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Research article

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Abstract

The aim of the present study was to determine the effects of a WBV training on sprint and jumping performance in junior volleyball players**.** Twenty-two young, healthy volunteers participated in this study (age 17.13 ± 0.81 years, body mass 70.84 ±5.94 kg, body height 175.18 ± 5.50 cm and BMI 23.02±0.75). All participants were students in high school. They were divided randomly as control group (CG) and whole-body vibration training group (WBVTG). During the period of the study, all players performed the same volleyball specific training, but the WBVTG had additional WBVT (amplitude: 4 mm, frequency: 40 Hz) three times per week for six successive weeks. They were given 48 hours of rest between each training session. Before starting the WBV training program, experimental group were applied WBV education program during 2 weeks. Countermovement jump (CMJ), 5 m and 10 m sprint tests were applied to evaluate the jump and sprint performances of the athletes at baseline and after 6 weeks. Since parametric conditions were observed, paired sample t test was used in intragroup analysis and independent sample t test was used in intergroup analysis. Additionally, differences were analyzed using a magnitude-based Cohen's effect size (ES) statistic with modified qualitative descriptors. There were no significant differences between training and control groups in demographic characteristics at baseline measures. After 6 weeks, control group had significant differences between the values of pre-test and post test in vertical jump (t= -3,03, $p<0.05$). On the contrary, there was no significant difference in the 5 and 10 m sprint values after 6 weeks in the control group. But, training group had significant differences between the values of pre-test and post test in all measurements. It can be concluded that implementation of 6-week WBV training in routine practice in volleybal improves the jumping and sprint performance in training group.

Keywords: Education program; vibration training; countermovement jump; linear sprint; performance

1. Introduction

Volleyball; it can be defined as an interval sport performed alternately with short periods of exercise and rest. It contains, spiking, blocking, repeated jumping power hitting, and setting which require a high level of strength and power (Lidor and Ziv, 2010). During the game, athletes need improved strength, power, speed, endurance, mobility, skill and coordination. However, as in all team sports, it is seen that coordinative abilities such as power and continuity in strength come to the fore in the struggle for possession of the ball. The physical and physiological structure required by this sport has an important place in being successful. The activities carried out by athletes may differ regards their individual roles' technical and tactical demands during the game. In addition, common movements such as running accelerations and decelerations, jumping, ball-striking, and multidirectional activities are used very often (Sheppard et al., 2009).

In the match analysis, it is stated that the volleyball players covered a distance of approximately 1221 ± 327 m in a 3-set match and 1757 ± 462 m in a 4-set match. A volleyball match takes an average of 90 minutes. During the competition, the athletes performed high intensity activities frequently. It is stated that the average intensity during the match is between 40-50% of VO2max. For this reason, athletes are needed advanced aerobic and anaerobic energy systems (Lidor and Ziv, 2010).

In recent years, whole body vibration (WBV) has been used frequently as an exercise and training method and has attracted the attention of researchers. WBV is defined as "the application of mechanical swings to the body through a vibration platform" (Tomas et al., 2011). If vibration is implemented to a muscle, reflex contractions called the tonic vibration reflex occur in the muscle (Mester et al., 2006). A few seconds after the vibration is implemented to the muscle, involuntary convulsions begin in the muscle and these convulsions gradually increase and keep on at an invariable level until the vibration application is terminated (Latash, 1998). WBV training ensures acute and chronic concordances and advancements in different populations, strength (Ronnestad, 2004), power (Bosco et al., 1998), balance (Fort et al., 2012), flexibility (Van den Tillaar, 2006) and speed (Mc Bride et al., 2002) have been shown in many studies to have positive and improving effects.

When the studies investigating the acute effect of WBV training on neuromuscular performance are investigated, it is seen that different results are obtained. Torvinen et al. (2002) reported that 4 minutes of TVT (4mm, 15-30 Hz) application caused an increase in jump height and isometric extension strength. In addition, Turner et al. (2011) showed that TVT (8 mm, 40 Hz) implemented for 30 seconds in the half-squat position resulted in a 6% increase in active jump performance. In addition to these studies, Erskine et al. (2007) determined that a one-minute TVT application (4 mm, 30 Hz) applied with 10 repetitions during half squat exercise caused a decrease in maximal isometric strength.

