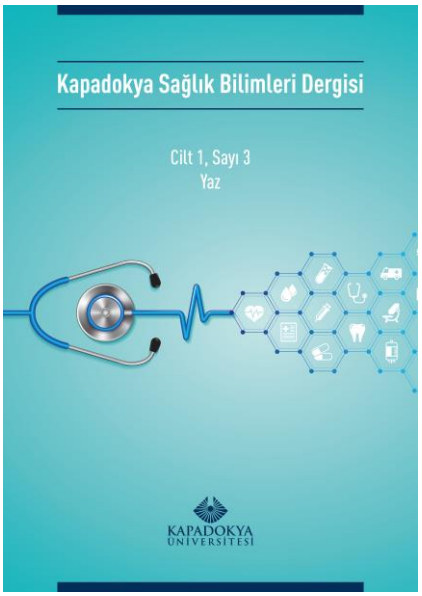

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Review

The Effects of Whole-Body Vibration Training on Trunk Muscle Strength: A Narrative Review

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Abstract

Mechanical vibration can improve neuromuscular function through postural control strategies, muscle tonic mechanisms, and tonic vibration reflexes. Whole body vibration (WBV) has also been announced to increase bone mineral density, muscle endurance and strength, as well as to enhance proprioceptive system. Moreover, WBV training was found to be a constructive strategy for improving the physical performance of elite athletes and healthy individuals in terms of muscle strength, agility, flexibility, and vertical jump height. Although there is still no consensus in research in this area, it is argued that certain molecular mechanisms involved in the physiological adaptations of exercise also emerge during WBV training. Clarifying these physiological mechanisms is crucial for optimizing the effectiveness of WBV trainings. Previous studies have examined the effects of WBV and have indicated developments in muscle strength, muscle endurance, flexibility, muscle cross sectional area, bone mineral density and body composition. However, no standard prescription has been established to optimize the effects of WBV, including the determination of vibration frequency and amplitude. In addition, the majority of previous studies have investigated the effects of WBV training on the extremities. There are few publications investigating its effectiveness on trunk and core muscle strength, which is one of the important indicators of athletic performance. Therefore, we conducted a narrative review of the literature, referring to the Cochrane Library and Medline databases, to summarize the most recent scientific evidence on the effects of whole-body vibration on trunk muscle strength. This narrative review concludes that at least 8 weeks of WBV training is more effective on trunk muscle strength than those performing the same exercises without WBV.

Keywords: Whole Body Vibration, Exercise, Trunk, Strength

Tüm Vücut Vibrasyon Eğitiminin Gövde Kas Kuvveti Üzerine Etkileri: Geleneksel Derleme

Öz

Mekanik vibrasyon, postüral kontrol stratejileri, kas tonus mekanizmaları ve tonik vibrasyon refleksleri yoluyla nöromüsküler fonksiyonu geliştirebilir. Tüm vücut vibrasyonu (TVV) ayrıca kemik mineral yoğunluğunu, kas dayanıklılığını ve kas kuvvetini artırmanın yanı sıra propriyoseptif sistemi geliştirdiği de bildirilmiştir. Ayrıca, TVV eğitimi elit sporcuların ve sağlıklı bireylerin fiziksel performansını, kas kuvveti, çeviklik, esneklik ve dikey sıçrama yüksekliği açısından geliştiren yapıcı bir strateji olduğu bulunmuştur. Bu alandaki araştırmalarda hala bir fikir birliği olmamasına rağmen, egzersizin fizyolojik adaptasyonlarında yer alan bazı moleküler mekanizmaların da TVV eğitimi sırasında ortaya çıktığı ileri sürülmektedir. Bu fizyolojik mekanizmaların açıklığa kavuşturulması, TVV eğitimlerinin etkinliğini optimize etmek için çok önemlidir. Önceki çalışmalar TVV'nin etkilerini incelemiş ve kas kuvveti, kas dayanıklılığı, esneklik, kas kesit alanı, kemik mineral yoğunluğu ve vücut kompozisyonunda gelişmeler olduğunu göstermiştir. Ancak, vibrasyon frekansı ve genliğinin belirlenmesi de dâhil olmak üzere TVV'nin etkilerini optimize etmek için standart bir reçete oluşturulmamıştır. Buna ek olarak, önceki çalışmaların çoğu TVV eğitiminin ekstremiteler üzerindeki etkilerini araştırmıştır. Atletik performansın önemli göstergelerinden biri olan gövde ve kor kas kuvveti üzerindeki etkinliğini araştıran az sayıda yayın bulunmaktadır. Bu nedenle, tüm vücut vibrasyonun gövde kas kuvveti üzerindeki etkilerine ilişkin en son bilimsel kanıtları özetlemek için Cochrane Library ve Medline veri tabanları kullanılarak literatür derlemesi yaptık. Bu literatür derlemesi, en az 8 haftalık WBV eğitiminin aynı egzersizleri WBV olmadan yapanlara göre gövde kas kuvveti üzerinde daha etkili olduğu sonucuna varmaktadır.

