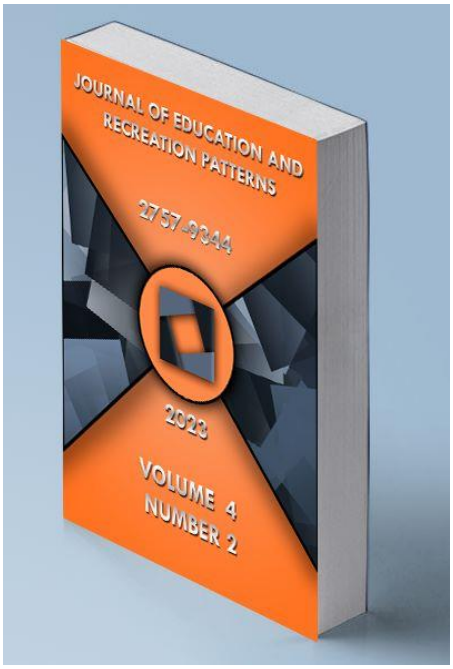

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Investigation of the Effect of Push-Up Exercises with and without Suspension on Some Motor Skills Applied to Young Volleyball Athletes

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ABSTRACT
The aim of this study was to compare the relationships between some motor skills in the upper extremity region of 20 male volleyball players aged 15-18 years, competing in the 8th Group of the 2nd League of the Turkish Volleyball Federation, with and without suspended and unsuspended Push-Up (PU) bosu ball exercises applied for 3 sessions every week for 8 weeks. In addition to the normal training program, the first group was trained with unsuspended (PU) and the second group was trained with suspended (PU) for 8 weeks. Both groups performed Medicine Ball Throw to evaluate upper extremity strength, Closed Kinetic Chain Upper Extremity Stability Test to evaluate endurance and Upper Extremity Y-Balance Test to evaluate balance before and after the training program. As a result of this study, the difference values of the test results before and after the training were compared. A significant difference was found between the groups in the upper extremity right and left arm 0,000, Y Balance Test Medial dominant 0,000, and non-dominant 0,004, Superolateral dominant and non-dominant 0,000, Inferiorlateral dominant 0,024 and non-dominant 0,000, chest and overhead 0,000 Health Ball Throw test difference changes ($p<0,05$). Performing the applications used in classical training methods on unstable grounds can increase the motivation of volleyball athletes and contribute to their performance. As a result, it seems that unsuspended and suspended (PU) exercises can increase the levels of medicine ball throwing, closed kinetic chain upper extremity stability test and upper extremity Y-balance test with the exercises applied, although the levels are different. Further studies on the subject by increasing the number of participants in different groups and using electronic devices will be useful.

Keywords: Bosu Ball, Motor Skills, Push-Up, Upper extremity, Volleyball

INTRODUCTION

As in the world, the interest in volleyball sport is increasing day by day in our country. Accordingly, the number of studies aimed at increasing the performance of athletes is also increasing visibly. Volleyball is a sport played by two teams on a playing field divided into two by a net. The aim of this sport is to pass the ball over the net, send it to the opponent's area, try to kill the ball there and prevent the opposing team from achieving the same goal. The technical movements used by players in volleyball during a competition are mainly;

- Serving,
- Header pass (defense),
- Finger rust,
- Dunk,

- It can be grouped as block applications (Yılmaz, 1997; Yeniçeri-Hindistan, 1998),

In short, we can define volleyball as a sport in which the feet, trunk and arms are used in coordination. But we can say that the final performance is determined by the upper extremity performance.

PU is a popular exercise to increase the strength and hypertrophy of the upper limb muscles. PU is also considered as a standardized measurement method for assessing upper extremity muscular endurance (Dillman et al., 1994). PU is an exercise using body weight to strengthen the triceps brachii and shoulder girdle musculature (Kisner et al., 2017). Standard PU is an exercise performed by keeping the knee joint, hip joint, pelvis and spine in a straight line from the head to the feet, flexion and extension of the shoulders and elbows, and protraction and retraction of the scapulae. PU is a very effective exercise for shoulder stability, upper body strength, core stabilization and hip flexor extension. During PU, body weight is used to strengthen the triceps brachi and shoulder girdle muscles.