When the written sources are examined, it is seen that acute WBV application is applied at different frequencies and amplitudes and different results are obtained. WBV training can result in some improvements in athletes' muscle force, power, speed, and' elasticity performances. The basic factors related enhancing in muscle performance are amplitude and frequency range, vibration type and application method, training intensity, exercise protocol, and participant characteristics (Torvinen et al., 2002; Delecluse et al., 2005; Bullock et al., 2008; Hortobágyi et al., 2015; Dallas et al., 2017; Minhaj et al., 2022). When looking at the relevant literature, it has been observed that there are not many studies examining the impact of WBV training on athletic performance, especially in young adolescent female athletes (Cochrane and Stannard, 2005; Paradisis and Zacharogiannis, 2007; Fernandez-Rio et al., 2012; Fort et al., 2012; Dallas et al., 2019). Accordingly, the aim of the present research was to determine the effects of a WBV training on sprint and jumping performance in junior volleyball players**.** It has been predicted that vibration training applied for 6 weeks will be more effective in increasing sports performance compared to no vibration program.

2. Method

2. 1. Experimental Approach to the Problem

This study was a randomized controlled trial involving junior volleyball players. To evaluate the likely positive effects of WBV in jumping and sprint performance, junior volleyball players performed countermovement jumps (CMJs), and 5-10-m sprint before and after either WBV or no vibration. All measurements were carried out between the hours of 10.30-12.00. Before the tests, all participants and parents signed the written informed consent form. All procedures were implemented according to the Helsinki declaration. The researchers received the approval of the ethics committee from the Pamukkale University Non-Invasive Clinical Research Ethics Committee (Decision number: 60116787-020-315531).

2. 2. Study Group

Twenty-two female athletes who volunteered attended to this study. (age 17.13 ± 0.81 years, weight 70.84 ±5.94 kg, body height 175.18 ± 5.50 cm and BMI 23.02±0.75). All participants were members of the local club in Denizli. They had at least two years of training experience and were participated in training program for 5 times per week in clubs of volleyball. Before starting the WBV training program, experimental group were applied WBV education program during 2 weeks (familirazation period). Experienced conditioning coaches demonstrated proper exercise technique throughout the study period. Coaches consistently encouraged the subjects to maintain proper technique performance. If a player fatigued and could not perform an exercise correctly, the exercise was stopped. Explainations on the correct teaching of the WBV training techniques and the attainments to be achieved during the exercises were provided.

They were haphazardly divided into two groups using a computer-based system (Research Randomizer, https://randomizer.org/). The investigators who made the measurements did not affect the randomization procedure. The participants were randomized to the training group *(WBVTG: n = 11)* and control group *(CG: n = 11).* No significant differences were found between training and control groups in demographic characteristics at baseline measures (Table 1). The descriptive characteristics of the subjects attending in the study is shown in Table 1.

Table 1. *Baseline features for the participants*

Variables	Training group (n=11)	Control group (n=11)
	X±Sd	X±Sd
Age (year)	17,08±0.79	17,17±0.83
Body height (cm)	175,5 ± 5,36	174,8 ± 5,64
Body mass (kg)	71,47 ± 6,37	70,20 ± 5,51
Body mass index (kg/m^2)	23,14± 0,85	22,9± 0,65

2. 3. Study design

The current study continued six weeks. During this period, all subjects were participated regularly to volleyball trainings. Before the measurements, all participants were informed about benefits, risks and the procedures of the research. Participants being absent 10% from the training were eliminated from the research. They were given 48 hours of rest between each training session. Two education program (familiarision sessions) were conducted before starting the first session. Firstly, the anthropometrical features of the participants (age, height, body mass) were taken and then sprint and jumping tests were performed. Tests were done at the baseline and after six weeks of vibration training. They were performed 24 hours before and after training, respectively. The WBV training protocol was set at three days per week as 2-3 sets, frequency of 40 Hz, amplitude of 4 mm and 60 sec (Table 1).

