



## THE EFFECT OF TRAINING ON UNSTABLE GROUND ON VERTICAL JUMP AND SPEED IN 11-14 YEARS OLD FEMALE HANDBALL PLAYERS

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### Abstract:

The study aimed to examine the effects of unstable ground training on the speed and vertical jump of young female handball players between the ages of 11-14. While 20 participants who trained regularly at a handball club in the central district of Kastamonu province participated in the study as the Study Group (WG), 20 participants from the same club participated as the Control Group (CG). While the study group was given a training program and routine handball training on unstable grounds 3 days a week for 8 weeks, the control group continued only routine handball training for 8 weeks. Statistical analyzes of the data were made with SPSS v.22 and Statistica package programs. Paired Samples Analysis was used for intra-group comparisons, and the Independent Samples T Test was used for inter-group comparisons. The differences in the results obtained from inter-group comparisons were taken, the results were re-evaluated, and the analyzes were recorded. The significance value of the data was accepted as  $p < 0.05$ .

**Keywords:** unstable, handball, vertical jump, speed

### 1. Introduction

Handball is one of our sports branches based on physical and technical performance and involving high combat power, which has increased its popularity all over the world, especially in Europe (Jasim & Shebab, 2020). Sport is one of the most important social activity tools to maintain our daily life in a balanced and healthy way. According to Albay *et al.* (2008), sport is a phenomenon in continuous development. This situation has

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revealed the necessity of following the development in sports with scientific methods as in other fields. The main goal in sports is to reach the masses, to catch the summit and to push beyond the summit. Scientific research findings have an important role in the development of sportive performance, and training programmes based on scientific data contribute to the improvement of athletes' performances (Albay-Duyul *et al.*, 2008).

Handball, which is the subject of our study, includes various movements such as throws, passes, kicks, jumps, pushes, blocks, runs and dribbling. These movements make handball an intermittent and high-intensity contact sport (Gorostiaga *et al.*, 2005). Handball is played in indoor sports halls. Handball, which is played as a team, is a sport in which it is aimed to apply offence in the fastest way with the least number of passes (Çelikkilek *et al.*, 2003). Handball involves special somatic biotypes that move fast and combine speed with strength, endurance and skills. To cope with such biological demands, the game of handball needs players with exceptional physical and mental qualities. Handball is a dynamic sport where players use their hands to dribble, pass and shoot at the opponent's goal; therefore, handball is characterised by highly developed motor skills such as coordination, speed and agility, endurance, reaction speed, as well as explosive power (Christia- Mic *et al.*, 2021).

In short-distance maximal intensity runs that will increase speed in athletes, almost all body muscles work. At the same time, more work falls on the respiratory muscles to meet the increasing respiratory function (Temoçin *et al.*, 2004). In addition, control of static and dynamic balance is very important for quality movements and successful performance in training and competitions (Sucan *et al.*, 2005). Balance can be defined statically as the ability to support the support point with small movements and dynamically as the ability to fulfil a task by maintaining a fixed position. According to Balter *et al.* (2004), good balance among experienced athletes may result from prolonged repetitive training activities that affect motor responses, rather than improved sensitivity of the vestibular system (Güner *et al.*, 2024). Vertical power production is a trainable physical trait as a performance-determining variable reported in many sports, especially those related to maximum sprint and jumping (Haug *et al.*, 2015). Vertical jump is an important skill for many team sports where jump height is related to in-game performance.

With the development of balance ability, the ratio of prime mover muscles (prime mover muscles) that are activated to stabilise the body will decrease so that these muscles can contribute as a driving force in activities such as jumping or running (Çağlayan, 2018). The fact that there are not many studies on unstable ground in handball in the literature reveals the importance of our research.

## 2. Material and Methods

The variable of our research model is the training applied on unstable grounds in 11-14 years old female handball players. The dependent variable of our research model is

vertical jump and speed. The research is an experimental study in which the effect of independent variables on dependent variables is investigated.