Anahtar Kelimeler: Tüm Vücut Vibrasyon, Egzersiz, Gövde, Kuvvet

INTRODUCTION

In recent years, whole body vibration (WBV) training has become a popular exercise method for athletes, patients and untrained individuals and has been widely introduced to beauty clinics, professional sport clubs and gym centers (Maeda et al., 2016). WBV devices are particularly produced machines that contract users' muscles passively (Cai et al., 2021). The oscillating vibration platform generates changes in the length of the muscle-tendon complex which activates muscle spindles to facilitate tonic vibration reflex. This strategy also enhances the excitability of the motor neuron and the synchronization of motor units to increase neuromuscular performance (Pollock et al., 2012).

WBV training is commonly referred to as a neuromuscular modality which enhances the muscle strength and physical performance (Wirth et al., 2011). However, studies have shown that it has positive effects on human body other than muscular hypertrophy. The biological effects of WBV on the endocrine system are an increase in testosterone and growth hormone secretion and a decrease in cortisol concentrations (Saldiran et al., 2020). WBV has also been shown to have positive effects on other systems such as, improving in circulation and oxygen uptake, stimulating of bone formation processes and improving body composition (Stania et al., 2016).

Core region has been defined as integration of the lumbo-pelvic and abdominal regions of the body (Kuszewski et al., 2018). The core musculature can be functionally divided into two groups: superficial muscles and deep muscles. The superficial muscles main function to generate movement and transmit forces from the lumbo-pelvic region to the extremities. The main task of the deep muscles which attaches directly to the lumbar vertebrae is to stabilize the spine (Raabe & Chaudhari, 2018).

Core stability exercises still remain popular and studies have supported the importance of core or trunk muscle strength for the optimal performance of sports-related and daily activities (Raabe & Chaudhari, 2018). Lack of sufficient strength and endurance in core musculature can lead to decreased quality of movement and these inappropriate movement mechanics predispose to injury (Kellis et al., 2020). Core trainings are applied not only in an athletic population but also in a patients and untrained adults. Well-developed trunk muscle strength plays a key role to stabilize the spinal column, to decrease the risks for low-back pain and various orthopedics problems (Arampatzis et al., 2019).

Although most of previous studies have investigated the effect of WBV on lower extremity muscle strength and athletic performance; Few studies have focused on trunk muscle strength.

In addition, most of these studies investigated the acute effects of WBV and only few studies were found that explored the long-term effects of WBV. The primary aim of this review is to examine the effect of WBV training on trunk muscle strength in adult asymptomatic individuals.

METHODS

In this narrative review, electronic databases of Cochrane Library and Medline (PubMed) were accessed online in December 2022. Searches were conducted using the following key words: Whole body vibration, training, trunk, core, muscle strength and endurance. We then tried to search for additional records through database search engines using relevant keyword combinations and checking reference lists of related studies. Inclusion criteria for current study were that articles must be about whole-body vibration training, the individuals must not have a diagnosis of a neurological disease, the study must include trunk muscle strength assessment. This review excluded case-control studies, case studies, case series studies, systematic reviews, meta-analyses, and retrospective cohort studies and studies that included only the experimental exercise group. The abstracts of the studies were read in accordance with the specified criteria and subsequently data were analyzed by reading the entire text via full-text resources. For this review 24 studies or articles were examined by primary author, and based on exclusion and inclusion criteria, 5 studies were finally selected. Of the 5 studies, 4 investigated the chronic effects and the other study investigated the acute effects. Figure 1 summarizes the search strategy process in a flow diagram. Ethical approval and informed patient consent were not required, as this research was a review and had no direct patient contact or influence on patient care.