Table 1. *Training load of WBV protocols*

Weeks	Training frequeny (days/week)	Number of sets	Vibration frequency	Vibration amplitude	Vibration duration
1-3	3	2	40 Hz	4 mm	60 sec
4-6	3	3	40 Hz	4 mm	60 sec

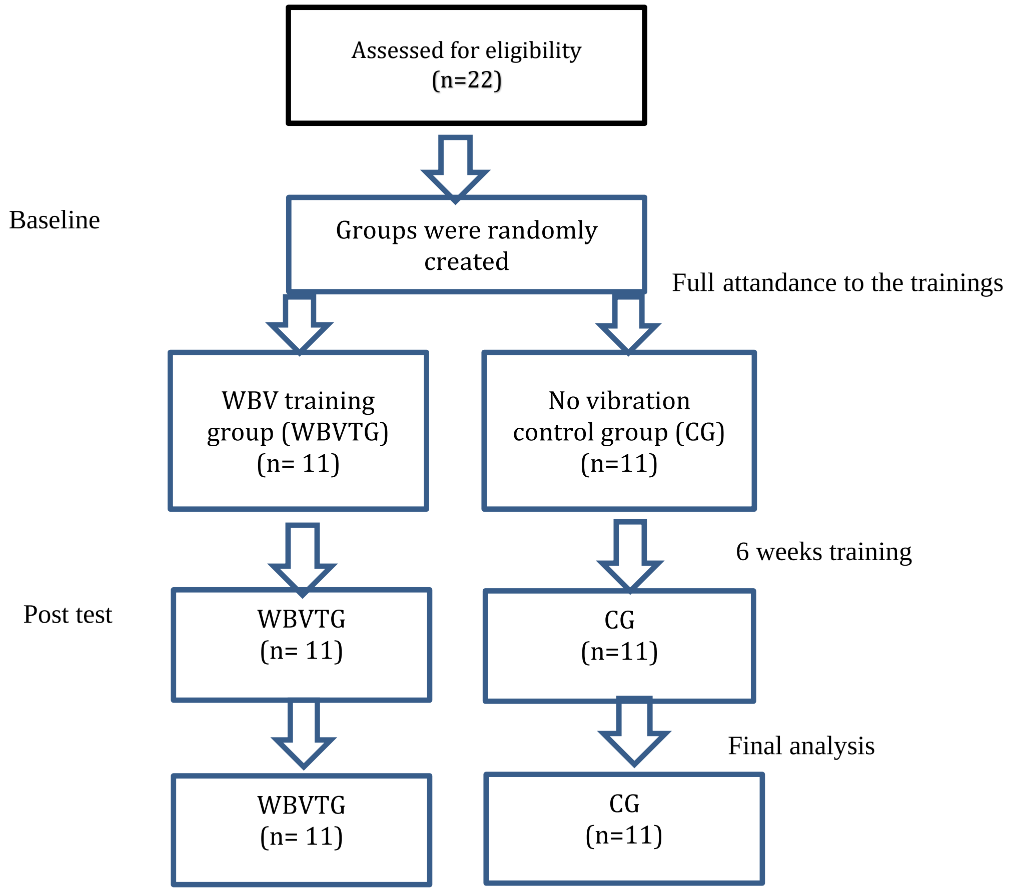

Figure 1. *The study design of the intervention groups; WBVTG and CG.*

2. 4. Data Collection Tool

2. 4. 1. Vertical Jump Tests

According to the protocol developed by Cronin et al. (2004) three CMJ applications were performed. Participants were asked to keep their hands on their hips during jumps. Each jump values were recorded and their averages were taken. 20 second rest was given between each jump. Test system included a portable hand-held computer unit linked to a contact mat (Swift Performance). It was previously reported that the test system is quite reliable.

2. 4. 2. Sprint Tests

Each participant performed 3 attempts in the sprint test of 5 and 10 m, and the best values were recorded to the nearest 0.01 second. 2 minutes of rest was given between each trial. Each sprint test was started in a stationary position from a line 30 cm before the start line. The sprint values of the participants were measured using a dual-beam, modulated, visible red-light system with a polarizing filter (Swift Performance) (Krawczyk et al., 2022).

2. 5. Statistical Analysis

All values are presented as Mean±SD. Shapiro-Wilk's test was used for normality analysis. In addition, Levene's test was used for homogeneity of variances. Since parametric conditions were observed, paired sample t test was used in intragroup analysis and independent sample t test was used in intergroup analysis. The percentages of change and effect sizes of the data were calculated.

Furthermore, the differences were analyzed using a magnitude-based Cohen's effect size (ES) statistic. The effect sizes were interpreted according to the following criteria >2.0 very large differences,>1.2–2.0 = large,>0.6–1.2 = moderate, 0.2–0.6 = small, <0.2 = trivial (Batterham and Hopkins, 2006). Significance was set at p <0.05

3. Findings

The test results of the participants attending in the study is shown in Table 2.

