Faculty Of physical Therapy
Cairo University

Cairo University

Effect of Whole Body Vibration on MotorNeuron Excitability in Healthy Subjects: A Randomized Controlled Trial

Salah Eldin B. Elsayed , Neveen A. Abdel Raoof, Omnia M. Elsayed

Department of Basic Science of Physical Therapy, Faculty of Physical Therapy, Cairo University

ABSTRACT

Background: Whole body vibration has been increasingly used for performance enhancement as well as treatment of some conditions. Although there is much focus on studying muscular performance accompanied with whole body vibrations, till now little is known about its effect on motor units whether it has excitatory or inhibitory effects. The purpose of this study was to investigate the effect of a single bout of whole body vibration on motor neuron excitability in healthy subjects immediately and 30 minutes post application.Participant and Methods: Sixty healthy male subjects participated in this study; their age was ranging between 18 and 25 years old. They were randomly divided into two equal groups; experimental and control groups, each group contained thirty subjects by drawing ballots from sealed envelopes. Experimental groupreceived whole body vibration with a frequency (50-60 Hz), and amplitude (0-10 mm) for 1 minute, 1minute rest period between each vibration set that was repeated 5 times. Control group stood on whole body vibration device for the same duration while it was off.H-reflex amplitude and H/M ratio were measured from soleus muscle (posterior tibial nerve) before, immediately (0 minute) and 30 minutes post application in both groups using surface EMG. Results: There were significant decrease in H-reflex amplitude at 0 min and 30 min measurements in the study group compared with control group (p = 0.002, 0.01 respectively). Moreover, there were significant decrease in H/M ratio at 0 min, and 30 min measurements in the study group compared with control group (p = 0.0001, 0.03 respectively).Conclusion: Whole body vibration decrease motor neuron excitability.So, whole body vibration may have therapeutic implications for people of central nervous system disorders, where spasticity is a major manifestation. Key words: Whole-body vibration, H-Reflex, motor neurons

INTRODUCTION

Whole body vibration (WBV) is the transmission of mechanical energy oscillations to the body as a whole, through a supporting system such as platform. Nowadays, there is increasing interest in the use of WBV as a therapeutic modality to improve muscle strength, postural stability, bone density, sensorimotor, and neuromuscular performance[1, 2].

WBV is a relatively new method that is increasingly used in physicaltherapy field. However the effectiveness and its underlying mechanisms are still under debate.It has also been claimed that WBV could offer a therapeutic alternative for people with limited physical ability [3, 4].

There are several approaches reported to supportthe effects of WBV in neurorehabilitation; the displacement of the platform is stated to mimic gait, vibration of the feet could evoke postural responses, and it might as a somatosensory stimulant have musculoskeletal benefits. Motor neuron excitability is a relatively new topic in the era of WBV. A few studies had been done to determine whether WBV has an excitatory or inhibitory effect on the motor units [5, 6].

One way to identify motor neuron excitability of WBV is to measure the Hoffman reflex (H-reflex). The H-reflex is an electrical equivalent of the mechanically induced stretch reflex; in which Ia fibers are activated. As the H-reflex bypass the muscle spindle, it is a valuable tool to assess modulation of monosynaptic reflex activity. Modulation of the H-reflex is altered after neurological injury. Therefore, modulation of the H-reflex by WBV would have clinical implications for use in the rehabilitation setting to improve functional performance [7].WBV has been attracted much attention in both research and clinical practice. Upper motor neuron lesions are associated with muscle tone abnormalities. There are different physical therapy modalities to normalize muscle tone. One of these interventions is the application of WBV that can have facilitatory or inhibitory effects [8].

Studies investigating the effects of WBV on the H-reflex have noted conflicting response patterns, most likely due to methodological differences in H-reflex application and WBV parameters [5, 9, 10, 11].

Sothis study was conducted to answer the following question is a single bout of WBV could have an immediate and remote effects on motor neuron excitability?