The PU exercise is usually performed on a stable surface with the hands at shoulder width. The exercise can also be performed on unstable ground. Since the stabilizer function of the muscles tends to develop more during resistance exercises on unstable ground, it can also improve balance and greater force, torque and power can be achieved during exercise (Behm and Anderson 2006). Most of the studies comparing PU exercise on unstable ground using tools such as Swiss balls, air discs, bosu and balance boards with the traditional approach suggest that it increases the activity of the shoulder girdle and upper arm muscles more (Cogley et al., 2005).

Suspension exercises (SE) is one of the newest forms of stabilization training that allows the user to work with their own body weight with the help of ropes and handles suspended at a fixed point at height (Snarr and Esco, 2013). The RedCord Suspension System (RSS) is an innovative suspension training system used for a variety of purposes ranging from athletic performance to general conditioning and rehabilitation. If the muscle strength of the individual can provide the PU movement with the RSS, which provides instability, this position is taken and the handles at the end of the rope fixed upwards are held with the hands and body alignment is ensured with the feet on the ground. For PU with RSS, the starting position is taken first. Then the individual is positioned on his/her toes, hands shoulder-width apart and elbows in full extension, maintaining full body alignment. Starting in this position, the body smoothness is maintained until the elbows are 90º flexion. After reaching this position, return to the starting position and one repetition is performed (Bayrak, 2018; Bettendorf, 2010).

RSS can provide rapid results for all individuals who want to perform better, build strength, prevent injury, avoid pain or simply stay active. It aims to maximize the use of the training or treatment area by using the individual's own body weight as resistance. RSS is a

new treatment and neurocontrol method developed to facilitate neuromuscular control of the extremities and trunk and to increase tonic contractions (Kirkesola, 2009).

RSS is designed to strengthen the deep core muscles that stabilize the spine and the large muscles that elicit motor movement and mobilize the joints involved in the movement. RSS allows the individual to move in any plane with static and dynamic resistance using ropes, springs or their own body weight. These movements can also be achieved using various equipment and accessories. In general, RSS is a new exercise method designed to increase strength and flexibility, provide joint mobilization and improve performance and technique.

When we examined the literature, it was seen that most of the studies involving PU exercises using suspension system investigated the muscle activation levels around the shoulder and the effects of vibration application (Beach et al., 2008; Borreani et al., 2015; Calatayud et al., 2014; Dannelly et al., 2011; De Mey et al., 2014; Kim et al., 2014).

In the light of the information given, it can be said that the superiority of these two exercise forms over each other is still controversial since the number of studies on the effects on balance strength and endurance of young volleyball athletes is limited, although there are studies examining PU strengthening exercises performed without suspension and using suspension system with electromagnetic system. In addition, the number of studies determining the performance of volleyball athletes is limited. In this context, this uncertainty constitutes the problem of this study.

In order to eliminate this uncertainty, the aim of this study was to compare the effects of 8-week suspended PU bosu ball strengthening exercise training and non-suspended PU exercises on some motor skills in young volleyball athletes.

METHOD

Research Design

The training was started 3 days a week, 3 days a week, without affecting the ongoing training program of Tuşba Youth Center Club, which competes in the 8th Group of the men's 2nd League of the Turkish Volleyball Federation, after the movements were explained to both groups and the mistakes were corrected.

The 1st group was trained in the first two weeks of PU exercise training without suspension with repetitions and sets of 8x2, 10x2, 8x3 and 10x3, respectively. From the 3rd week until the end of the 8th week, both groups performed PU exercise with 3 sets and 12 repetitions.

In the 2nd group, the PU movement with suspension (bosu ball) was performed for 8 weeks with 3 sessions per week and at least 1 day intervals in order to eliminate the fatigue effect. In the first two weeks, the number of repetitions and sets were 8x2, 10x2, 8x3 and 10x3 for the adaptation of the suspended PU bosu ball exercise. From the 3rd week to the end of the 8th week, both groups performed PU exercise with 3 sets and 12 repetitions. Thus, both groups participated in 24 units of training.

Study Group and Sample

The model of our study is experimental. In our study, 24 adolescent male volleyball athletes between the ages of 15-18 years, who were competing in Turkey Volleyball Federation Men's 2nd League 8th Group, were included in the study. During the training process, 4 athletes were excluded from the study because they could not participate in the training regularly due to different injuries they experienced. After obtaining permission from Tuşba Youth Center

Club, a parental consent form was obtained from the athletes under the age of 18 and a consent form was obtained from those who were 18 years old.

Demographic Information: Age, height, body weight, age at the start of sports and upper extremity length demographic information were obtained from the participants.

