Effect of Whole Body Vibration Therapy on Selected Musculo-Skeletal Parameters of Untrained University Adolescents

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Abstract

The study focused on the effect of whole body vibration therapy on selected musculo-skeletal parameters of untrained University adolescents. Twenty (20) participants volunteered to be part of this study and were recruited purposively. Their consent was sought to be part of the study while measurements were taken before they were exposed to the whole body vibration treatment for a period of twelve weeks. This study was hinged on the second law of motion as postulated by Sir Isaac Newton. Four main hypotheses were formulated in the study while student t-test was used to analyse the hypotheses. Results showed that significant effect of treatment exists in arm muscle strength (Crit-t = 2.00, Cal.t = 7.636, df = 19,P<.05), hip flexibility (Crit-t = 2.00, Cal.t =4.659, df = 19,p<.05), average leg power (Crit-t = 2.00, Cal.t = 4.098, df = 19,p<.05) and peak leg power (Crit-t = 2.00, Cal.t = 3.551, df = 19,p<.05). It was recommended that whole body vibration be adopted as a viable therapy to help improve musculo-skeletal parameters of inactive persons who are sedentary.

Keywords: Adolescents, university, whole body vibration

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Introduction

Whole body vibration has been proposed as an exercise intervention because of its potential for increasing force generating capacity in the lower limbs. Its recent popularity is due to the combined effects on the neuromuscular and neuroendocrine systems and a result from a preliminary study which recommended vibration exercise as a therapeutic approach for sarcopenia and possibly osteoporosis. Vibration is a mechanical stimulus characterized by an oscillatory motion (Bosco, Cardinale, Colli, Tihanyi, von Duvillard, and Viru 1998). The biomechanical variables that determine its intensity are the frequency and amplitude while the extent of the oscillatory motion determines the amplitude (peak to peak displacement, in mm) of the vibration. The repetition rate of the cycles of oscillation determines the frequency of the vibration (measured in Hz). Mechanical stimulation in the form of vibration has been recently shown to produce specific adaptive responses in humans (Bosco, Cardinale, Colli, Tihanyi, von Duvillard, and Viru, 1998).

The possibility of using vibration in an athletic setting was introduced by Russian scientists, who developed specific devices to transmit vibratory waves from distal to proximal links of muscle groups, mainly during the performance of isometric exercises (Nazarov and Spivak, 1985 in Gojanovic, et. al, 2014). Recently many studies have been conducted with the aim of understanding the acute and chronic responses to whole body vibration training (WBVT). The principles of whole body vibration lie in the law of motion as stated by Sir Isaac Newton; mainly, that the force (F) of an object is equal to the mass (M) multiplied by its acceleration (A) (F=M×A). Thus, functional force can be improved by either applying more mass or more acceleration to a body. Whole body vibration machines instead, utilizes acceleration by keeping the body weight constant (Cardinale and Bosco, 2003). It has been hypothesized that a low-frequency, low-amplitude vibratory stimulation is a safe and effective exercise intervention. A single session of 10 min divided in 2 sets of 5 bouts of 60 s whole body vibration with 60 s rest in between sets has been shown to improve vertical jumping performance in well-trained individuals (Bosco, Iacovelli, Tsarpela, Cardinale, Bonifazi, and Tihanyi J et al 2000). Evidence from Torvinen et al., (2002) suggests that short-time exposure to whole body vibration can lead to an improvement in vertical jump performance and force generating capacity in lower limbs. In a related study, untrained individuals showed acute improvement in vertical jumping ability and hamstrings flexibility following low frequency vibration exercise and acute decrease in vertical jumping and hamstrings' flexibility following high-frequency vibration exercise (Cardinale & Lim, 2003).

Cardinale and Bosco, (2003), have reported an improvement of the flexibility of subjects that have performed whole body vibration exercises. Flexibility is related to the ability to move joints through their full range of motion (ROM), from a flexed to an extended position and this physical characteristic is highly desired and relevant to a subject to do their daily activities. The flexibility of a joint depends on conditions related to the muscles, ligaments, bones, and cartilage which form the joint. Although the flexibility of a joint can be genetic, it can also be improved by stretching and appropriated exercises (Tsuji, Kitano, Tsunoda, Himori, Okura, and Tanaka, 2014). In addition, it is suggested by Rittweger, Rees, Murphy, and Watsford, (2007) that the stretching could reduce the stiffness and hysteresis of the tendon (Figueroa, R. Gil, A. Wong et al., 2012), alter properties of the intramuscular connective tissue and possibly alter those of other passive skeletal structures that together define the ROM for a specific joint (Wheeler and Jacobson, 2013). As whole body vibration exercise involves mechanical stretching (Kinser, Ramsey, O'Bryant, Ayres, Sands, and Stone, 2008; Behboudi, Azarbayjani, Aghaalinejad, and Salavati, 2011), this fact could justify the increase of the flexibility by the exercise generated by vibration produced in oscillating/vibratory platform and the improvements.

