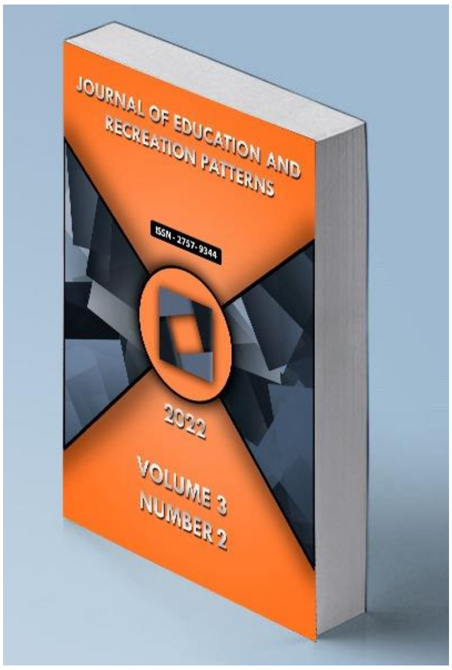

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Investigation of the Effect of Plyometric Training on Anaerobic Capacity in Skateboard Athletes

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ABSTRACT

This study examines the effect of plyometric training on anaerobic capacities in skateboarding athletes. A total of 28 skateboarding athletes, 14 in the experimental group and 14 in the control group, between the ages of 14-18 participated in the research. As the experimental and control groups continued to practice skateboarding regularly, the experimental group had an extra 8 weeks and two days of plyometric training.

Two measurements were taken before and after the workout (pre-test). The data were obtained using the SPSS26 statistical package program. Since the number of participants is 28, the Data did not show a normal distribution. Wilkoxcan Test was used in the comparison of preliminary and final test in the group. The Man Whitney U test was used to compare the data between the groups and was accepted as a level of 0.05.

The result was statistically compared between the test group and the control group, and it was determined that there was no significant difference between the vertical jump and anaerobic power parameters ($p>0.05$). When we compare the intra-group data of the experimental group and the control group, there is a statistically significant difference in the mean of vertical spatter and anaerobic power ($p<0.05$).

As a result, a positive increase in vertical jump and anaerobic power parameters was determined after 8 weeks of plyometric training of the experimental group.It can be said that regularly planned and programmed 8-week plyometric training can contribute to the development of parameters such as vertical jump, anaerobic power, explosive strength in athletes.

Keywords: Plyometric Training, Explosive Strength, Skateboarding

INTRODUCTION

Theoretical background of the study with some cross-sectional examples in the literature Skateboarding emerged as an activity started by surfers in the 1950s when surfing could not be done on the West Coast of the USA (Borden, 1998). Although it became popular among young people in the 1960s, the period when it began to be in greatest demand coincides with the advent of the polyurethane wheel and some improvements in the 1970s, when skateboards had more effective maneuverability and mobility (Forsman & Eriksson, 2001). The most effective way for a skateboarder to create self-awareness and make sense of the sport while doing this sport is a series of movements performed during the activity. Movements are acquired directly from peers or from internet videos that have become popular recently. Every movement with skateboard has a name that defines it (Woolley & Johns, 2001). To perform various combinations of skateboarding movements, both ankles must be simultaneously in plantar flexion and inversion (Ou, Chen & Yeh, 2021).

Ollie is the movement that skaters see and often use as the basis of almost all movements. It is a commonly used maneuver by skaters to jump, land, and cross over things. This maneuver is complex and needs to be fully coordinated but is essentially a jumping movement that aims to bring both the skateboard and the skateboarder to a new position vertically and horizontally. Since skateboard is not connected to the skateboarder in any way, an absolute sequence of movements is necessary to keep the skateboarder and the board together (Frederick, Determan, Whittlesey & Hamill, 2006).

To make Ollie a reality, the skateboarder slams the board on the rear axle with the right muscle force quickly to the ground and makes the tip lift up. This allows the board to rise by popping (bouncing) the tail of the board from the ground. At the same time, the skateboarder often jumps forward when using the side front of the leading leg to control and guide the orbit and spatial orientation of the board. The board and skater follow similar trajectories and eventually land on the board (Frederick et al., 2006).

Muscle strength enables a certain muscle to produce the same amount of work in a shorter time in activities such as sprint, jump, and rapid reorientation, or at the same time to produce a larger job (Peterson, Alvar, Rhea & Research, 2006). Requires the coordination of various muscle groups in order to be able to maintain rhythmic movements which are an integral part of exercise (İpekoğlu, Erdogan, Fatmanur, Colakoglu & Baltaci 2018). Jumping ability has been accepted as a basic criterion for successful performance in many sports branches (Sheppard et al., 2008). Likewise, the ability to balance is stated as an extremely necessary parameter for performing well and increasing performance (Yarim, Özcan, Yelken & Uzun 2020).