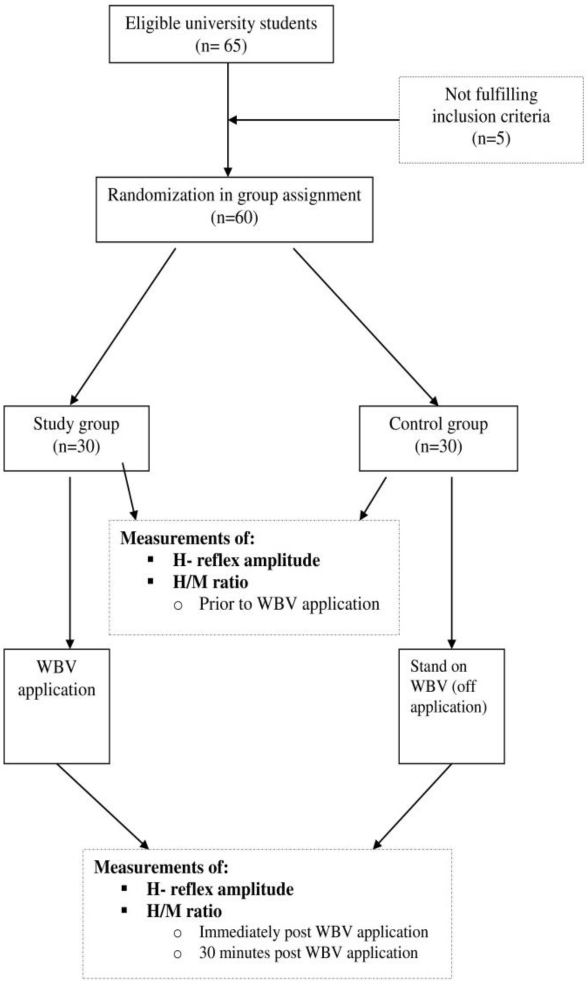
PARTICIPANTS AND METHODS

A randomized controlled trial pretest –post test single bout study was carried out at Neurophysiologic Unit in Zagazig University Hospital, Egypt from May to August 2015 to investigate the effect of single bout WBV on H–reflex amplitude and H/M ratio in healthy subjects.

Participants:

The present study recruited 65 healthy male subjects between the age of 18 to 25 years from the Zagzig University; five of them were excluded from the experiment as they did not meet the inclusion criteria. Thus 60 participants were included in the study after approval of Ethical Committee of the Faculty of Physical Therapy, Cairo University, and all participants were given verbal instructions concerning the purpose and procedures of the study and signed a consent form. Subjects were randomly assigned to two groups; control group (n=30) and study group (n=30) by an independent person who selected the numbers from sealed envelopes containing numbers chosen by a random number generator. The randomization was restricted to permuted blocks of different sizes to ensure that equal numbers were allocated to each group. Each random permuted block was transferred to a sequence of consecutively numbered, sealed, opaque envelopes that were stored in a locked drawer until required. As each participant formally entered the trial, the researcher opened the next envelope in the sequence in the presence of the participant. (as shown in fig 1.).

Figure 1: Flow chart of participants



through the study

Control group: Included 30 healthy subjects, they stood on WBV for 9 minutes (switched off), their weight (75.75 ± 5.77kg), their height (173.3 ± 5.11cm), H-reflex amplitude and H/M ratio were measured initially, immediately, and 30 minutes after the experiment.

Experimental group: Included 30 healthy subjects their weight (77.25 ± 3.76 kg), their height (174.9 ± 3.74 cm) that received WBV for 1 minute, 1minute rest period between each vibration set that was repeated 5 times. H-reflex amplitude and H/M ratio were measured initially, immediately, and 30 minutes after the experiment.

Participants were included if they were non-smokers and their age ranged from 18 to 25 years. All participants were new to WBV.

The Exclusion criteria for participants were;recent or possible thrombosis, diabetes, severe headache, vestibular disorders, arthritis, lower limb implant, synthetic implant, lumbar disc disorder, acute systemic infection or inflammation, recent fracture, gall bladder or kidney stone, malignancy, or history of neurological, orthopedic or cardiovascular problems.

- They are instructed to avoid heavy physical activities 12 hours before the study [12], refrained from eating or drinking any substances containing caffeine 2 hours before the study [13], refrained from taking any tranquilizers or analgesics that may affect motor neuron excitability [14].

Instrumentations:

I. Electromyography (EMG) device; a computerized EMG ToenniesNeuroscreen plus 1.59 was used to record the H-reflex and H/ M ratio for both groups before and immediately after and 30 minutes post WBV application.

The apparatus include:

- Amplifier: four electrically isolated amplifier channels with impedance 100 Mohm, sensitivity 40000Mv/0.5, the amplifier gains up to ten traces on screen with resolution of 1000 points per trace were available.
- Room temperature was constant at 23^{0} C.

II .Whole body vibration device: Pro-Hanson WBVDevice(China). EH-BFMO1WIN, was used in this study.

Experimental procedures:

I.For EMG application:

- The subject positioned prone lying with the examined leg positioned in zero position in extension , mid way between abduction and adduction in the hip joint. The knee joint was flexed about 20 degrees by placing a small cushion under the leg to relax the gastrocnemius muscle and the ankle joint was placed in planter flexion.
- All subjects were asked to empty their bladder before the study [17].