Ethics committee approval was obtained from Istanbul Rumeli University in the first process for the research. Then, 20 people from 11- 14 years old female handball players who have been playing handball for at least 2 years in a private club in Kastamonu province participated as the experimental group to apply the trainings. In Kastamonu province, 20 people from 11- 14 years old female handball players who have been playing handball for at least 2 years as an athlete in a private club participated as the control group. An 8-week training plan was applied in the study. For 8 weeks, athletes who did not regularly participate in the study were not included in the study. All handball players in the study have an athlete licence issued by the Turkish handball federation. For this reason, people whose health examinations are followed regularly every year are included in the study. Each of the 11- 14-year-old female handball players who voluntarily participated in the study was informed, and an informed consent form was obtained from their families. In the study, some biometric measurements and physical performance tests were performed before and after the training programme in order to evaluate the effect of the 8-week training programme on the participants.

### **A. Participants**

The study was conducted on 40 healthy female handball players aged between 11 and 14 years who were determined to be eligible for participation. Female handball players were divided into 2 groups as experimental group (Group 1, n=20) and control group (Group 2, n=20). 1 group and 2 groups continued handball training for 8 weeks. The training programme was applied to 1 group 3 days a week for 8 weeks. Being between 11 and 14 years old, female and licensed handball players for at least 2 years, being eligible to participate in the study for three days during the 8 weeks in the research programme and not having any health problems or injuries are among the inclusion criteria. Failure to continue the 8-week programme, the occurrence or occurrence of any injury and the request of the athletes to leave the study voluntarily were determined as the exclusion criteria.

### **B. Height and Weight Measurements**

The height of the participants was measured in m with a wall-mounted stadiometer (Holtain, UK) with an accuracy of 0.1 cm in an anatomical posture, barefoot, with feet fully on the ground, heels together and in contact with the wall, knees tense and body upright position, with reference to the point where the tip of the head touches the height meter table. Body weights were measured with a digital scale (Seca, Vogel and Halke, Hamburg) with an accuracy of 0.1 kg, while wearing light sportswear consisting of shorts and T-shirt, barefoot and in anatomical posture. Height and body weight were measured twice, and the mean of the two measurements was taken as the descriptive statistical value'.

### **C. Vertical Jump**

In the study, vertical jump measurement was applied to measure the explosive strength of the participants. During the vertical jump test, the jump test was measured with a Jump Meter. The participants were asked to try to jump as high as possible with both feet. The participants performed the jump test by taking the starting position on the mat with hands at the side and 90 degrees flexion of the trunk and knees. Since the measurement did not cause any loss of effort, it was repeated twice at 20-second intervals, and the highest jump height was recorded.

### **D. 20 Meter Sprint**

In the study, the participants were measured for the 20-metre sprint test with a photocell device with a precision of 0.01 cm in an indoor sports hall for the 20-metre test. Measurements were made 2 times with 10-minute rest intervals. The best degree was recorded.

### **E. Statistical Analysis**

Statistical analyses of the data were performed with SPSS v.22 and Statistica package programmes. In the measurements applied in the study, descriptive statistical analyses were performed as a result of the data obtained. Shapiro-Wilk test was applied for the normality test of the obtained data and Levene test was applied to determine the homogeneity of the data. As a result of the Shapiro-Wilk and Levene test, it was determined that the data were not suitable for normal distribution. Paired Samples Analysis was applied for intra-group comparisons, and the Independent Samples T Test was applied for inter-group comparisons. By taking the differences in the results obtained from the intergroup comparisons of the groups, the results were re-evaluated, and the analyses were recorded. The significance value of the data was accepted as  $p < 0.05$ . Descriptive statistical methods (Number, Percentage, Mean, Standard deviation) were used to evaluate the data. The findings obtained were determined to be at a  $p < 0.05$  significance level. It was observed that the data showed normal distribution. The findings obtained in the study were evaluated at a  $p < 0.05$  significance level.

## **3. Results**

The study was conducted on 40 healthy female handball players aged between 11 and 14 years who were determined to be eligible for participation. Female handball players were divided into 2 groups: the experimental group (Group 1,  $n=20$ ) and the control group (Group 2,  $n=20$ ).