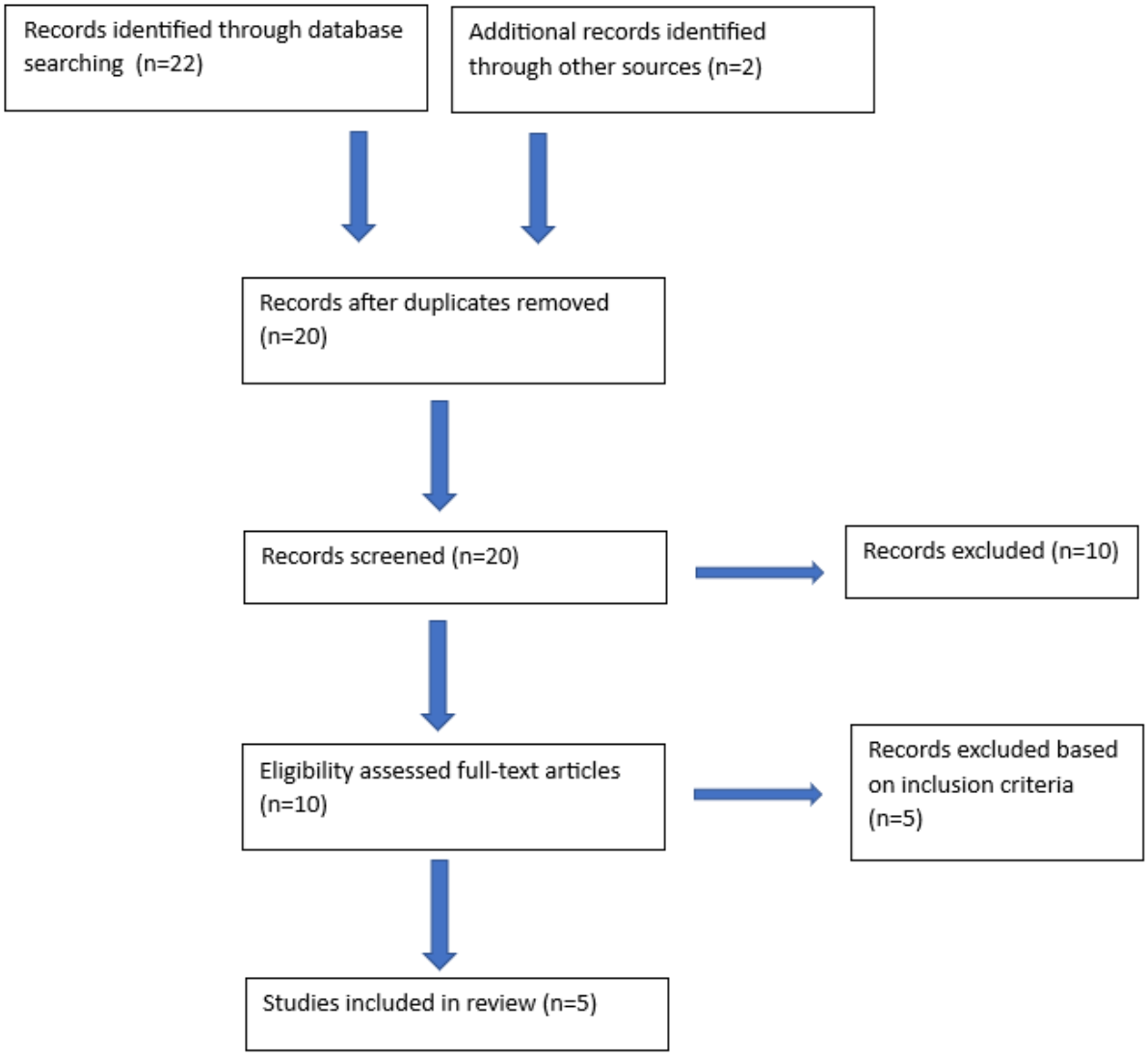

Figure 1. Flow diagram of the process of study selection

RESULTS

A total of 5 different studies were examined in this review. Three of the 4 studies investigating the effectiveness of long-term WBV training on trunk muscle strength showed greater improvement than those performing the same exercises without WBV. In the current review, there is only one study investigating the effects of short-term WBV training on trunk muscle strength. In that study, it was reported that the improvement in the WBV group was higher than the control group.