Skin preparation: The skin was rubbed lightly with a piece of cotton soaked with alcohol to reduce the skin impedance.

Electrode position

The stimulating electrode; was placed on the popliteal fossa at the posterior tibial nerve.

The active recording electrode; was placed over the soleus muscle 2cm below the junction of the two heads of gastrocnemius muscle in a line with the Achilles tendon.

The ground electrode; was placed between the stimulating and recording electrodes.

The reference electrode;was placed on the Achilles tendon[18] (as shown in fig 2).

Figure 2: H-reflex electrodes placement

Recording the H-reflex; The H-reflex was elicited by stimulating the posterior tibial nerve at the popliteal fossa using 1000 ms pulse duration with a stimulus frequency 0.5Hz and a wide range of stimulus intensities were applied starting from that needed to obtain the threshold value of the H or the M value to the highest value required for maximum M value(M max).This range of stimulus intensity also provided the maximum value of the H-reflex(H max).The normalized value of H max/M max was computed for each subject.

The H/M ratio was measured for each subject according to the following sequences:

The current intensity was slowly increased until the stimulus just activates the large Ia afferent fibers without concomitant activation of the motor fibers or just threshold for only motor fibers. The stimulus was delivered at a rate of 1 stimulus every 2-3 seconds to avoid suppressing the H-reflex. The intensity of the stimulus was gradually increased to record the maximum H- reflexes as well as the maximum M value.

II. For WBV application:

To eliminate probable circadian effects, all experiments were performed between 9:11 a.m. Participants were instructed to stand comfortably on the vibration platform with their knees extended. All subjects get a familiarization session before the experimental procedure. They were instructed to grasp the handle of the device keeping their feet, shoulders width apart. Vibration was delivered for 1 minute, 1minute rest period between each vibration set that was repeated 5 times [15], at a frequency of 50-60Hz, 0-10 mm amplitude and 50 m/sec speed [16].Participants were instructed not to shift their weight or step off of the WBV platform during the rest period. The vibration (the side altering) platform delivered an asynchronous (vertical sinusoidal stimulus) while balancing around a central point. All subjects stood on WBV device barefoot to eliminate any damping of the vibration caused by the foot wear (as shown in Figs 2 and 3).

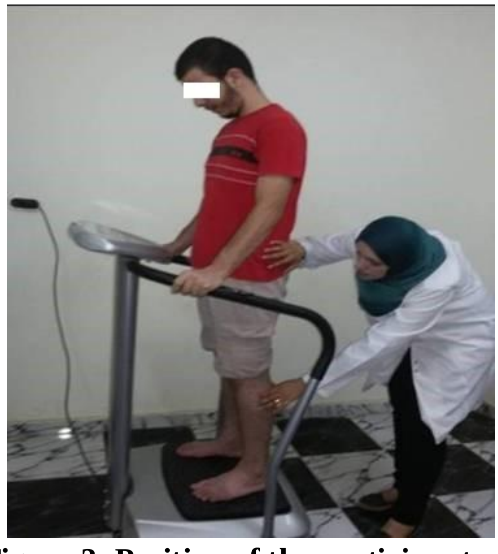


Figure 3: Position of the participant on WBV platform maintaining knee extension

Figure 4: Participant's position during WBV application

Statistical analysis:

Descriptive statistics and t-test were conducted for comparison of the mean age, weight, height, and BMIbetween both groups. Mixed ANOVA was conducted to compare the effect of time (pre versus post) and the effect of treatment (between groups), as well as the interaction between time and group on mean values of H reflex amplitude and H/M ratio. The level of significance for all statistical tests was set at $p < 0.05$. All statistical measures were performed through the statistical package for social studies (SPSS) version 19 for windows (Chicago, IL, US).The Kolomogrov-Smirnov test was applied to check the normality of the data.

The sample size estimation was based on a previous study that examined the effect of WBV on muscle activity in active and inactive subjects [19], using G*Power 3.1 software (Universitat Dusseldorf, Dusseldorf , Germany).

Data obtained from both groups pre treatment, immediately and at 30 minutes after WBV application (30 min measurement) regarding H-reflex amplitude and H/M ratio were statistically analyzed and compared.

RESULTS

Participants' characteristics

Comparing the demographic data of the subjects of both groups revealed that there was no significance difference between both groups in the mean age, weight, height, and BMI ($p > 0.05$).