Kartal and Günay (1995) training practices based on scientific foundations in the branch of sports, the individual; While improving muscle strength, power, endurance, speed and flexibility, there is also an improvement in body structure (Civan &Uzun 2022). In order to improve the performance of the athlete, the training method called power and agility "plyometric" has been widely used since the late 70s. Plyometric training is generally defined as eccentric contraction that includes power and explosive movements, followed by explosive concentric contraction (Clark, Lucett & Kirkendall 2010). Plyometric training is a very popular form of training that allows you to do exercises involving body weight jumping using the stretch-shortening cycle (SSC) muscle movement (Markovic & Mikulic, 2010). The aim of plyometric training is to increase the strength of subsequent movements by using the natural elastic components of both the muscle and tendon and the stretching reflex (Meylan, Malatesta & Research, 2009). Plyometric training is a sport-specific, effective, time-saving and easy-to-apply training method and it has been reported that this method also improves jump performance (De Villarreal, Suarez-Arrones, Requena, Haff, & Ferrete 2015). De Villarreal, Kellis, Kraemer, Izquierdo, & Research (2009) found that body weight plyometric studies, including a combination of counter-motion jumps, depth jumps, and squat jumps, resulted in an increase in vertical jump height of 4.7% to 15%.

Plyometric training is a training method that increases the explosive force in the performance of most exercises or sports activities by overloading isotonic exercise and causing muscle reflexes. This is the strength training used to produce faster and stronger forces during muscle contraction (Bogdanis et al., 2019). Plyometric training, which is widely used to improve the performance of athletes, is considered to be a useful training method used especially to increase lower extremity muscle strength (De Villarreal, Requena, Newton, & Sport, 2010). After plyometric training, it is desirable to quickly obtain the maximum force, especially the expected duration of movement between the eccentric (elongation) phase of muscle movement and the eccentric-concentric (shortening) phases can occur in a minimum time. Rapid deceleration-acceleration movement is the increase of speed and force, followed by the increase of explosive force (Shiroka et al., 2012).

The aim of this study is to examine the effect of 8-week plyometric training to be applied to 14-18 age group skateboard athletes together with skateboard training on anaerobic power.

METHOD AND MATERIALS

Population and Sample

This study was conducted on a total of 28 skateboarders voluntarily participating in two groups, experimental (n=14) and control (n=14), whose mean age was 16,46 years. Information was given about the scope and purpose of the study in order to motivate the subjects to use their maximal capacities. The study lasted 8 weeks and was applied as 30 minutes on 3 days of each week. While the control group continued their normal training 3 days a week, the study group athletes received plyometric training (15 minutes) 2 days a week after their normal training. Before the training, all athletes were given 10-15 minutes of stretching and warm-up movements. Before starting the studies, the pre-test of the entire group of homogeneously formed athlete students was taken, divided into 2 groups, the studies were continued, and the post-test was performed 8 weeks later.

Measurement Methods

Weight and Height Measurement

The height measurements of the athletes participating in the study were measured in centimeters with a telescopic height measurement tool. Their weights were measured with clothes such as shorts and T-shirts by using pharmacy type scale.

Vertical Jump Measurement

The distance between the height that the athlete can reach and where he/she can reach by jumping, measured using the vertical jump test (Sargent jump), was recorded in centimeters (Cicioğlu, Gökdemir, & Emre, 1996).

Determination of Anaerobic Power

The vertical jump test (Sargent Jump test), whose validity and reliability were accepted by sports scientists, was performed. Anaerobic power was determined using the Lewis formula (Garnbetta, 1989).

P=Anaerobic Power (kg/m/sec)

W=Body Weight (kg) Standard Time (sec) =4.9

D=Vertical jump

P= √ 4.9x(W)x D

Executed Training Program

The normal training program was prepared in the light of the information obtained by reviewing the literature. The plyometric training program applied to the athletes is as follows:

