

# Effect of Whole Body Vibration Training during the Recovery Time on the Anaerobic Performance Indices and the Blood Lactate Concentration of Men Wrestlers

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**Received:** 12 January 2018

**Accepted:** 15 May 2018

**Published online:** 1 June 2018

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**Competing interests:** The authors declare that no competing interests exist.

**Citation:** Arshadi S, Noura M, Shakibatabar R. Effect of whole body vibration training during the recovery time on the anaerobic performance indices and the blood lactate concentration of men Wrestlers. Report of Health Care. 2018; 4 (2): 1- 7.

## Abstract

**Introduction:** Whole body vibration (WBV) has been studied as a relatively new and effective way to provide strong mechanical stimulation in the muscular nervous system, cardiovascular, respiration, bone and muscle tissue in a wide range of medical, ergonomic and animal experiments. This study aimed to investigate the effect of WBV during the recovery period on the anaerobic performance indices and the blood lactate concentration of wrestlers.

**Methods:** Twelve male wrestlers of college students in Tehran with a mean age of  $25.75 \pm 2.55$  years old, height  $175.58 \pm 6.35$  cm, weight  $71.4 \pm 7.75$  kg and body fat percentage  $14.22 \pm 6.87$  (%) volunteered for participation in the study. The training protocol was 10 minutes of warming and then the subjects performed intensive anaerobic activity for 2 minutes and then 15 minutes of recovery was performed; after a recovery, the same 2 minutes of intensive anaerobic activity was repeated. On the first day, inactive recovery, and after four days on the second day, WBV as active recovery was used. In this study, blood lactate concentrations were measured four times. Paired sample t-test, repeated measure ANOVA and Bonferroni post hoc at significant level of 0.05 were used to analyze the data.

**Results:** The results of present study showed that WBV in comparison with inactive recovery, improves the anaerobic power of wrestlers in the second activity than the first activity (Peak Power,  $p=0.61$ ; Average Power,  $p=0.62$ ), but does not have a significant effect on the concentration of blood lactate ( $p=0.006$ ).

**Conclusion:** This study showed WBV as an active recovery method can have beneficial effects on the improvement of anaerobic power indices and blood lactate in wrestlers.

**Keywords:** Anaerobic Performance, Lactate, Recovery, Whole Body Vibration

## Introduction

Wrestling is one of the sports activities in which the utmost need is to increase energy capacity by strengthening the lactic acid system. In regard with the wrestling's physiology, what doubles the problem is the duration of each wrestling match, since a wrestling match may take only 10 seconds and another match may last 6 minutes. Therefore, the reinforcement of all three adenosine three phosphate (ATP) producing systems (phosphagene, lactic acid, and oxygen) should

be put on the agenda of the crew of the wrestling (1). During their preparation, wrestlers often undergo hard work through tough exercises, and during the recovery period, the lost energy of the body reserves will be recovered and restored to its initial state, and this cycle continues (2). During this period, various metabolism events occur in the body, all of which are used to recover energy and store it. The events of this period are as important as the events of the period of activity and work (3). In most cases, the

wrestler may perform several contests during a day, and in most sporting events, the interval between two turns of the match is not long enough so that the time itself may not solve the problem of the restoration of the lost energy. Failure to complete recovery period will immediately lead to reduced ability to perform physical work. If the severity and duration of the recovery period are not sufficient, the athlete may experience complications such as chronic fatigue, illness and over-training, which often negatively affect the quality, quantity and ability of the body (4, 5). The recovery period is said to last from the moment the work or exercise ends until it reaches the initial condition or rest period (5). During this period, various metabolism events occur in the body, all of which are used to recover energy and store it. During sport exercise, multiple physiologic factors stimulate the involved cells to provide better adaptation to withstand stresses from exercise. When doing sport exercise, muscle cells are stimulated and then tense, but the main adaptation occurs during the recovery period. The justification for this adaptive process may be that when engaging in muscle tensions, the cell consumes metabolic energy to withstand stress, and when recovery, it uses the energies to adapt (6, 7). Various methods are used to return to the initial state of the art, including massage, sauna, stretching, drinking sports tonics, and doing sports activities (7). One of the methods used today in most sports teams is the use of whole body vibration devices (WBVD). WBV is widely used to improve performance in a variety of settings, such as professional exercise, fitness centers, and rehabilitation clinics in the United States, Japan, and European countries (8). WBV has been studied as a relatively new and effective way to provide strong mechanical stimulation in the muscular nervous system, cardiovascular, respiration, bone and muscle tissue in a wide range of medical, ergonomic and animal experiments (9, 10). WBV is performed using various vibrating devices and,