Closed Kinetic Chain Upper Extremity Stability Test (CKCUES Test): CKCUEST is used for the evaluation of upper extremity strength, endurance and closed kinetic chain.

The test was performed as follows: In the push-up position, the distance between the two hands was adjusted to 90 cm, then one hand was extended towards the other hand and the number of repetitions completed within 15 s was recorded (Figure 1). The test was repeated 3 times. A 45 s rest period was given between tests to avoid fatigue caused by high-intensity activity (1:3 activity/rest ratio). In cases where the feet were off the ground during the tests, significant flexion of the hip occurred and the dorsal dorsal of the other hand was not touched, the test was considered invalid and repeated after a 45 s rest. The 3 tests were recorded and the average of these 3 values was taken as a score and the results were obtained by dividing this average by the height of the individual (Ellenbecker and Davies, 2000).

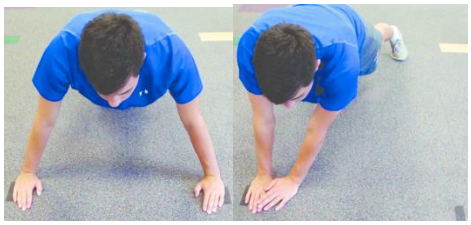

Figure 1: CKCUES Test

Upper Extremity Y-Balance Test: The YBT is a simple balance testing method used to identify injury risks and functional asymmetries in athletes that have been established as a result of scientific research. Both upper extremities are tested separately. In the study, the participants were shown how to perform the test in all directions 3 times for both upper extremities for the purpose of testing. Afterwards, the test was applied and performed in medial, inferolateral and superolateral directions (Figure 2). After the individual was allowed to rest for 45 seconds, the measurements were repeated for the other arm. The average of the 3 results obtained by reading the strip measurement on the edge of the reach indicator at the point where the farthest part of the arm reached the maximum reach distance was recorded in cm. The validity and reliability study of the test was conducted in 2012 (Westrick et al., 2012).

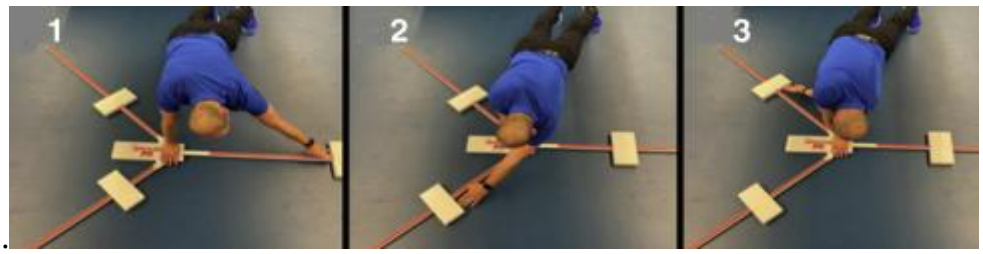

Figure 2: Upper Extremity Y-Balance Test YBT and its stages

Medicine Ball Throwing Test (MBT Test): It is used to assess upper limb explosive power. In this test, the distance measured by throwing a ball weighing 3 kg is taken. The

assessment was performed in 2 different positions. In the first test, the participant grasped the medicine ball with both hands and threw it forward over the head while sitting on a chair without armrests at a height where the scapula would remain idle, and the distance thrown was recorded in cm. The test was invalidated if the participants lowered the ball to the level of the nape of the neck and threw it, or if they threw the ball while leaning forward from the trunk, and the test was repeated. In the second test, the participant again took the same starting position, grasped the medicine ball with both hands, brought it to chest level and threw it forward and the distance was recorded (Figure 3.). When the throw was made by leaning forward from the trunk, the test was invalidated and the test was repeated. Necessary explanations were given to the participant before the test. The test was repeated three times and the total distance measured was averaged (Negrete et al., 2010). Harris et al., (2011) found the ICC value as 0.99 in their reliability study in elderly individuals.