Table 2. *Physiological features for the participants in control group*

Variable	Test	Means	Sd	t	p	Cohen d	Δ%	ES
Vertical Jump	Pre	43,08	4,25	-3,026	0.012*	0,293	1,56	Small
	Post	44,16	4,28					
5 m Sprint	Pre	1,22	0,16	0,747	0,471	0,024	-0,81	Trivial
	Post	1,21	0,13					
10m Sprint	Pre	1,97	0,27	1,159	0,271	0,057	-0,50	Trivial
	Post	1,96	0,26					

ES: Effect size, p <0.05

After 6 weeks, control group had significative differences between the values of pre-test and post test in vertical jump (t= -3,03, *p*<0.05). On the contrary, there was no significative difference in the 5 and 10 m sprint values after 6 weeks in the control group (*p*>0.05) (Table 2).

Table 3. *Physiological features for the participants in training group*

Variable	Test	Means	Sd	t	p	Cohen d	Δ%	ES
Vertical Jump	Pre	44,83	4,01	-11,93	0.000*	0,866	10,77	Moderate
	Post	49,66	4,57					
5 m Sprint	Pre	1,21	0,15	3,694	0.004*	0,382	-4,13	Small
	Post	1,16	0,12					
10 m Sprint	Pre	1,96	0,18	6,714	0.00*	0,672	-2,04	Moderate
	Post	1,92	0,16					

ES: Effect size, p <0.05

After 6 weeks, training group had significant differences between the values of pre-test and post test in all measurements ($p < .0.05$) (Table 3).

Table 4. *Comparison of pre-test values of control and training groups*

Variable	Group/Test	Means	Sd	t	p	Cohen d	Δ%	ES
Vertical Jump	Control / Pre	43,08	4,25	-1,036	0,311	0,046	3,9	Trivial
	Training / Pre	44,83	4,01					
5m Sprint	Control / Pre	1,22	0,15	0,198	0,845	0,001	-0,82	Trivial
	Training / Pre	1,21	0,15					
10m Sprint	Control / Pre	1,97	0,26	0,116	0,908	0,000	-0,51	Trivial
	Training / Pre	1,96	0,18					

ES: Effect size, p <0.05

When looking at the comparison of the pre-test values of the control and training group, no significant differences were found in all parameters (p>0.05) (Table 4).

Table 5. *Comparison of post-test values of control and training groups*

Variable	Group/Test	Means	Sd	t	p	Cohen d	Δ%	ES
Vertical Jump	Control / Post	44,16	4,28					
	Training / Post	49,66	4,57	-3,039	0,006	0,295	12,45	Small
5m Sprint	Control / Post	1,21	0,13					
	Training / Post	1,16	0,12	0,967	0,344	0,04	-4,13	Trivial
10m Sprint	Control / Post	1,96	0,25					
	Training / Post	1,92	0,16	0,433	0,669	0,008	-2,04	Trivial

ES: Effect size, $p < 0.05$

When looking at Table 5, the significant differences were no found between two groups in the post-test in all parameters ($p > 0.05$) (Table 5).

4. Conclusion and Discussion

The purpose of the current research was to determine the effects of a WBV training on sprint and jumping performance in junior volleyball players.

The main findings were that WBV training program validated efficacious in enhancing both jumping and sprint performance in training group after 6 weeks. Besides, it was observed improved jumping performance but not sprint performance in control group.

Although there was a moderate improvement (2.51%) on jumping performance, non-significant main effect was found on sprint performance in control group after 6 weeks. But, significant changes were observed on jumping performance (10.77%), on 5 m sprint (4.13%) and on 10 m sprint (2.04%) in the training group.

These findings reveal that the vibration training applied to the training group has a significant effect on the selected parameters. The training effects of WBV may have occurred as a result of neural adaptation to vibration stimuli.

After 6 weeks of training, the jumping performance increased by 10.77% in WBVTG and 2.51% in CG, however the level of enhancing was nearly the similar as that determined in the studies with a similar interfering regimes that continued for up to 6 weeks (Perez-Turpin et al., 2014), 12 weeks (Delecluse et al., 2005) and in longer (Torvinen et al., 2002) from 1% (Owen, 2004) to 12% (Bosco et al., 1998) for counter movement jump. This development by 10.77% support previous results of Wyon et al. (2006) that determined a significant impact of vertical jump performance after 6-week WBV training in partially trained undergraduate female dance students. In similar studies in the literature, it has been reported that wbv has a meaningful impact of 3-12% on jumping performance in young skiers, beach volleyball and volleyball athletes (Mahieu et al., 2006; Perez-Turpin et al., 2014). This improvement in the vibration group showed that it supports previous findings that revealed that wbv increases the explosive power of the lower extremities (Fernandez-Rio et al., 2012).