**Table 1:** Characteristics of the participants

Variables	WG		CG	
	Pre	Post	Pre	Post
Number (n)	n = 19		n = 19	
Age (year)	12.6±0.8		12.9±1.02	
Height (cm)	155.1±0.5	156.4±0.5	157.1±0.5	158.1±0.6
Weight (kg)	51.7±9.3	52.1±9.2	49.7±6.9	50.0±6.6
BMI (kg/m <sup>2</sup> )	21.2±3.2	21.1±5.6	20.1±2.2	19.8±2.0

**Table 2:** Changes in the variables of the participants before and after the tests

Variables	WG (n = 19)		T	p-Value	CG (n = 19)		T	p-Value
	Pre	Post			Pre	Post		
Vertical Jump	34.5±4.8	38.9±5.3	-10.25	.000*	35.8.6±4.5	36.9±4.3	-4.191	.001*
Sprint	3.61±0.17	3.45±0.18	8.004	.000*	3.68±0.27	3.65±2.7	1.778	.092

Values are expressed as means ± standard deviations. WG = working group, CG = control group

**Table 3:** Within group statistical comparison

Variables	Groups		T	p-Value
	WG (n = 19)	CG (n = 19)		
Vertical Jump	20.5±4.29	19.8±2.86	6.499	0.000*
Sprint	27.3±6.94	25±5.32	-4.870	0.000*

Values are expressed as means ± standard deviations. WG = working group, CG = control group.

#### 4. Conclusion and Discussion

When the data obtained as a result of this study were analysed, significant differences were observed in the effects of unstable ground training on sprint and vertical jump of young female handball players aged 11-14 years. Firstly, biometric measurements of 11-14 years old female handball players were evaluated. In biometric measurements, height, body weight and body mass index of the participants were found to be 12.94 according to the average age values of the control group, height was 1.57 in pre-test and 1.58 on post-test, body weight was 49.74 on pre-test and 50.00 in post-test, BMI was 20.10 in pre-test and 19.92 in post-test, vertical jump (DS) was 35.78 in pre-test and 36.89 in post-test and 20 metres (m) was 3.68 in pre-test and 3.65 in post-test. In the experimental group, the mean age of the participants was 13.26, height was 1.55 in the pre-test, and 1.57 in the post-test, body weight was 51.65 in the pre-test and 52.15 in the post-test, BMI was 21.20 in the pre-test and 19.87 in the post-test, ds was 34.52 in the pre-test, and 38.89 in the post-test, and 20 m was 3.61 in the pre-test and 3.45 in the post-test.

A significant difference was observed in the pre-test and post-test intragroup comparison analyses of the control group and the experimental group. During the eight-

week training period, a significant difference was found in height (cm), and vertical jump (DS) parameters between the initial values and the measurements at the end of the training programme in female handball players according to the pre-test post-test intragroup comparison analyses of the control group ( $p < 0.01$ ). According to the findings, height (cm) was positively significant at the level of ,000, and DS was positively significant at the level of ,001 in female handball players. When the other parameters were examined, it was found that there was no significant difference in the 20 metres parameter.

According to the pre-test post-test intragroup comparison analyses of the experimental group between the initial values and the measurements at the end of the training programme during the eight-week training period, a significant difference was found in the parameters of height (cm), vertical jump (DS) and 20 metres (m) ( $p < 0.01$ ). According to the findings, height (cm) was positively significant at the level of ,000, DS was positively significant at the level of ,000 and 20 metres was positively significant at the level of ,000 in female handball players. When other parameters were analysed, it was found that there was no significant difference in body weight and BMI parameters. According to the comparison analyses of the experimental and control group pre-test results of the participants, no significant difference was recorded in the independent comparison evaluations of the pre-tests of the parameters between the groups ( $p > 0.05$ ).

In the findings, no significant difference was observed between the parameters according to the comparison analyses of the participants' experimental and control group pre-test results. According to another result, the differences of the comparisons of the pre-test and post-test results of the participants between the experimental and control groups were evaluated by analysis, and a significant difference was found in Vertical jump (DS) and 20 metres parameters ( $p < 0,01$ ) in the differences of the comparisons of the pre-test and post-test intergroup differences of the participants. In the experimental and control groups, the vertical jump was found to be positively significant at the level of ,000 in both groups, and similarly, it was found to be positively significant at the level of ,000 in the 20 metres parameter. There was no significant difference in the other parameters of the participants ( $p > 0.05$ ).