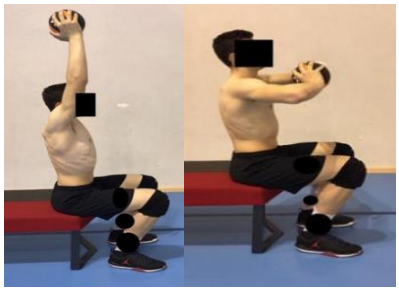

Figure 3: MBT Test

Analysis of Data

SPSS 23.0 (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.) program was used for analysis. Continuous variables were expressed as mean ± standard deviation and median (minimum and maximum values), and categorical variables were expressed as number and percentage. Shapiro-Wilk test was used for the conformity of the data to normal distribution. When parametric test assumptions were met, the Significance Test of the Difference Between Two Means was used to compare independent group differences; when parametric test assumptions were not met, the Mann-Whitney U test was used to compare independent group differences. In addition, the relationships between continuous variables were analyzed by Pearson correlation analysis. Statistical significance value was accepted as ($p<0.05$).

FINDINGS

Table 1. Demographic Information of the Participants

All Participants (n=20)	**Weekly Training hours (7,5)**	**Dunk Handle (Right n=20)**
Variables	**$\bar{x}$**	**±sd**
Age	15,85	1,18
Height	177,25	7,71
Weight	63,57	6,78
BMİ	20,17	2,32
Age of starting sports	11,10	2,04
Arm length	86,05	4,90

When Table 1 is examined, a total of n=20 people with ages ranging from x̄=15.85±1.18, heights x̄=177.25±7.71, weight x̄=63.57±6.78, BMI x̄=20.17±2.32, age of starting sports x̄=11.10±2.04, arm length x̄=86.05±4.90 participated in the study. It is seen that the weekly training hours applied to the participants were 7.5 hours and the participants used the right arm as the dominant hand and dunking arm.

Table 2. Comparison of Test Values of the Groups Before PU Exercise Training

Variables	Group 1 (n=10) (without suspension)		Group 2 (n=10) (suspension)			
	Min-Maks	$\bar{x}$ ±sd	Min-Maks	$\bar{x}$ ±sd	*t*	p
Upper Extremity Stability Test Right	17-30	26,2±7,42	22-37	28,4±5,12	-,771	,450
Upper Extremity Stability Test Left	14-34	22,5±5,96	17-34	25,7±4,39	-1,36	,189
Medial Dominant	58-93	72,4±11,89	52-85	69,2±11,99	,599	,557
Medial Non-Dominant	50-100	73,3±14,81	59-81	69,4±8,97	,712	,486
Süperolateral Dominant	68-94	81,3±7,95	52-102	82,0±15,25	-,129	,899
Süperolateral Non-Dominant	45-67	56,2±7,46	45-74	58,1±8,90	-,517	,611
İnferiorlateral Dominant	43-55	50,6±3,92	39-89	55,9±14,76	-1,097	**,014***
İnferiorlateral Non-Dominant	66-116	85,1±15,89	66-107	85,2±11,39	-,016	,987
Medicine Ball Throw from the Chest	250-400	315,5±54,21	260-400	319,7±46,23	-,186	,854
Medicine Ball Launch Overhead	150-400	280,3±64,76	250-373	306,5±39,09	-1,095	,288

*Statistically significant difference (*p<0.05), t: Significance test for the difference between two means, Min: Minimum, Max: Maximum, x̄: Mean, sd: Standard Deviation.*

When the test values of the participants in Group 1 and Group 2 before PU training were compared in terms of variables, it is seen in Table 2 that the inferiorlateral dominance test showed a significant difference between Group 1 and Group 2 (p<0.05), while the other measurement variables did not differ between Group 1 and Group 2.

Table 3. Comparison of Test Values of the Groups After PU Exercise Training

Variables	Group 1 (n=10) (without suspension)		Group 2 (n=10) (suspension)			
	Min-Maks	x̄ ±sd	Min-Maks	x̄ ±sd	t	p
Upper Extremity Stability Test Right	22-38	29,00±5,55	26-38	32,10±3,98	-,771	,169
Upper Extremity Stability Test Left	16-36	24,50±6,16	20-38	28,80±4,70	-1,36	,097
Medial Dominant	59-93	74,10±11,45	57-86	72,50±10,79	,599	,752
Medial Non-Dominant	55-100	75,20±13,94	60-84	73,00±9,26	,712	,646
Süperolateral Dominant	71-95	82,70±7,46	58-104	85,00±13,63	-,129	**,002***
Süperolateral Non-Dominant	48-68	58,30±6,84	49-75	61,10±8,49	-,517	,683
İnferiorlateral Dominant	44-56	52,50±4,27	42-80	57,40±12,43	-1,097	,428
İnferiorlateral Non-Dominant	70-116	87,10±15,35	71-108	88,30±10,42	-,016	,840
Medicine Ball Throw from the Chest	255-408	322,20±54,32	270-410	330,40±44,42	-,186	,716
Medicine Ball Launch Overhead	159-400	286,70±62,93	252-373	312,80±39,84	-1,095	,282

