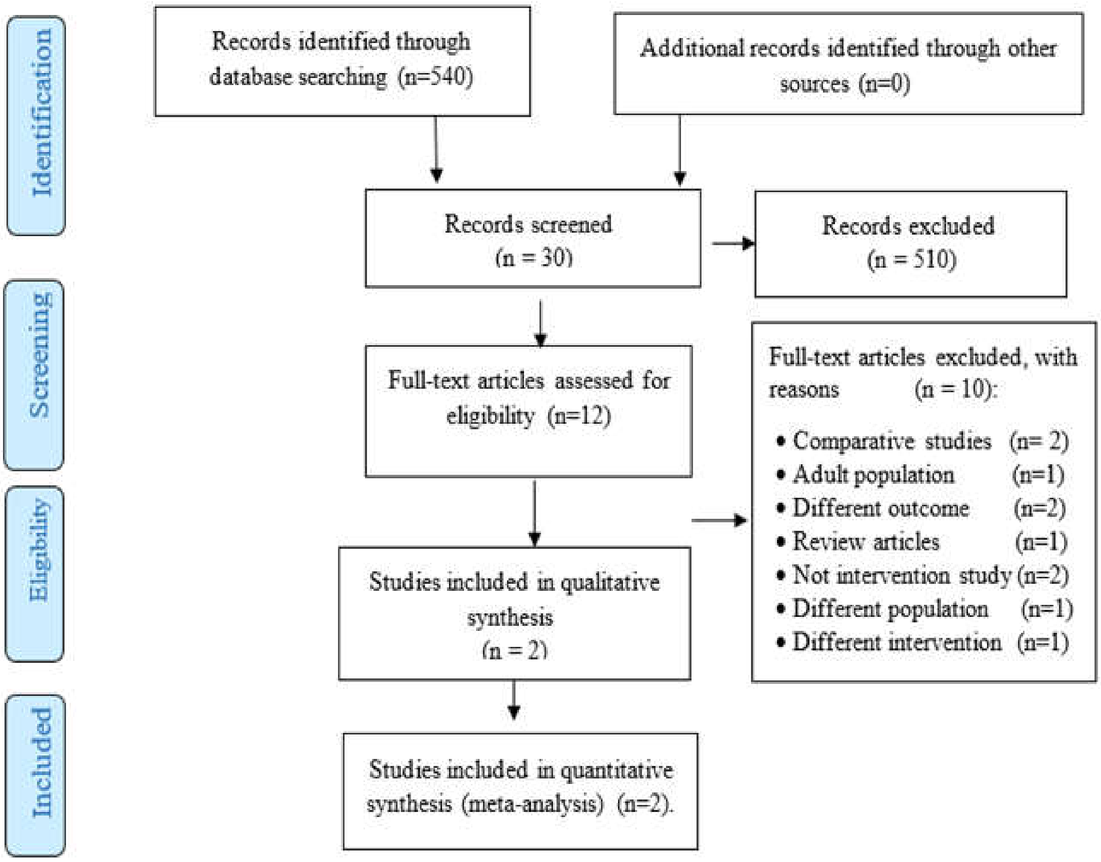

Figure 1. Modified PRISMA flow chart for the selection of reviewed studies

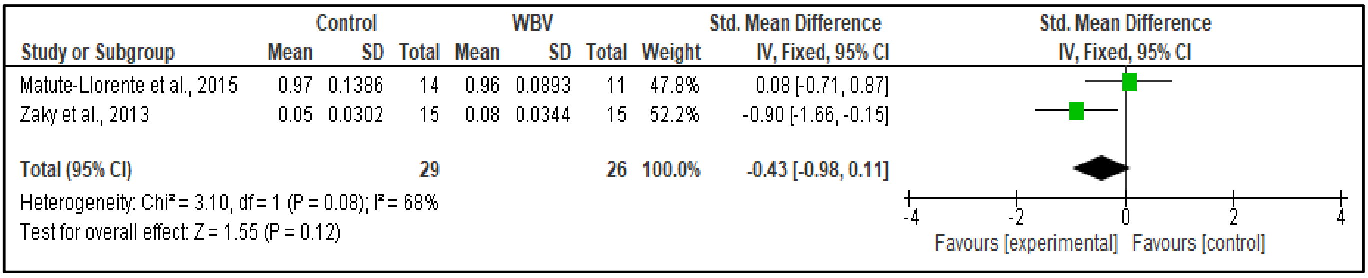

Figure 2. Forest plot: Comparison between study and control groups regarding change in bone mineral density following whole body vibration (WBV)

The magnitude of the effect observed was higher when compared to postmenopausal women (Puyalto, 2018).Whole body vibration may have some adverse effects. For example, individuals using WBV platforms may be at risk of falls because of balance problems, disorientation or orthostatic hypotension as not all platforms provide safety features, such as handrails (Seidel, 1988). Vibration has been recognized as an occupational hazard associated with low back pain, musculoskeletal problems, cardiovascular disorders, and the Raynaud syndrome (Tiemessen, 2008).