As a result, it is thought that the reason for the statistically significant increase in the vertical jump in the control group and the increase in the speed, although not statistically significant, is due to the fact that all of the female handball players in the control group continued their handball trainings and made sprint runs and jumping throws in these trainings and that the athletes were in the puberty period. In our study, exercises for the whole body were selected as strength exercises applied to the experimental group on unstable grounds. These included exercises involving the trunk, core and lower extremities. The training programme, which we planned to strengthen the deep back muscles and the muscles in the core region of young handball players in the adolescent period without using additional weight, aimed to keep the spine in an upright position as well as to ensure balance, and it has been shown that these exercises can provide an optimal level of power output during the performance of the desired

movements (Öztürk and Tutar, 2024; Atan *et al.* 2013). With the 8-week training programme, the training programme applied to the experimental group gains importance considering the decreases that may occur in the performance parameters of these young female handball athletes in adolescence as a result of changing weight centres due to bone elongation. In the studies conducted in the literature, there are publications revealing the effect of balance on performance (Davlin, 2004). Similar studies have also shown that the exercises in the training programme can increase strength and movement speed on unstable surfaces to a similar extent as traditional resistance training. Muñoz *et al.* (2014), in their study of two experimental groups in stable and unstable conditions, found that the similar strength and speed gains produced, the instability provoked, and the speed of execution of movements in unstable conditions led to neuromuscular adaptations similar to traditional resistance training, resulting in increased strength and speed of movement. In the study, improvements in strength and movement speed on unstable surfaces were found to be dependent on the repetition of exercises and the gradual increase of loads in the medium and long term.

In another study, Drinkwater *et al.* (2007) concluded that the unstable surface did not improve the development of speed and power on the stable and unstable surface. According to the findings, it was also stated that speed and range of motion can be affected more than strength. In another similar study, Koshida *et al.* (2008) concluded that training on unstable surfaces resulted in a lower development of speed and power. However, the data obtained in our study do not coincide with the findings of Drinkwater *et al.* (2007) and Koshida *et al.* When the literature is examined, Çağlayan *et al.* (2018) showed statistically significant improvement in leg strength, both leg balance and double leg vertical jump of wrestlers in the plyometric study applied on unstable grounds, similar to our study. In Küçükylmaz's (2021) study, the study conducted on young men showed statistically significant improvement in the right leg vertical jump and left leg vertical jump measurements of the experimental group in proprioceptive and neuromuscular exercises for the lower extremities of hetbol players applied on unstable ground and is compatible with our study. According to the results of the analysis made at the end of the study, a significant positive difference was observed on vertical jump strength as a result of the exercises performed on unstable ground in handball training. In this case, hypothesis 1 is supported. According to another analysis result of the study, as a result of the exercises performed on unstable ground in handball training, a significant positive difference was similarly observed on speed. This shows that hypothesis 2 is supported. In line with the data we obtained as a result of our study, it is seen that there is a significant relationship between unstable strength exercises applied to young female athletes and performance parameters. Many studies supporting our findings in the literature reveal the effects of these exercises on characteristics such as strength, power, balance and flexibility in many branches and age groups.

## 5. Recommendations

Although there are many exercise strategies to improve physical characteristics, the importance of balance and stability is not often emphasised, whereas, during the execution of a movement, the centre of balance is constantly changing in order for the movement to be optimal. The best implementation of this change in different movement patterns will bring with it a balanced performance of motoric characteristics and, thus an exemplary implementation of the desired skill.

In this context, the effect of the exercise programme planned with their own body weight on female athletes in adolescence was shown. It is thought that the application of such training programmes planned in accordance with the purpose after the warm-up programme during the season will be effective on performance parameters.

### Conflict of Interest Statement

The authors declare no conflicts of interest.

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