like other methods of exercise, has its own specific variables, including frequency, amplitude, duration, and body position when using the vibration machine (10). Some researchers, such as ImYongtaek *et al.* (2017) (11), Bosco *et al.* (2009), Torvinen *et al.* (2012) and Paradise *et al.* (2015), investigated the effects of vibration exercises on performance and hormonal indices and reported different results. However, in those studies, vibration was used as a method of exercise, while in the present study, this practice is used as a recovery method. Active recovery is one of the common ways to reduce lactate, eliminate fatigue and return to the initial state compared to inactive recovery. The active recovery generally includes a pattern of low intensity and size of sports activity, in proportion to the current athletic training load capacity. Inactive recovery, on the other hand, refers to the courses in which an individual does not engage in any activity, and its duration can be very short for a few days or several days after a lengthy workout or hard labor (12, 13). In wrestling, at times, there is a situation where the interval between two contests does not allow full recovery and this may have a negative effect on the performance of the athlete in the next race (12, 13), therefore it is necessary to use an active recovery method that can prepare the athlete for the next race and to some extent prevent the loss of performance. In the present study, WBV was used as an active recovery method, because theoretically in terms of the nature of vibration, on the one hand, and in terms of the physiological principles of the recovery phase, on the other hand, it is possible to see more beneficial effects from the use of WBV in practice. Therefore, the purpose of this study was to investigate the effect of WBV on anaerobic power indices and blood lactate in wrestlers.

## Methods

The statistical population of the present study consisted of male wrestler students in Tehran

universities. Subjects were included in the study with at least 5 years of practice experience and no clinical problems. Twelve of them were selected by convenience sampling. Table 1 shows the general anthropometric characteristics of the subjects. A week before the test, the research objectives were explained to the subjects at a meeting. In the meantime, their height, body mass, and body fat percentage were measured, and the method of working with the vibration machine and the related tests were described in practical terms. The subjects were reminded to avoid doing heavy exercise 24 hours before the test and to shun eating solid foods 4 hours before the test. The research was conducted in two days with the same protocol. However, the subjects used sedentary inactive recovery on the first day, and four days later, WBV was used as an active recovery method. The practice protocol was that each day the subjects performed intensive anaerobic activity for 2 minutes after 10 minutes of warming, which included Foot Wingate tests for 30 seconds (for anaerobic peak strength, anaerobic average power, minimum anaerobic power and fatigue index), Swedish swim for 40 seconds and zigzag jumping from 10 cm for 40 seconds with maximum power and Hand Wingate for 9 seconds. Afterwards, 15 minutes of recovery was implemented (12). After the recovery period, 2 minutes of anaerobic activity was repeated. In the recovery period on the first day, the subjects had inactive sedentary resting and on the second day the subjects used recovery with vibration. The vibration was performed 8 turns, each turn one minute with a frequency of 20 Hz and an amplitude of 10 mm in a semi-squat position with knee flexion of 100° and followed by a resting minute after each turn of vibration (12). In this study, blood lactate concentration was measured four times: before the first activity, 3-5 minutes after the first activity (before the recovery period), 3-5 minutes before the second activity (after the recovery period), and 3-5 minutes after the end

of the second activity. Descriptive and inferential statistics were used to analyze the data. In the descriptive statistics, measures of central tendency and dispersion including mean and standard deviation were used. In the inferential statistics, Paired sample t-test and repeated measure ANOVA measures and Bonferroni's post hoc test were used to compare the data at the significance level of  $p \leq 0.05$ .