- ✓ **Jumping Rope:** The athlete jumps using a double leg or single leg rope following the instructions given.
- ✓ **Double Foot Jump Without Using Arms:** The athlete is standing still, double foot next to the arms, jumps.
- ✓ **Double Foot Jump Using Arms:** Athlete standing with fixed double legs, using arms, jumping.
- ✓ **Single Foot Tab (Right and Left):** The athlete moves forward and jumps with one right or one left foot.
- ✓ **Side Jump Over Barrier:** The athlete jumps forward, right or left over a small barricade prepared beforehand.
- ✓ **Long Jump Changing Direction:** Obstacles are placed in three different directions. The obstacles are 10 m ahead of the jumping place. The Athlete's Feet are shoulder-width apart and rest in a half-squat position. The arms are supported from the back to the front and jump to the most extreme point possible. Sprint run is made to the funnel located in any direction 10 m ahead of the landing place.
- ✓ **Hexagonal Work:** Hexagon drawn with 1 m equal edge to flat ground is used. The athlete in the hexagon jumps over the lines using each equal line in turn and then back to the center.
- ✓ **Jump Over Funnel to Change Direction with Sprint:** The funnels are placed in 6 rows, 1 meter apart. In front of the first funnel, the feet are shoulder-width apart and the two feet start by jumping to the last funnel. When it jumps in the last funnel (in the air), it is returned to the starting place by making a 5-6-step sprint run in the direction of the trainer (right-left).
- ✓ **180° Return Funnel Jumps:** A straight line is drawn and 6 funnels with 2-3 steps spacing are placed on it. Standing next to the first funnel it jumps, rotates 180° in the air and falls between the funnels. Likewise, the funnels are completed by rotating 180°.
- ✓ **Pushing the Body Upward by Changing the Feet:** The athlete's left heel on the grind box with a height of 40 cm, the right foot is on the ground. It is tried to reach as high as possible with the foot on the box. While in the air, the feet are changed and the right foot is landed on the chassis with the left foot on the ground. We use both arms for height and balance.

- ✓ **Box Jump:** Athletes jump into the box in a half squat position, feet shoulder-width apart and in front of the box, with support from both arms. When Athlete are in a half squat position with our feet shoulder-width apart in front of the box, we jump to the box with support from both arms.
- ✓ **Single Foot Depth Jump:** The toes fall on the ground with one foot adjacent to the spot with a height of 50 cm and jump as high as possible using the same foot, then the same work is done in the other foot.
- ✓ **Fast Jump:** In our 50 cm spotlight, the feet stand in front of the shoulder-width box. Jumped with two feet onto the box using the arms. As soon as he/she falls on the box in the form of a half-squat, he/she jumps forward once more. He/she jumps up as high as possible, and a reverse arc movement is made in the air. The two feet fall to the ground.
- ✓ **Depth Jumping Between the Crates with the Right Foot:** An assembly is set up in which boxes are 40 cm high and 50 cm apart. Start by standing in front of the first box. The assembly is completed by jumping to the ground on the box with the right foot.
- ✓ **Depth Jumping Between the Crates with the Left Foot:** An assembly is set up in which boxes are 40 cm high and 50 cm apart. Start by standing in front of the first box. The assembly is completed by jumping to the ground on the box with the left foot.
- ✓ **Depth Jumping Between the Crates with Both Feet:** The height of the boxes is 40 cm and the distance between the two boxes is 50 cm. of boxes a setup is established. The setup is completed by jumping onto the box with both feet, over the box to the ground (Cicioğlu et al., 1996).

Data Analysis

The data obtained were obtained using the SPSS 26 statistical package program. The data did not show a normal distribution. Wilkoxcan Test was used for the pre-test and post-test comparisons within the group. Man Whitney U test was used to compare the data between the groups and the significance level was accepted as 0.05.

FINDINGS

The distribution of the athletes participating in the study according to their demographic characteristics, vertical jump and anaerobic power pre-test and post-test values were examined.

Table 1. Descriptive Statistics of Experimental and Control Groups

	N	Minimum	Maximum	X	Sd
Age (years)	28	15	18	16.35	1,06
Height (cm)	28	150	182	167,75	9,06
Body weight (kg)	28	45	80	56,25	8.95
Athlete Age (years)	28	1	4	1.89	1.03

Table 1 it is seem that the average age of the participants participating in the research was 16.35 ±1.06 years, average height 167.75±9.06 cm, average body weight 56.25 ± 8.95 kg, and average sports age 1.89 ±1.03 years.