Table 1: Demographic characteristics of participant

Variable	Study group(n=30)	Control group (n=30)	p- value	Sig
	$\bar{X}$ ±SD	$\bar{X}$ ±SD		
Age (years)	21.45 ± 2.32	21.55 ± 2.41	0.89	**NS**
Weight (kg)	77.25 ± 3.76	75.75 ± 5.77	0.33	**NS**
Height (cm)	174.9 ± 3.74	173.3 ± 5.11	0.26	**NS**
BMI (kg/m²)	25.25 ± 1.09	25.19 ± 1.06	0.85	**NS**

$\bar{X}$: Mean **SD: Standard Deviation** **p value: Probability value**

NS: Non significant

Effect of whole body vibration on H-reflex amplitude:

Multiple pairwise comparison showed that there was no significant difference in the mean values of H reflex amplitude between study and control groups pre treatment ($p = 0.97$). However, there was a significant decrease in H-reflex amplitude at 0 min measurement in the study group compared with control group ($p = 0.002$). Also, there was a significant decrease in H-reflex amplitude at 30 min measurement in the study group compared with control group (p = 0.01), and there was a significant interaction between time and treatment effect (p = 0.0001). (Table 2, fig 5).

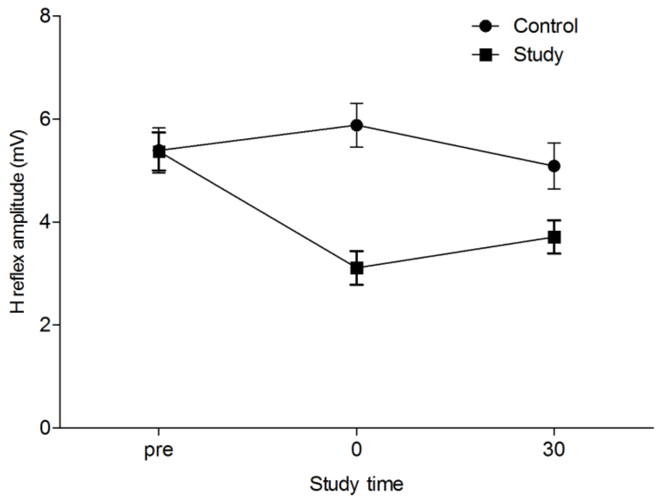


Figure (5): Mean values of H reflex amplitude at pre treatment, 0 min, and 30 min measurements post treatment of both groups.

Table 2.*Mean values of H reflex amplitude at pre treatment, 0 min, and 30 min measurements post treatment of both groups:*

H- reflex amplitude (mV)					
$\bar{X}$ ±SD					
Study group			**Control group**		
Pre treatment	**0 min**	**30 min**	**Pre treatment**	**0 min**	**30 min**
5.37 ± 1.64	3.11 ± 1.45	3.71 ± 1.42	5.39 ± 1.95	4.88 ± 1.9	5.09 ± 1.99
MixedANOVA					
Within group comparison (time effect)					
F = 149.84			***p = 0.0001***		
Multiple pairwisecomparison (Bonforrni correction)					
		MD	**% of change**	**p-value**	**Sig**
Study group	Pre treatmentvs 0 min	2.26	42.08	0.0001	**S**
	Pre treatmentvs 30 min	1.66	30.91	0.0001	**S**
	0 min vs 30 min	-0.6	19.29	0.0001	**S**
Control group	Pre treatmentvs 0 min	0.51	9.46	0.001	**S**
	Pre treatmentvs 30 min	0.3	5.56	0.03	**S**

	0 min vs 30 min	-0.21	4.3	0.16	**NS**
Between group comparison (treatment effect)					
F = 3.77		***p = 0.06***			
Multiple pairwise comparison (bonferroni correction)					
		MD	**p-value**		**Sig**
Study vs control	Pre treatment	-0.02	0.97		**NS**
	0 min	-1.77	0.002		**S**
	30 min	-1.38	0.01		**S**
Interaction effect (time*treatment)					
F = 61.87		***p = 0.0001***			

x̄: Mean **SD: Standard Deviation** **MD: Mean difference**

p value: Probability value **S: Significant** **NS: Non significant**

Effect of whole body vibration on H/M ratio:

Multiple pairwise comparison showed that there was no significant difference in the mean values of H/M ratio between study and control groups pre treatment (p = 0.13). However, there was a significant decrease in H/M ratio at 0 min in the study group compared with control group (p = 0.0001). Also, there was a significant decrease in H/M ratio at 30 min measurement in the study group compared with control group (p = 0.03), and there was a significant interaction between time and treatment effect (p = 0.0001). (Table 3, fig 6)