Some authorities have demonstrated that whole body vibration exercises might improve muscle strength (Russo, Lauretani, and Bandinelli et al., 2003) and muscle power (Schuhfried, Mittermaier, Jovanovic, Pieber, and Paternostro-Sluga, 2005). Moreover, the health-related quality of life is increased and the fall risk is decreased (Ness and Field-Fote, 2009). Cochrane and Stannard (2005) have suggested that the muscle activation due to the WBV may induce improvements in strength and power performance similar to those observed with strength training. This study therefore was conducted to determine the effect of whole body vibration therapy on selected musculo-skeletal parameters of untrained university adolescents.

Methodology

The randomized pretest posttest experimental research design was adopted for this study and study was hinged on the second law of motion as postulated by Sir Isaac Newton. Twenty (20) participants volunteered to be part of this study and were recruited purposively. Their consent was sought to be part of the study while measurements were taken before they were exposed to the whole body vibration treatment for a period of twelve weeks. Participants whose medical record do not contra-indicate exercise participation and those who were apparently sedentary and were not actively involved in sports at the moment this study was conducted were included, while participants with heart rate above 100 beat per minute and blood pressure measures of 140/100 millemeter per mercury, asthmatic patients and patients with related medical history were excluded from participating in the study. Posttest measures were taken afterwards and data were sorted, coded and presented for analysis using the appropriate statistical model. Descriptive statistics of mean and standard deviation, with inferential statistics of independent t-test was used to analyze the data at 0.05 level of significance.

The following research instruments were used for data collection;

1.) Vibration Machine: The Galileo™2000 (White Plains, NY.) which was developed to mechanically stimulate muscles at specific frequencies, typically 25-30 Hz, causing the muscles to contract and relax by natural reflex, 25-30 times per second. The Galileo™2000 functioned in a one-directional, oscillating pattern based on the concept of a center fulcrum and alternating up/down motion.

2.) Flexbox: Wells and Dillon (1952) sit and reach protocol which propounded a box with an index or heel line marked at 23 cm (9.1 inches) took care of respondents' lower back and hamstring muscles.

3.) Switch mat: The Bosco Countermovement vertical jump (CMJ) protocol was adopted for the leg power estimates; jump height = 4.9 x (0.5 x Time)^2)

4.) Hand grip dynamometer: Xinjing sports Wolibiao; Serial no: 0574-8137-8898 13004651895 xinjingsport@163.com was used to estimate participants' arm strength.

Validity and Reliability of the Instruments

Instruments were standardized, handy and were used in the measurement of musculo-skeletal parameters and for muscle excitation as has been used in previous studies. The degree of consistency between the sets of scores obtained with the same instrument and the extent to which the results were consistent and accurate for the population under study were obtained using the Cronbach Alpha reliability approach.

Procedure for Data Collection

Ethical approval was gotten from the University of Ibadan Ethical Committee. Each recruited participant signed a consent form to be part of this study after a thorough explanation on the purpose and benefits of the study with procedures to follow had been made explicit to them. Data on the musculo-skeletal parameters of the participants were collected before and after training programme, which lasted for twelve (12) weeks by researcher and his assistants.

Flexibility: Researcher placed the flex box against the wall to prevents it from slipping during the testing process, he led the participants through a 10 minutes warm-up, had subjects removed their shoes and sat on the floor with the heels and soles of their feet placed against the index and heel line (23 cm mark), with legs fully extended and with the medial sides of their feet about 20cm (8 inches) apart. Researcher placed his hands across the subjects' knees to ensure full leg extension; subjects stretched their hands forward, one on top of the other with palms facing down, bend forward and moved their hands along the measuring scale on the flex box, held position for 2 seconds and researcher recorded the resulting measures on the record sheet.

Leg power: Researcher placed a mat in the gymnasium with an appropriate ceiling clearance above it, participants performed structured warm-up which prepared them for the vertical jump. The researcher explained the countermovement jump protocol and demonstrated it to subjects. Participants were positioned with feet at shoulder width apart, instructed to dip their hips and knees 90^0 to push-off from the ground while extending body as high as possible into the air. Participants were instructed to bend at their knees when landing to absorb landing forces and this was performed for three times with 2 minutes intervals before the next trial. Researcher recorded flight time achieved during each jump on the record sheets.

Arm strength: The participants held the dynamometer in the hand that was tested, with the arm at right angles and the elbow by the side of the body. The handle of the dynamometer was adjusted while the base rested on first metacarpal (heel of palm) and the handle rested on middle of four fingers. Participants squeezed the dynamometer with maximum isometric effort, which was maintained for about 5 seconds. No other body movement was allowed. The participants were encouraged to give maximum effort.

RESULTS

There will be no significant effect of treatment on arm strength of untrained University adolescent following 12 weeks of whole body vibration therapy.

	Whole Body Vibration	N	Mean	Std. Dev.	Crit-t	Cal-t.	DF	P
ARM STRENGTH	Pretest	20	31.2500	7.2029	2.00	7.636	19	.000
	Posttest	20	50.3500	15.3804				

The table presents the results of the significant effect of treatment on arm strength of untrained University adolescent following 12 weeks of whole body vibration therapy: From results presented, it was observed that arm strength (Crit-t = 2.00, Cal.t = 7.636, df = 19,P<.05) was significant.