DISCUSSION

Maeda et. al. investigated the effect of WBV training on trunk muscle strength in healthy adults. A total of 21 healthy individuals participated in their study. 10 of the participants were included in the WBV group, while the other 10 performed the same exercises without WBV. Individuals trained 3 times per week for 8 weeks and single training sessions lasted 30 minutes. The main outcome measure of their study was isometric flexor trunk muscle strength and muscle strength was measured using an Isoforce GT-350. Their findings showed that the WBV group had greater enhancement than the control group in trunk-flexor muscle strength (Maeda et al., 2016).

Wang et al. examined the effect of WBV training on trunk muscle strength in patients with chronic low back pain. Patients were randomly assigned as an experimental group and a control group. The intervention group participated in whole body vibration exercise twice a week for 3 months. The control group received general exercise twice a week for 3 months. The WBV training protocol comprises five exercises: double leg stance, deep squat, lower back extension, bridge pose, and push-up. The participants in the control group performed the same exercises without WBV. This study revealed that whole-body vibration exercise produced more beneficial effects for chronic low back pain than general exercise (Wang et al., 2014).

Resistance training increases muscle strength and endurance. Recently, the popularity of resistance training combined with whole-body vibration has also increased. Osawa et al. investigated the comparison of resistance training combined with whole-body vibration versus resistance training alone. 18 untrained individuals (21–39 years) were randomly assigned to either an exercise with WBV group or an exercise group without WBV. Participants performed a total of 8 different exercises targeting the lower extremities and trunk for 12 weeks. Participants and investigators recognized the allocation but the assessor was unaware of the group allocations. The lumbar extension strength of the participants was measured with an isometric lumbar extension device. No significant differences between the WBV group and control group at baseline were observed. This study revealed that 12-week resistance training combined with WBV did not provide superiority in trunk muscle strength development compared to resistance training alone (Osawa et al., 2011).

In another study conducted by Osawa et al., researchers examined the effect of WBV combine with resistance training on cross-sectional areas (CSA) of trunk muscles and isometric lumbar extension torque. A total of 32 individuals were randomly allocated to either WBV with

resistance training (RT) group or RT group. They applied WBV at a 35 Hz frequency and 2 mm amplitudes for 13 weeks. Their results showed significantly higher increases in the CSA of the erector spine muscle in WBV combine with RT group compared to RT group alone. Similarly, isometric lumbar extension strength increased more in the WBV with RT group (Osawa & Oguma, 2013).

There are many frequency options available for WBV trainings. However, the superiority of these frequencies over each other has not been proven. Ye et. al. (2014), investigated the immediate effects of different frequencies of whole-body vibration on the performance of trunk muscles of healthy young adults. A group of 30 healthy participants enrolled in the study. Each participant received 3 sessions of vibration exercise with frequencies of 25 Hz, 40 Hz and 0 Hz. Before and after each WBV exercise session, individuals were evaluated for trunk muscle strength and endurance. There was a substantial enhancement in trunk extensor strength ($p< 0.05$) after low frequency (25 Hz) WBV exercise. Researchers suggested that low-frequency short-term WBV training was effective in improving trunk extensor strength in healthy individuals (Ye et al., 2014).

CONCLUSION

When the studies in the literature are examined, it is seen that there is not much research in this area. However, WBV trainings have become quite common. There is a need for standardized protocols for the appropriate use of these devices in clinics, sports centers and even beauty centers. This review will benefit clinicians and researchers in this context. It seems that 3 of 4 studies investigating the effectiveness of at least 8 weeks of WBV training on trunk muscle strength showed greater improvement than those who performed the same exercises without WBV. We think that the only study that does not have a superiority is due to the fact that trunk muscle strength was evaluated with the isometric test method alone. In the only study investigating the immediate effects on trunk muscle strength, it was reported that the improvement in the WBV group was higher than in the control group. According to the results of the study included in the review, it shows that training with WBV is more beneficial than traditional training. However, studies in this area need stronger methodological procedures. Using isokinetic systems, which is the gold standard for strength measurement, will create stronger evidence. Also, there is no consensus on the frequency and amplitude parameters to be used in WBV trainings. There is a need for more studies investigating the 2 parameters that have a primary effect on the effectiveness of the WBV trainings.