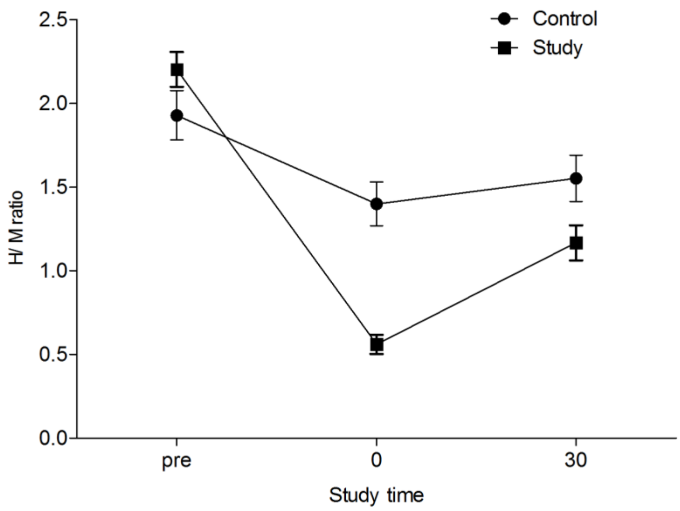


Figure (6): Mean values of H/M ratio at pre treatment, 0 min, and 30 min measurements post treatment of both groups

Table 3. ***Mean values of H/M ratio at pre treatment, 0 min, and 30 min measurements post treatment of both groups:***

H/M ratio					
$\overline{X}$ ±SD					
Study group			**Control group**		
Pre treatment	**0 min**	**30 min**	**Pre treatment**	**0 min**	**30 min**
2.2 ± 0.46	0.56 ± 0.25	1.16 ± 0.47	1.92 ± 0.65	1.4 ± 0.58	1.55 ± 0.61

MixedANOVA	
Within group comparison (time effect)	
F = 221.61	***p = 0.0001***

Multiple pairwisecomparison (Bonforrni correction)					
		MD	**% of change**	**p-value**	**Sig**
Study group	Pre treatmentvs 0 min	1.64	74.54	0.0001	**S**
	Pre treatmentvs 30 min	1.04	47.27	0.0001	**S**
	0 min vs 30 min	-0.6	107.14	0.0001	**S**
Control group	Pre treatmentvs 0 min	0.52	27.08	0.0001	**S**
	Pre treatmentvs 30 min	0.37	19.27	0.0001	**S**
	0 min vs 30 min	-0.15	10.71	0.08	**NS**

Between group comparison (treatment effect)	
F = 4.14	***p = 0.04***

Multiple pairwise comparison (bonferroni correction)				
		MD	**p-value**	**Sig**
Study vs control	Pre treatment	0.28	0.13	**NS**
	0 min	-0.84	0.0001	**S**
	30 min	-0.39	0.03	**S**

Interaction effect (time*treatment)	
F = 57.13	***p = 0.0001***

x̄: **Mean** **SD: Standard Deviation** **MD: Mean difference**

p value: Probability value **S: Significant** **NS: Non significant**

DISCUSSION

The purpose of this study was to investigate the effect of single bout WBV on motor neuron excitability in healthy subjects. The results of this study showed that, both groups showed a decrease in H-reflex amplitude and H/M ratio, but statistically significant difference was recorded between both groups in favor of the experimental group.

The results regarding the control group might be attributed to the transition between prone, standing and ambulation to and from the vibration platform. Prolonged static position used during the off time intervention and this might made participants less stressful. However, there was no significant difference in H-reflex amplitude and H/M ratio between 0 and 30 min measurements.

Our results are in agreement with those of other previous research [5, 11, 16, 20, 21, 22].H- reflex is used to study the effects of vibration on MN pool excitability. H-reflex is a monosynaptic reflex that can show the changes of MN recruitment [23]. The most common parameter of the H-reflex that is studied is the H-reflex amplitude. The H-reflex recruitment curve is a better parameter that provides a more precise evaluation of MN excitability [24]. H-reflex is extensively used both as a research and a clinical tool [25]. It is known that modulation of the H-reflex is altered after neurological injury. Thus, modulation of the H-reflex by WBV would have clinical implications for use in the rehabilitation setting to improve functional performance [7].

WBV has been shown to modulate Ia afferent motorneuron synaptic transmission by causing presynaptic inhibition. Previous studies have shown that H-reflex was depressed during and after whole body vibration in young adult healthy persons. Using transcranial magnetic stimulation, it was found that WBV increase the excitability of the corticomotor pathway and intracortical inhibition while decreasing intracortical facilitation. Also, there is some evidence that WBV could increase temperature and blood flow in both skin and lower limb muscles, which may lead to alterations in viscoelastic properties of soft tissue[26]. In addition, the ratio of the maximal H-reflex (Hmax) to the maximal M-wave (Mmax) is a proper index for revealing the level of excitability of the motor neuron pool [27].