Limitations: Our review has some limitations, as there is a difference in the results which may be due to a limited number of studies, the small number of participants and different bone sites of the body. In addition, the type of platform used is a moderator of the effect of the training or therapy performed (Marín, 2010). Another limitation in our review is the inclusion of only published studies. Therefore, more studies using different protocols to detect the real effect of WBV on children with Down syndrome are needed.

Conclusion

The methodological quality of the included studies is fair. The effect of WBV on bone density is still indebted due to lack of high-quality studies.More studies are required to confirm the effect of WBV on bone density and support evidence-based decisions regarding the usage of WBV to increase bone density in children with Down syndrome.

REFERENCES

Frank, K., Esbensen, A.J. 2015. Fine motor and self-care milestones for individuals with Down syndrome using a Retrospective Chart Review. *Journal of Intellectual Disability Research,* 59(8):719-729.

Weijerman, M.E., de Winter, J.P. 2010. Clinical practice. The care of children with Down syndrome. European Journal of Pediatrics, 169(12): 1445-1452.

Ulrich, D.A., Lloyd, M.C., Tiernan, C.W., *et al*. 2008. Effects of intensity of treadmill training on developmental outcomes and stepping in infants with Down syndrome: A randomized trial. Physical Therapy Journal, 88(1):114-122.

Özçivici, E. 2013. Effects of spaceflight on cells of bone marrow Origin. Turkish Journal of Hematology, 30(1):1-7.

McKelvey, K.D., Fowler, T.W., Akel, N.S., *et al*. (2013): Low bone turnover and low bone density in a cohort of adults with Down syndrome. Osteoporosis International Journal, 24(4):1333-1338.

Cole, R.E. 2008.Improving clinical decisions for women at risk of osteoporosis: dual-femur bone mineral density testing. American Osteopathic Association Journal, 108(6): 289-295.

World health organization 2003. Prevention and management of osteoporosis: Report of a WHO scientific group. Available athttp:/apps.who.int/iris/handle/10665/4284. (Accessed 25 August 2018).

American Bone Heath 2016. Understanding-the-bone-density result. Available at https://americanbonehealth.org/. (Accessed 29 April 2018).

AlBasini, A., Krause, M., Rembitzki, I. 2010. Using whole body vibration in physical therapy and sport. Churchill Livingstone: Elsevier.

Lam, T.P., Cheung, L.W., Lee K.M., *et al*. 2013. Effect of whole body vibration (WBV) therapy on bone density and bone quality in osteopenic girls with adolescent idiopathic scoliosis: A randomized controlled trial. Osteoporosis International, 24:1623-1636.

Gloeckl, R., Heinzelmann, I. Kenn, K. 2015. Whole body vibration training in patients with COPD: A systematic review. Chronic Respiratory Disease Journal, 12 (3):212-221.

Von Stengel, S., Kemmler, W., Bebenek, M., *et al*. 2011. Effects of whole-body vibration training on different devices on bone mineral density. Medicine Science in Sports Exercise Journal, 43(6):1071-1079.

Valkenet, K., van de Port I.G., Dronkers, J.J.2011. The effects of preoperative exercise therapy on postoperative outcome: A systematic review. *Clinical Rehabilitation Journal,* 25(2):99-111.

Straus, S.E, Glasziou, P.,Haynes R.B. 2005. Evidence based medicine: how to practice and teach EBM. Toronto, ON, Canada: Elsevier.

Zaky, N.A., Elbagalaty, A.E. 2013. Effect of high frequency, low magnitude vibration on bone density and lean content in children with Down syndrome. Indian Journal of Physiotherapy and Occupational Therapy, 7(3):134-139.

Matute-Llorente, A., González-Agüero, A., Gómez-Cabello, A., *et al*. 2015. Effect of whole body vibration training on bone mineral density and bone quality in adolescents with Down syndrome: A randomized controlled trial. *Osteoporosis International,* 26(10):2449-2459.

Cardinale, M., Rittweger, J. 2006. Vibration exercise makes your muscles and bones stronger: Factor or fiction? British Menopause Society Journal, 12(1):12–18.

Puyalto, J.M., Cabello, A.G., Agüero, A.G., *et al*. 2018. Is vibration training good for your bones? An overview of systematic reviews. *BioMed Research International Journal,* (10):1-16.

Seidel, H., Harazin, B., Pavlas, K., *et al*. 1988. Isolated and combined effects of prolonged exposures to noise and whole-body vibration on hearing, vision and strain. *International Journal of Occupational and Environmental Health,* 61:95-106.

Tiemessen, I.J., Hulshof, C.T., Frings-Dresen, M.H., *et al*. 2008. Low back pain in drivers exposed to whole body vibration: analysis of a dose-response pattern. Occupational Environment Medicine Journal, 65(10): 667-675.

Marín, P.J.,Rhea, M.R. 2010. Effects of vibration training on muscle power: A meta-analysis. *Journal of Strength and Conditioning Research,* 24(3):871–878.

****