Table 2. Statistics of Experimental Group Vertical Jump and Anaerobic Power Values

	Pre-Test		Post-Test			
Variable	**Mean**	**Sd**	**Mean**	**Sd**	**T**	**P**
Vertical Jump (cm)	35.93	± 8,60	42,57	± 9.01	-3,31	0,01 *
Anaerobic Power (watts)	75,54	±18.37	82,36	±19.67	-3,29	0,01 *

***p<.05**

When Table 2 is examined, it is seen that the pretest average vertical jump values of the experimental group were 35.93 ± 8.60 cm, the vertical jump posttest average was 42.57 ± 9.01, and there was a significant difference between the vertical jump pretest and posttest data (p<0.05). In addition, it was determined that the average anaerobic power pretest was 75.54 ± 18.37 watts and the average anaerobic power posttest was 82.36 ± 19.67, and there was a significant difference between the anaerobic power pretest and posttest data (p<0.05).

Table 3. Statistics of Control Group Vertical Jump and Anaerobic Power Values

	Pre-Test		Post-Test			
Variable	**Mean**	**Sd**	**Mean**	**Sd**	**T**	**P**
Vertical Jump (cm)	35.64	± 10,55	37,43	± 10.37	-3,28	0,01 *
Anaerobic Power (watts)	73,01	±73.01	74,85	±15.25	-3,18	0,01 *

***p<.05**

When Table 3 is examined, the mean vertical jump values of the control group were found to be 35.64 ± 10.55 cm and the mean vertical jump post-test was found to be 37.43 ± 10.37. There was a significant difference between the vertical jump pretest and post-test data (p<0.05). The mean anaerobic power pre-test was73.01 ± 15.64 watts and the mean anaerobic power post-test was 74.85 ± 15.25 watts. It is seen that there is a significant difference between anaerobic power pre-test and post-test data (p<0.05).

Table 4. Comparison of Pre-Test Values of Experimental and Control Groups

	Group	**N**	**X**	**Sd**	**Min**	**Max**	**Rank Avg.**	**Z**	**P**
Vertical Jump	**Experiment**	28	35,79	± 9.44	20	55	14,86	-0.23	0,81
	Control						14,14		
Anaerobic Power	**Experiment**	28	74,27	± 16.79	46,72	106,25	15,43	-0,59	0,55
	Control						13,57		

In Table 4, the average of the vertical jump pre-test data of the experimental group and the control group was found to be 35.79 ± 9.44 cm. There was no statistically significant difference in vertical jump data between the experimental group and the control group (p>0.05). When we examined the anaerobic power values of the experimental and control groups, the average of the pre-test data was 74.27 ± 16.79 and there was no statistically significant difference in anaerobic power data between the experimental group and the control group (p>0.05).

Table 5. Comparison of Post-Test Values of Experimental and Control Groups

	Group	N	X	Sd	Min	Max	Rank Avg.	Z	P
Vertical Jump	**Experiment**	28	40.00	±9.88	22	59	16,71	-1,42	0,15
	Control						12,29		
Anaerobic Power	**Experiment**	28	78,60	± 17.69	46,72	106,25	16,14	-1,05	0,29
	Control						12,86		

When Table 5 is examined, the average of the experimental group and control group vertical jump post-test data was found to be 40,00 ± 9.88 cm. There was no statistically significant difference in vertical jump data between the experimental group and the control group ($p>0.05$). The mean of the anaerobic power post-test data of the experimental and control groups was 78.60 ±17.69 watts. There was no statistically significant difference in vertical jump data between the experimental group and the control group ($p>0.05$)

DISCUSSION AND CONCLUSION

In this study, the effect of plyometric training on anaerobic capacity in skateboarding athletes is investigated. Age, height, weight, body mass index, vertical jump test data of the athletes participating in the research were evaluated and compared with similar studies. When the experimental group and control group data were compared statistically between the groups, it was determined that there was no significant difference. It is seen that there is a positive increase in vertical jump values after 8 weeks of branch-specific training performed by the control group. After the additional 8 weeks of plyometric training performed by the experimental group, an increase in vertical jump performance was observed, and accordingly, an increase in anaerobic power values was detected.

Cicioğlu et al. (1996) conducted 8-week plyometric training on 32 male basketball players between the ages of 14-18 in their study. As a result of the 8-week training, a positive increase was found in the vertical jump parameter of the experimental group. It can be said that this study is like our study.

Fischetti et al. (2018) examined the effects of plyometric training program on the speed and explosive power of the lower limbs in young athletes; It has been stated that eight weeks of plyometric training in addition to the standard athletic program improves the speed and explosive power of the lower limbs in young athletes.

Kim, Rhi, Kim & Chung (2022) examined the effects of plyometric training on physical fitness and muscle damage in baseball players. 21 high school baseball players participated in plyometric training for 3 days a week for a total of 8 weeks and the control group only participated in normal baseball skill training without plyometric training. While there was no difference between the groups after 8 weeks of training, it was observed that physical fitness such as maximum power, agility and power developed positively ($p<0.05$).