.The results could help to explain the beneficial effects of WBV in people suffering from exaggerated reflex activity. In hemiparetic patients, for instance, the WBV-induced reduction of Ia afferent transmission might help to reduce the abnormal muscle tone and reduce the co-contraction of their muscles. Furthermore, the partial and largely long duration of reflex suppression after WBV is probably helpful to facilitate voluntary motor actions in patients with a high muscle tone caused by exaggerated Ia afferent input. This assumption is well in line with previous observations showing that WBV training enhances the walking ability and balance control in persons with spastic diplegia[4], improves mobility and muscle force in bilateral spastic cerebral palsy children [28]. Those improvements were accompanied by a reduction of spasticity that might be associated with a suppression of Ia afferent transmission [4].

The authors supposed themechanisms that may contribute to the vibratory-induced reflex depression were obtained from experiments in humans with local application of vibration to a muscle or its tendon. Also H-reflex is suppressed due to an increased firing threshold of Ia afferent fibers and presynaptic inhibition of Ia terminals with primary afferent depolarization and post-activation depression due to repetitive activation of the Iamotoneuron synapse followed by reduced probability of transmitter release [22].

The results of this study disagreed with previous studies [29, 30, 31, 32].The differences in results might probably attribute to differences in the mechanical characteristics of the devices (such as amplitude, frequency, and duration of exposures, study populations (age, gender, and health status), acute or training effects and / or treatment protocols (acute or training effects) and lastly the position of the knee whether relaxed or flexed. That might influence the effects of WBV on the neuromuscular system of the human body.

The most frequently cited mechanism by which WBV increases muscle activity is the tonic vibration reflex (TVR). However TVR has been well proven for locally applied vibration over the muscle belly or its tendon, but no conclusive evidence till now that the TVR is applicable to WBV too[19].

The major findings of this study were that single bout ofWBV produced a significant decrease in H-reflex amplitude and H/M ratio at 0 minute and at 30 minute post treatment in healthy male subjects.

Limitations of this study were firstly participant were healthy male. So, the generalisability of the findings may be compromised as a result. Therefore, future studies should address this issue and study the effects at different age groups and gender. Secondly, this study was done as a single to study the acute effects of WBV. Thus training study over long period is needed. Further studies investigating the use of WBV with the same parameter used here in patients with neurological disorders.

The findings of the current study imply that potentially WBV might be an option to decrease motor neuron excitability and in this way, whole body vibration can be used by physiotherapists in rehabilitation of patients with hypertonia.

In conclusion the present study showed that WBVwith the protocol used in this study are effective in decreasing the motor neuron excitability in healthy male adults immediately and 30 minutes after its application.

REFERENCES

1. **Lai Cl, Chen HY, Tseng SY, liao WC, liu BT, lee MC and Chen HS, (2014):** Effect of whole-body vibration for 3 months on arterial stiffness in the middle-aged and elderly. ClinInterv Aging; 9: 821–828.DOI: 10.2147/CIA.S60029.
2. **Mason RR, Cochrane DJ, Denny GJ, Firth EC and Stannard SR, (2012):** Is 8 weeks of side-alternating whole-body vibration a safe and acceptable modality to improve functional performance in multiple sclerosis? DisabilRehabil;34:647–54. DOI: 10.3109/09638288.2011.615370.
3. **Schuhfried O, Mittermaier C and Jovanovic T, (2005):** Effects of Whole body vibration in patients with multiple sclerosis. A pilot study. ClinRehabil; 19:834-842.
4. **Ahlborg L, Andersson C and Julin P, (2006):** Whole-body vibration training compared with resistance training. Effect on spasticity, muscle strength and motor performance in adults with cerebral palsy. J Rehabil Med; 38: 302–308.
5. **Armstrong WJ, Nestle HN, Grinnell DC, Cole LD, Van Gilder EL, Warren GS and Capizzi EA, (2008):** The acute effect of whole-body vibration on the Hoffmann reflex. J Strength Cond Res; 22: 471–476.
6. **Kipp K, Johnson ST, Doeringer JR and Hoffman MA, (2011):** Spinal reflex excitability and homosynaptic depression after a bout of whole-body vibration. Muscle and Nerve; 43:259-62.
7. **Trimble MH, Behrman AL, Flynn SM, Thigpen MT and Thompson FJ, (2001):** Acute effects of locomotor training on over ground walking speed and H- reflex modulation in individuals with incomplete spinal cord injury. J Spinal Cord Med; 24(2):74-80.
8. **Yoosefinejad AK, Torkaman G, Firoozabadi SM,(2015):**Effect of Tendon and Bulk Vibration of The Soleus Muscle on the Threshold and Positive Slope of the H-Reflex Recruitment Curve. Turkish Journal of Physical Medicine & Rehabilitation.
9. **Palmieri RM, Ingersoll CD and Hoffman MA, (2004):** The Hoffmann reflex methodologic considerations and applications for use in sports medicine and athletic training research. J Athl Train; 39: 268–277.
10. **Shinohara M(2005):** Effects of prolonged vibration on motor unit activity and motor performance. Med Sci Sports Exerc; 37(12):2120-5.
11. **Kipp K, Johnson ST and Hoffman MA,(2011):** Functional Principal Component Analysis of H-reflex recruitment curves. Journal of Neuroscience Methods; 197:270-273.
12. **Motl RW and Dishman RK, (2003):** Acute leg-cycling exercise attenuates the H-reflex recorded in soleus but not flexor carpi radialis. Muscle and Nerve; 28: 609–614.