REFERENCES

Arampatzis, A., Frank, J., Laube, G., & Mersmann, F. (2019). Trunk muscle strength and lumbo-pelvic kinematics in adolescent athletes: Effects of age and sex. *Scand J Med Sci Sports*, 29(11), 1691-1698. https://doi.org/10.1111/sms.13503

Cai, Z.-Y., Wang, W.-Y., Lin, J.-D., & Wu, C.-M. (2021). Effects of whole body vibration training combined with blood flow restriction on muscle adaptation. *Eur J Sport Sci*, 21(2), 204-212. https://doi.org/10.1080/17461391.2020.1728389

Kellis, E., Ellinoudis, A., Intziegianni, K., & Kofotolis, N. (2020). Muscle thickness during core stability exercises in children and adults. *J Hum Kinet*, 71(1), 131-144. https://doi.org/10.2478/hukin-2019-0079

Kuszewski, M. T., Gnat, R., & Gogola, A. (2018). The impact of core muscles training on the range of anterior pelvic tilt in subjects with increased stiffness of the hamstrings. *Hum Mov Sci*, 57, 32-39. https://doi.org/10.1016/j.humov.2017.11.003

Maeda, N., Urabe, Y., Sasadai, J., Miyamoto, A., Murakami, M., & Kato, J. (2016). Effect of whole-body-vibration training on trunk-muscle strength and physical performance in healthy adults: preliminary results of a randomized controlled trial. *J Sport Rehabil*, 25(4), 357-363.

Osawa, Y., & Oguma, Y. (2013). Effects of resistance training with whole-body vibration on muscle fitness in untrained adults. *Scand J Med Sci Sports*, 23(1), 84-95. https://doi.org/10.1111/j.1600-0838.2011.01352.x

Osawa, Y., Oguma, Y., & Onishi, S. (2011). Effects of whole-body vibration training on bone-free lean body mass and muscle strength in young adults. *Int J Sports Med*, 10(1), 97.

Pollock, R. D., Woledge, R. C., Martin, F. C., & Newham, D. J. (2012). Effects of whole body vibration on motor unit recruitment and threshold. *J Appl Physiol*, 112(3), 388-395. https://doi.org/10.1152/japplphysiol.01223.2010

Raabe, M. E., & Chaudhari, A. M. (2018). Biomechanical consequences of running with deep core muscle weakness. *J Biomech*, 67, 98-105. https://doi.org/10.1016/j.jbiomech.2017.11.037

Saldiran, T. Ç., Mutluay, F. K., Yağci, İ., & Yilmaz, Y. (2020). Impact of aerobic training with and without whole-body vibration training on metabolic features and quality of life in non-alcoholic fatty liver disease patients. *Annales d'Endocrinologie*, 493-499. https://doi.org/10.1016/j.ando.2020.05.003

Stania, M., Juras, G., Słomka, K., Chmielewska, D., & Król, P. (2016). The application of whole-body vibration in physiotherapy–A narrative review. *Acta Physiologica Hungarica*, 103(2), 133-145.

https://doi.org/10.1556/036.103.2016.2.1

Wang, X.-Q., Pi, Y.-L., Chen, P.-J., Chen, B.-L., Liang, L.-C., Li, X., . . . Zhang, J. (2014). Whole body vibration exercise for chronic low back pain: study protocol for a single-blind randomized controlled trial. *Trials*, 15(1), 1-6.

Wirth, B., Zurfluh, S., & Müller, R. (2011). Acute effects of whole-body vibration on trunk muscles in young healthy adults. *J Electromyogr Kinesiol*, 21(3), 450-457. https://doi.org/10.1016/j.jelekin.2010.12.007

Ye, J., Ng, G., & Yuen, K. (2014). Acute effects of whole-body vibration on trunk muscle functioning in young healthy adults. *The Journal of Strength & Conditioning Research*, 28(10), 2872-2879. https://doi.org/10.1519/JSC.0000000000000479