Hammami et al. (2020) examined the physical performance responses of young male handball players to plyometric training; It was stated that there was an increase in the vertical jump values of the handball players. The vertical jump results of this study are similar to our results.

In a study by Meszler and Vaczi (2019); the effects of short-term in-season plyometric training in adolescent female basketball players were investigated. As a result of the study in which an additional 7-week plyometric training program evaluated lower extremity strength, balance, agility and jump performance, it was stated that high-intensity plyometric trainings performed during the season did not improve the measured variables other than knee extensor strength.

Ateş and Ateşoğlu (2007) examined the effect of plyometric training on the upper and lower extremity strength parameters of 16-18-year-old male football players.10-week plyometric training was found to have a positive effect on upper and lower extremity strengths ($p<0.05$).

Bianchi et al. (2018) examined the comparative effects of weekly single and double plyometric training on jumping, sprinting and COD abilities of elite young football players. A total of 21 subjects participated in the study in a low-intensity plyometric training group (LPG = 10) and a high-intensity plyometric training group (HPG = 11). Exercise-induced meaningful changes in performance for both LPG and HPG occurred after the training. LPG and HPG reported improvements in long jump, triple hop right, triple hop left , 10 m sprint .

In their study, Biswas and Ghosh (2022) examined the effects of various plyometric training (black plyometric training, aqua plyometric training, and weighted vest aqua-plyometric training) on the anaerobic power of 48 school athletes. As a result of the study, it was found that different plyometric training groups improved significantly in anaerobic strength compared to the control group ($p<0.05$).

In the study conducted by Uzun and Eriş (2021), they investigated the effect of plyometric training on bio-motor characteristics in male Badminton players aged 14-17 years. Plyometric training was applied to the experimental group together with badminton training. They continued the control group with a normal training program. As a result of their study, they observed a significant improvement between 30 meters speed, T-agility test, horizontal jump, vertical jump, balance, back and leg strengths.

Brown, Mayhew & Boleach (1986) found significant increases in students' vertical jump performance as a result of their study to investigate the effects of plyometric training on vertical jump performance. This study supports our study by showing parallelism with our study.

In the study conducted by Hosseini Kakhak (2022) on tennis players aged 11-14, two types of plyometric and elastic band resistance training programs were applied. There was no difference between the groups after 6 weeks of training. However, it was observed that it significantly increased agility, muscle strength, anaerobic power, explosive power and tennis performance after training ($p<0.05$).

Bogdanis et al. (2019) in a study conducted by; the effect of plyometric training on jumping, running and changing direction speed in child female athletes was investigated. 10 m and 20 m sprint, 5+5 m and 10+10 m COD tests of athletes, one foot and two-foot counter motion jump (CMJ), fall jump (DJ), squat jump (SJ) and standing long jump (SLJ) test data received. As a result of 8 weeks of plyometric training, it was determined that there was a significant difference between the test data of the two-legged CMJ of the experimental group and the control group.

Ramirez-Campillo et al. (2020) ın their study examining the sequencing effects of plyometric training applied before or after regular soccer training on measures of physical fitness in young players, it was revealed that when combined with regular football training, plyometric training was effective in improving physical fitness measurements in young male football players. More specifically, it has been reported to have a greater effect on physical fitness if plyometric training is performed before soccer-specific training.

Diallo, Dore, Duche & Van Praagh (2001) found significant increases in the vertical jump, vertical jump in motion, repetitive bounce and long jump values of the experimental group as a result of their study to investigate the effects of plyometric training on jump performance. This study supports our study by showing parallelism with our study.

Jlid et al. (2019) examined vertical jump performance, change of direction performance and dynamic posture control of multi-directional plyometric training in young footballers; It is stated that the inclusion of versatile plyometric trainings in the in-season period of young male football players improves the vertical jump height, agility and balance performance of the athletes. The jump performance of this study is like our study.

In conclusion, it can be said that regular and scheduled 8-week plyometric training will contribute to the development of parameters such as vertical jump, anaerobic power, and explosive force in athletes. This development would have a positive effect on the performance of the athlete. Especially in branches where jumping is prominent, this type of work can be an important factor in achieving success.

Limitations and Recommendations

This research, it was limited to a total of 28 skateboarding athletes, 14 in the experimental group and 14 in the control group, between the ages of 14-18 and plyometric training for 8 weeks and 3 days a week. It is thought that by increasing the number of participants, conducting studies investigating the effects of plyometric trainings with different intensity in different age, gender and sports branches will contribute to the science of sports.

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