13. **Walton C, Kalmar J and Cafarelli E, (2003):** Caffeine increases spinal excitability in humans. Muscle and Nerve; 28(3):359-364.
14. **Kakinohana M, Fuchigami T, Nakamura S, KawabataT, and Sugahara K, (2002):**Propofol Reduces Spinal Motor Neuron Excitability in Humans. Anesthesia & Analgesia; 94(6): 1586-1588.
15. **Bosco C, Iacovelli M, Tsarpela O, Cardinale M, Bonifazi M, Tihanayi J, Viru M, De Lorenzo A and Viru A, (2000):** Hormonal responses to whole-body vibration in men. Eu J ApplPhysio; 81:449–454.
16. **Games KE and Sefton JM, (2013):** Whole-body vibration influences lower extremity circulatory and neurological function. Scand J Med Sci Sports; 23: 516–523.
17. **Inghilleri M, Carbone A, Pedace F, Conte A, FrascaV, Berardelli A, Cruccu G and Manfredi M, (2001):** Bladder filling inhibits somatic spinal motoneurons. ClinNeurophysiol; 112(12):2255-2260.
18. **Alrowayeh and Sabbahi, (2009):** Medial and lateral gastrocnemius H-reflex intersession reliability during standing and lying postures at varied foot positions in healthy participants. ElectromyogrClinNeurophysiol; 49(4):143-148.
19. **Lienhard K, Vienneau J, Nigg S, Meste O, Colson SS, Nigg BM.(2015):** Relationship Between Lower Limb Muscle Activity and Platform Acceleration During Whole-Body Vibration Exercise. J Strength Cond Res. 29(10):2844-53. doi: 10.1519/JSC.0000000000000927.
20. **Cakar HI, Cidem M, Kara S and Karacan I, (2014):** Vibration paradox and H-reflex suppression: is H-reflex suppression results from distorting effect of vibration? J Musculoskelet Neuronal Interact; 14(3):318-324.
21. **Ritzmann R, Kramer A, Gollhofer A and Taube W,(2013):** The effect of whole body vibration on the H-reflex, the stretch reflex, and the short-latency response during hopping. Scandinavian journal of medicine & science in sports; *23*(3): 331-339.
22. **Sayenko DG, Masani K, Alizadeh-Meghrazi M, Popovic MR and Craven BC, (2010)**: Acute Effects of Whole Body Vibration during Passive Standing on Soleus H Reflex in Subjects with and Without Spinal Cord. Neuroscience Lett; 482(1):66-70.
23. **Yoosefinejad AK, Torkaman G and Firoozabadi SM, (2015):** Effect of Tendon and Bulk Vibration of the Soleus Muscle on the Threshold and Positive Slope of the H-Reflex Recruitment Curve. Turkish Journal of Physical Medicine and Rehabilitation; 61(1): 18-22.
24. **Voerman GE, Gregoric M and Hermans HJ, (2005):** Neurophysiological methods for assessment of spasticity: The Hoffmann reflex, the tendon reflex

and the stretch reflex. DisabilRehabil; 27:33-68.