There will be no significant effect of treatment on hip flexibility of untrained University adolescent following 12 weeks of whole body vibration therapy.

	Whole Body Vibration	N	Mean	Std. Dev.	Crit-t	Cal-t.	DF	P
HIP FLEXIBILITY	Pretest	20	.9875	.9730	2.00	4.659	19	.000
	Posttest	20	1.8170	1.5524				

The table presents the results of the significant effect of treatment on hip flexibility of untrained University adolescent following 12 weeks of whole body vibration therapy: From results presented, it was observed that hip flexibility (Crit-t = 2.00, Cal.t =4.659, df = 19,p<.05) was significant.

There will be no significant effect of treatment on average leg power of untrained University adolescent following 12 weeks of whole body vibration therapy.

	Whole Body Vibration	N	Mean	Std. Dev.	Crit-t	Cal-t.	DF	P
A/L PWR	Pretest	20	2225.9000	741.4928	2.00	4.098	19	.001
	Posttest	20	2877.6000	1122.6527				

The table presents the results of the significant effect of treatment on average leg power of untrained University adolescent following 12 weeks of whole body vibration therapy: From results presented, it was observed that average leg power (Crit-t = 2.00, Cal.t = 4.098, df = 19,p<.05) was significant.

There will be no significant effect of treatment on peak leg power of untrained University adolescent following 12 weeks of whole body vibration therapy.

	Whole Body Vibration	N	Mean	Std. Dev.	Crit-t	Cal-t.	DF	P
P/L PWR	Pretest	20	4462.1500	1422.5914	2.00	3.551	19	.002
	Posttest	20	5583.3000	1925.9734				

The table presents the results of the significant effect of treatment on peak leg power of untrained University adolescent following 12 weeks of whole body vibration therapy: From results presented, it was observed that peak leg power (Crit-t = 2.00, Cal.t = 3.551, df = 19,p<.05) was significant.

Discussions

Findings from de Ruiter, van der Linden, van der Zijden, Hollander, de Haan, (2003) & Da Silva, Nunez, Vaamonde, (2006), found an increase in muscle strength and performance of participants. This study indicates that there was significant improvement in the effect of whole body vibration on arm muscle strength of participants studied. Findings from this study are in line with those of Bogaerts et al., 2007; Kawanabe et al., (2007); Machado et al., (2010); Tapp and Signorile, 2014), who suggested that whole body vibration exercise could be an alternative exercise modality for eliciting muscle strength in older adults. It has also been established by the findings of Figueroa et al., (2010); Figueroa et al., (2012); Roelants et al., (2004), that there is an improvement in the strength of younger individuals following whole body vibration training. Consequently, the addition of vibration to exercise programmes has been shown to increase strength and power more than exercise programmes without vibration (Kawanabe et al., (2007); Ronnestad, 2004).

The study also found out that there was significant improvement in the effect whole body vibration on the flexibility of participants who took part in the study. Earlier findings from Tsuji, Kitano, Tsunoda, Himori, Okura, and Tanaka, (2014), Karatrantou, Gerodimos, Dipla, and Zafeiridis, (2013) and Wheeler and Jacobson, (2013), submitted that whole body vibration exercise involves mechanical stretching which could justify the increase in the flexibility by the exercise generated by vibration produced in oscillating/vibratory platform and the improvements observed in subjects that have performed whole body vibration. Cochrane and Stannard, (2005) also reported an improvement in the sit and reach test after acute whole body vibration exercise.

Consequently, studies on the efficacy of whole body vibration therapy produced notable results which were both positive and this include improved flexibility, (Fagnani, Giombini, Di Cesare, Pigozzi, Di Salvo and power, (2006), Bosco, Cardinale, & Tsarpela, 1999). The result of this study also revealed that there was significant effect of treatment on leg power of participants under study. This was in line with the submission made by experts in American Journal on Physical and Medical Rehabilitation (2006) who affirmed that whole-body vibration group displayed a significant improvement in leg extension strength and countermovement jump performance in a research conducted on various measures in female competitive athletes. Consequently, there was significant effect of treatment on peak leg power performance of participants. This finding was corroborated by an earlier submission of (Rietschel, Van Koningsbruggen, Fricke, Semler and Schoenau, 2008), which was conducted on 10 adults (three males; seven females) aged 24 - 47 years, for three months of intermittent whole body vibration exposure (18 minutes) five days/week, that significant improvement occurred in lower-extremity muscle force and power. Furthermore, it was also posited that strength training with greater intensity (fewer repetitions and greater weight) with multiple sets elicited greater improvements in strength and power (Pollock, Vincet, Corbin, Pangrazi, 1996).

Conclusion

It has been established that whole body vibration therapy exposure at moderate frequency and amplitude for a period of 12 weeks can improved body parameters of untrained adolescents when exposed to it. It could offer both preventive and therapeutic measures akin to the reduction in morbidity, mortality and economic burden from lifestyle-related non-communicable diseases. Hence, it is recommended that whole body vibration be adopted as a viable therapy to help improve musculo-skeletal parameters of inactive persons who are sedentary.

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