## Results

Results of paired sample t-test in Tables 2 showed that the peak anaerobic power and mean power after inactive recovery were significantly lower than before ( $p=0.005$  and  $p=0.009$  respectively), but there was no significant change in WBV ( $p=0.61$  and  $p=0.62$  respectively). The minimum anaerobic power after inactive recovery was decreased significantly ( $p=0.007$ ) and the fatigue index after inactive recovery was increased but don't significant ( $p=0.58$ ) While this change was significant in WBV ( $p=0.01$  and  $p=0.02$  respectively) (Table 2). Results of paired sample t-test showed that the percentage of reduction in peak anaerobic power and mean power as a result of inactive recovery (12.5% and 16.22%, respectively) were significantly more than WBV (1.01 and 0.8%, respectively) ( $p=0.005$  and  $p=0.003$  respectively), which suggests that the WBV maintains a higher level of anaerobic power and average power in comparison with inactive recovery. Results of repeated measure ANOVA showed intragroup changes in blood lactate in both types of WBV and inactive recovery is significant ( $p=0.001$ ), but this changes in between group not significant ( $p=0.69$ ). The results of Bonferroni post hoc test showed that both types recovery significantly reduced the lactate concentration after recovery than pre-recovery (in WBV  $p=0.009$  and Inactive  $p=0.027$ ). However, WBV caused further decrease in blood lactate (5.76%) compared to inactive recovery (3.55%) (Table 3).

**Table 1.** Anthropometric characteristics of subjects

Variable	Mean ± Standard Deviation
Age (Year)	25.75±2.05
Height (Cm)	175.58±6.35
Weight (Kg)	71.40±7.75
Body Fat (%)	14.32±6.87

**Table 2.** Paired sample t-test results on anaerobic performance indices as a results of inactive recovery and WBV

Variable	Group	Before (M±SD)	After (M±SD)	Difference in Means	t	P
PP (w/kg)	Inactive Recovery	11.75±1.27	10.28±0.67	1.47	25.01	0.005*
	WBV Recovery	11.82±0.96	11.70±0.88	0.12	23.04	0.61
AP (w/kg)	Inactive Recovery	5.98±1.00	5.01±0.57	0.97	17.31	0.009*
	WBV Recovery	6.25±0.47	6.20±0.42	0.12	15.06	0.62
MP (w/kg)	Inactive Recovery	3.43±0.39	2.84±0.60	0.59	13.33	0.007*
	WBV Recovery	3.27±0.49	2.76±0.48	0.05	13.65	0.01*
FI (%)	Inactive Recovery	71.43±2.55	72.39±5.07	0.96	20.76	0.58
	WBV Recovery	72.07±5.35	76.35±3.97	0.51	21.54	0.02*

PP (w/kg) = peak anaerobic power (watts per kilogram)

AP (w/kg) = average anaerobic power (watts per kilogram)

MP (w/kg) = minimum anaerobic power (watts per kilogram)

FI (%) = Fatigue index, SD ± SD = Mean ± SD

\* Significant difference between pre and post recovery

**Table 3.** Results of repeated measure ANOVA for changes in blood lactate

Blood lactate	Rest (mm/l)	before recovery (mm/l)	after recovery (mm/l)	End Lactate (5 minutes after) (mm/l)	F	P
Inactive Recovery	0.96	12.13	7.39	11.81	1.07	0.001*
WBV Recovery	1.01	11.65	6.61	11.10	1.01	0.001*

\* Intragroup Significant difference

## Discussion

The results showed that WBV in comparison with inactive recovery caused a lesser decrease in the relative peak anaerobic power (1.01 and 12.5 %, respectively) and relative average anaerobic power (0.8 % and 22.22 %, respectively), and these changes were significant. Also, WBV caused a relatively lower concentration of lactate (5.76 %) in comparison with inactive recovery, but this decrease was not significant. There were no significant differences in other variables. The results of this study were consistent with the

research by ImYongtaek *et al.* (2017), in which after 5 minutes of WBV they reported improved anaerobic power and decreased lactate concentration in Taekwondo athletes during the recovery period (11). The findings of the present study are also in line with the findings of the research by Bosco *et al.* (2009) (12), Torvinen *et al.* (2012) (13), Paradises *et al.* (2015) (14), Torvinen *et al.* (2011) (15) which reported improvements in anaerobic power indices. On the other hand, they are inconsistent with the findings of Issurin *et al.* (2009) (16) and Feland *et al.* (2016) (17) who