*Statistically significant difference (*p<0.05), t: Significance test for the difference between two means, Min: Minimum, Max: Maximum, x̄: Mean, sd: Standard Deviation.*

The test values of the participants in Group 1 and Group 2 after PU training were compared in terms of variables. As a result of the comparison, it is seen in Table 3 that the superolateral variable in group 1 and group 2 variables showed a significant difference between the two groups (p<0.05), while the other variables did not show a significant difference between the two groups.

Table 4. Comparison of Test Values of the Groups Before and After PU Exercise Training

Variables	Group 1 *n=10*		Group 2 *n=10*			
	Mak/min	**$\bar{x}$ ±sd**	**Mak/min**	**$\bar{x}$ ±sd**	**t**	**p**
Upper Extremity Stability Test Right	20,89/31,50	26,20/7,42	25,02/32,97	29,00/5,55	-7,094	**,000***
Upper Extremity Stability Test Left	18,23/26,76	22,50/5,96	20,08/28,91	24,50/6,16	-10,860	**,000***
Medial Dominant	63,89/80,90	72,40/11,89	65,90/82,29	74,10/11,45	-7,804	**,000***
Medial Non-Dominant	62,70/83,90	73,30/14,81	65,22/85,17	75,20/13,94	-3,289	**,004***
Süperolateral Dominant	75,60/86,99	81,30/7,95	77,35/88,04	82,70/7,46	-8,107	**,000***
Süperolateral Non-Dominant	50,85/61,54	56,20/7,46	53,40/63,19	58,30/6,84	-5,928	**,000***
İnferiorlateral Dominant	47,74/53,40	50,60/3,92	49,44/55,55	52,50/4,27	-2,461	**,024***
İnferiorlateral Non-Dominant	73,72/96,47	85,10/15,89	76,11/98,08	87,10/15,35	-9,239	**,000***
Medicine Ball Throw from the Chest	276,71/354,28	315,50/54,21	283,34/361,05	322,20/54,32	-11,227	**,000***
Medicine Ball Launch Overhead	233,96/326,63	280,30/64,76	241,67/331,72	286,70/62,93	-6,850	**,000***

*Statistically significant difference (*p<0.05), t: Significance test for the difference between two means, Min: Minimum, Max: Maximum, $\bar{x}$: Mean, sd: Standard Deviation*

In our study, the difference values of the test results before and after the training were compared in order to compare the groups in terms of the effectiveness of PU exercise training in Group 1 and Group 2. In the PU tests, a significant difference was found between the groups ($p<0.05$) in the pre and post-training difference changes in the UEST right and left arm, ICT medial dominant and non-dominant, superolateral dominant and non-dominant, inferiorlateral dominant and non-dominant, STFT chest and overhead medicine ball throwing test. The difference in change in Group 2 was found to be greater than in Group 1 ($\bar{x}$ ±sd), (Table 4.).

DISCUSSION

In recent years, studies in which balance platforms are at the forefront of strength training have been visibly increasing. It is seen that these studies are aimed at determining the activation of muscles by electromyographic method and there are few studies evaluating motor performance. In order to overcome this deficiency, our study was conducted to investigate the effects of Suspension and Non-Suspension PU Exercises on stability, strength and dynamic balance in the upper extremity region of 20 male volleyball athletes aged 15-18 years, competing in the 8th Group of the 2nd League of the Turkish Volleyball Federation.

When the studies in which the closed kinetic chain upper extremity stability test was at the forefront were examined, Tucci et al., (2014) concluded that male individuals had 24.78 ± 3.19 and female individuals had 27.97 ± 3.84 touch numbers in the study in which 20 male and 20 female individuals participated in the reliability and validity study on the subject. Roush et al., (2007) found the mean and standard deviation values as 30.41 ± 3.87 in a study applied to male baseball athletes aged 18-22 years. Studies conducted on athletes active in sports where the upper extremity is at the forefront reported that volleyball players between the ages of 18-25 reached a touch number of 27.72 ± 3.68, and in the same study, the touch numbers of handball and tennis athletes were in the same direction as volleyball athletes (Audenaert et al.,2017). In our study, the pre-test number of touches in the PU group without suspension was 26.2±7.42 for the right arm and 22.5±5.96 for the left arm, while the pre-test number of touches in the PU group with suspension was 28.4±5.12 for the right arm and 25.7±4.39 for the left arm. After the 8-week exercise program, the pre-test number of touches in the PU group without suspension was 29.00±5.55 for the right arm and 24.50±6.16 for the left arm, while the pre-test number of touches in the PU group with suspension was 32.10±3.98 for the right arm and 28.80±4.70 for the left arm. Literature studies are in the nature of due diligence and reflect the current performances of the athletes. In this sense, the first and last measurements we obtained as a result of our study are generally in parallel with the literature. We can attribute this result to the fact that the individuals included in the studies in the literature and the individuals