Conversely, in a study carried out by Delecluse et al. (2005), it was determined that 5 weeks of additional vibration training applied to athletes did not show a significant effect on the performance compared with the resistance training group in sprint athletes.

The findings of current study demonstrated that WBV training gave rise to a reduction in sprint time by 4.13% at 5m and 2.04% at 10m in trining group. Considering these findings, it is seen that the WBV effect on sprint time at 5 and 10 meters is more effective, especially at 5-meter sprint.

Gümüsdag et al. (2013) study results suggest that Yo-Yo IR1 could be used to determine HRmax of soccer players and have strong relationship with VO2max and this test may provide a more effective field-based assessment of both aerobic and anaerobic performance in soccer players (MST, CMJ & Hoff DT).

The results of this research were similar to the findings of the study carried out by Giorgos and Elias (2007). Also, Cochrane et al., (2004), Giorgos and Elias, (2007), Owen, (2004) reported that the effects of WBV training applied to athletes on athletes' 5- and 60-meter sprint times increased up to 4.3%. In a similar study conducted by Paradisis and Zacharogiannis (2007), it was reported that athletes had a 2.10% improvement in 60-meter sprint times. But the findings of the study carried out by Roberts et al. (2009), were not suitable for our studies' results. They reported that there was no significant difference in 30-meter sprint times in collegiate athletes.

Some similar studies conducted (Torvinen et al., 2002; Mester et al., 2006; Giorgos and Elias, 2007; Osawa et al., 2013) revealed a significantly greater WBV impacts in training group compared with control group. Besides, differences in WBV implementation procedures among last researches, subject features and the time of the experimental procedure may have an effect in the differences in the magnitude of the observed influences

Conversely, our results opposed to those of Cochrane et al. (2004) and Cole & Mahoney (2010). Because, the significant differences were not found in sprint times at 5, 10, 20 and 40 m in WBV training group in their studies. In addition, it has been reported that the WBV stimulus has no positively affects in the athlete' sprint performances in other similar studies (Roberts et al, 2009; Cochrane, 2013).

When the related literature was examined, it was determined that the findings of the studies were different from each other (Cochrane et al. 2004; Cole and Mahoney 2010; Osawa et al., 2013; Chen et al., 2014). The reason for the different results in these studies can be explained as using a number of dissimilar frequencies, durations and amplitudes using a staggered process uygulamathus increasing the intensity of the frequency and/or duration and/or amplitude of the WBV implementation (Cole and Mahoney, 2010). It has been reported that WBV implementation induces tonic vibration reflection; a higher activation of the muscular spindles and motor neurons. The reason for this fast improvement in performance can be explined as neurological theory of muscular coordination. In addition, synergist muscles cocontraction, antagonist muscles inhibition and coordination and integration in motor units contributes to these progressions (Cardinale and Wakeling, 2005).

The current study had a limitation. Because the sample was quite small. Therefore, the results of studies conducted on WBV should be construed rigorously. Additional studies are required to validate the specific benefits of WBV training in athletes.

It is very important to emphasize that the majority of sport events occur in a dynamic environment that requires speed, strength and explosive power. Therefore, having quality and diverse training methods is necessary for children's plyometric training. Plyometric training can be taught in fun ways using obstacle games in which children can perform a wide variety of plyometric drills around and above various objects (Konukman et al., 2022).

A 6-week FIFA 11+ program had a significant effect on jumping performance in young male soccer players. In many studies in the literature, it has been determined that as a result of the implementation of the FIFA 11 + program, there is a decrease in the risk of injury and medical costs as well as improvements in the athletes' performance (Egesoy and Gümüsdag, 2022).

Suggestions

In this study, it is suggested that the education of WBV applications applied to the participants in high school should be included in the training planning as it provides improvement in performance outputs. In the studies to be carried out after that should be investigated effects from potential load increase of mechanical oscillation source, muscle hypertrophy and hormonal response to WBV.

Conflict of interest

There were no conflicts of interest

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