reported no significant improvement in anaerobic power indices. Since the researchers did not use WBV as a recovery method, the results of this study can't be compared with their results. But these studies have shown that WBV is effective in improving anaerobic performance indexes. In this study, WBV was used as an active recovery method. The WBV is basically a variation in the tonic vibration reflex (TVR) caused by vibration in the tendon. The TVR created as a result of the implementation of WBV increases the call of motion units through the activity of muscle spindles and polysynaptic paths, which seems to increase temporal muscular nervous activity, and hence can be effective in maintaining anaerobic power. Long-term stimulation of WBV over muscle spindles results in tension and muscle tiredness and increased accumulation of lactate and ultimately impairment in power generation (18). Gamma motor neurons control the susceptibility of muscle spindles. These neurons send nerve impulses into internal fibers located in the muscular spindles and increase the motor neurons' discharge. Finally, this action increases the susceptibility of the spindle muscles to the stimulus and, in the short term, increases mechanical and physiological responses that can be effective in improving the power and production of strength (19, 20). WBV causes rapid extrinsic-intrinsic contractions, which increases the amount of muscle metabolism (11); this leads to warming and increasing muscle temperature, which by improving neural efficacy, decreasing the resistance to blood viscosity, and increasing the elasticity of the muscle, results in improved power and strength production (11, 19). It has been shown that WBV increases the blood flow in the lower muscles of the trunk; the reason is reported to be the blood distribution throughout the tiny surface of arteries, which causes a decrease in peripheral resistance, suggesting that this may increase the rate of average blood flow (20). WBV increases the

surface of tiny vessels in the muscle and decreases in peripheral resistance. Decrease in peripheral resistance is probably the reason to decline the resistance index in the muscle, and it may also increase the average blood flow in the muscle by decreasing blood viscosity, which can affect the disposal of wastes resulting from activities, especially blood lactate (20). Some methods of recovery, such as massage, tend to stimulate vibration or pressure to smooth muscle stiffness and the release of the stimulus points that are pressurized by training or competition. This method also causes faster circulation, which results in the disposal of wastes and transport of nutrients and oxygen to the muscles, and can lead to a faster return to the initial state (1). Given the physiological principles of the WBV, it is likely that the WBV, like massage, will have a positive effect on the body, resulting in a faster return to the initial state, so that the athlete can participate in the next match better. In general, the possible reasons for the effect of WBV on anaerobic performance indices and blood lactate concentration are as follows: 1) Stimulators of Ia and IIa muscular fibers, which cause contraction of muscle reflex, such as TVR (6, 12). 2) Stimulating active metabolism and increasing metabolism, which increases muscle temperature, muscular nervous activity and increased muscle blood flow (20, 21). 3) Improvement in muscular nervous system, regulation of neural traffic in muscular nervous system, improvement in contractility of collaborative muscles and increase in inhibitory power of opposite muscles (22, 23). 4) Double increase in blood flow, decrease in blood resistance index and decrease in viscosity of blood, which leads to improvement in blood circulation (24). Since the results of the WBV implementation are significantly influenced by the frequency, amplitude, duration and intensity of vibration, it is likely that different results can be obtained by changing each of the above. The results of this study indicate that WBV in comparison

with inactive recovery has a greater effect on maintaining the anaerobic power of male wrestlers in the second activity than the first activity, but it has no significant effect on the concentration of blood lactate. Thus, it can be argued that low-frequency vibration exercises can be used along with other recovery techniques. There were limitations in the study, such as the lack of control of daily activities of individuals, the nutritional status, mental conditions and the rate of sleep and rest of the individuals. At the end, it is suggested that more researches should be done on vibration with different frequency, duration and intensity on physical fitness factors.

### Conclusion

In the present study, results showed that vibration training as an active recovery method can have beneficial effects on the improvement of anaerobic power indices and blood lactate.

### Ethical issues

No applicable.

### Authors' contributions

All authors equally contributed to the writing and revision of this paper.

### Acknowledgments

The authors would like to thank and appreciate all participants who cooperated with the research study.

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