25. **Wang JS, (2002):** Assessment of soleus motoneuronal excitability using the joint angle dependent H-reflex in humans. J Electromy and Kines; 12: (5)361-366.
26. **Huang M, Liao LR, Pang MY. (2015):** Effects of whole body vibration on muscle spasticity for people with central nervous system disorders: A systematic review. ClinRehabil. 2015 Dec:1- 11. pii: 0269215515621117.
27. **Scaglioni G, Narici MV, Maffiuletti NA, Pensini M and Martin A, (2003):** Effect of ageing on the electrical and mechanical properties of human soleus motor units activated by the H reflex and M wave. J Physiol; 548: 649–661.
28. **Stark C, Nikopoulou-Smyrni P, Stabrey A, Semler O and Schoenau E, (2010):** Effect of a new physiotherapy concept on bone mineral density, muscle force and gross motor function in children with bilateral cerebral palsy. J Musculoskelet Neuronal Interact; 10 (2): 151–158.
29. **Apple S, Ehlert K, Hysinger P, Nash C, Voight M and Sells P, (2010):** The Effect of Whole Body Vibration on Ankle Range of Motion and the H-reflex. North American Journal of Sports Physical Therapy; 5(1):33-39.
30. **Hong J, Kıpp K, Johnson ST and Hoffmann MA, (2010):** Effects of Four Weeks Whole Body Vibration on Electromechanical Delay, Rate of Force Development and Presynaptic Inhıbition. International Journal of Physiotherapy and Rehabilitation; 1(1):30-40.
31. **McBride JM, Nuzzo JL, Dayne AM, Israetel MA, Nıeman DC and Triplett NT, (2009):** Effect of an Acute Bout of Whole Body Vibration Exercise on Muscle Force Output and Motor Neuron Excitability. Journal of Strength and Conditioning Research; 23(4):1-6.
32. **Nishihira Y, Iwasaki T, Hatta A, Wasaka T, Kaneda T, Kuroiwa K, Akiyama S, Kida T and Ryol KS, (2002):** Effect of Whole Body Vibration Stimulus and Voluntary Contraction on MotoneuronPool. Advances in Exercise and Sports Physiology; 8(4):83-86.

الملخص العربى

تاثير الاهتزاز الكلى للجسم على استثاره الخليه العصبيه الحركيه فى الاشخاص الاصحاء: محاوله عشوائية محكمه

خلفية: الاهتزازالكلى للجسم قد استخدم بصوره متزايدهلتحسين الاداء فضلا عن علاج بعض الحالات. وعلى الرغم من ان هناك الكثير من الدراسات التى تركز على دراسه الاداء العضلى المصاحب للاهتزاز الكلى للجسم - حتى الان القليل معروف عن تاثيره على الوحدات الحركيه ما اذا كان له تاثير مثير ام مثبط. وكان الغرض من هذه الدراسه التحقق من تاثير نوبه واحده من الاهتزاز الكلى للجسم على استثاره الخلايا العصبيه الحركيه فى الاشخاص الاصحاء مباشره وبعد 30 دقيقه من التطبيق.

المشاركين والطرق: ستون شخص من الذكور الاصحاء قد شاركوا فى هذه الدراسه، كانت اعمارهم تتراوح بين 18 و 25 عاما .قد تم تقسيمهم عشوائيا الى مجموعتين متساويتين : التجريبيه والحاكمه فى كل مجموعه 30 شخص . تلقت المجموعه التجريبيه اهتزازا الجسم الكامل مع التردد (50-60 هرتز) والسعة (0-10 مم)لمدة 1 دقيقة، ثم فترة راحة لمده1 دقيقة بين كل مجموعة الاهتزازات التي تكررت خمس مرات . فى الجموعه الحاكمه تم الوقوف على جهاز اهتزاز الجسم الكامل لنفس المدة بينما كانت لا تعمل. تم قياس رد الفعل لهوفمان و معدل تغير المدى لهوفمان بالنسبة لمعدل تغير رد فعل العضلةالنعلية (العصب القصبى الخلفى) قبل، بعدهمباشره (0 دقيقة) و 30 دقيقة بعد التطبيق في كلتا المجموعتين باستخدام رسم العصب السطحى .

النتائج: كان هناك نقص ذو دلالة احصائية فى رد الفعل لهوفمان عند 0 دقيقه و 30 دقيقة من القياسات فى فريق الدراسة بالمقارنة مع مجموعة التحكم (P = 0.01, 0.002 على التوالى). وعلاوة على ذلك، كان هناك نقص ذو دلالة احصائية فى معدل تغير المدى لهوفمان بالنسبة لمعدل تغير رد فعل العضلة عند 0 دقيقة و30 دقيقة من القياسات فى فريق الدراسة بالمقارنة مع مجموعة التحكم (P = 0.0001, 0.03 على التوالى).

الخلاصة: الاهتزاز الكلى للجسم يقلل من استثاره الخليه العصبيه الحركيه للاشخاص الاصحاء لذا فانه قد يكون الاهتزاز الكلى للجسم له اثارعلاجيه على الاشخاص المصابين باضطرابات الجهاز العصبى المركزى التى يعتبر التشنج مظهر من مظاهره الرئيسيه.

الكلمات الدالة: الاهتزاز الكلى للجسم-الخلية العصبية الحركية –رد فعل هوفمان