included in our study were all trained individuals. If we analyze the second data we obtained separately, although the PU bosu ball with suspension is higher in the no-training group, the development in both groups is a significant situation. In general, we can attribute the positive contribution of the two different training programs to the closed kinetic chain upper extremity stability test, even at different levels, to the natural effect of the applied training.

The upper limb y-balance test is a test that evaluates unilateral dynamic upper limb function in a closed kinetic chain position. It allows comparison of dominant and non-dominant extremities in terms of dynamic balance functions. In the literature, there are several studies evaluating suspension systems and dynamic balance. Borms et al., (2016) found no difference between extremities in healthy athletes engaged in sports involving overhead activity. Similarly, Butler et al. (2014) found no significant difference between the throwing arm and the other arm in adolescent baseball and softball players. Myers et al. (2016) did not observe a difference between dominant and non-dominant extremities in their study of wrestlers and baseball players. In addition, Gorman et al., (2012) and Westrick et al. (2012) reported that there was no difference between extremities in healthy individuals. In a study of 60 volleyball players aged 15-18 years, a significant difference was found between 2 extremities only in the medial and superolateral direction. The results of the non-dominant extremity were observed to be higher (Sezik, 2018). Related to the subject Yarım, İ.., et al. (2020) In a study in which a total of 48 male and female athletes including Wrestling (n:13), Futsal (n:10), Taekwondo (n:15) and Ski Running (n: 10), a total of 48 male and female athletes participated in the study in which Y balance test was used. In the evaluation, there was a significant difference between Wrestling-Futsal, Futsal-Ski Running, Taekwondo-Ski Running sports branches in right anterior, between Wrestling-Futsal, Futsal-Taekwondo, Futsal-Ski Running sports branches in right medial, There was a statistically significant difference in balance parameters between left anterior Wrestling-Taekwondo, Wrestling-Ski running, Futsal-Taekwondo, Futsal-Ski running, Taekwondo-Ski running sports branches and left medial and Wrestling-Futsal, Futsal-Taekwondo, Futsal-Ski running sports branches. ($p<0,05$). Literature studies generally consist of studies aimed at determining the current state of active athletes. In our study, in the comparison of the test values before and after PU exercise training in the dominant and nondominant extremities between the groups, only in the Inferiorlateral Dominant extremity before exercise training, 0.014 and in the Superolateral Dominant extremity after PU exercise training, 0.002 ($*p<0.05$) showed a difference in two parameters, in general, it can be stated that the data overlap with the literature. The parallelism with the literature can be attributed to the fact that the studies were conducted in individuals who were active in sports.

If the studies on the medicine ball throwing test are examined; Bayrak (2018) randomly divided 32 healthy male university students into two groups as PU group without suspension (n=15) and PU group with suspension (n=17). PU exercise training was performed for 10 weeks, 2 sessions per week. The unsuspended PU group reached a mean value of 424.20±45.14 cm before the exercise training and 438.60±52.77 cm after the exercise training. In the PU group with suspension, the mean value of 427.17±51.07 cm before exercise training and 446.50±55.67 cm in the measurements made after exercise training. In our study, the mean value of 280.3±64.76 cm in the PU group without suspension before exercise training and 286.70±62.93 cm in the measurements made after exercise training. The PU group with suspension reached a mean value of 306.5±39.09 cm before exercise training and 312.80±39.84 cm after exercise training. In both studies, an increase is observed in the measurements taken before and after exercise. Although the study groups are different, we can attribute this to the positive response to the exercises applied in the training programs applied.

If the studies in the literature in which PU exercises with and without suspension are examined with muscle activation method are examined;

Sparkes and Behm (2010) included 10 males and 8 healthy females aged 18-30 years in their study to compare the effectiveness of stable and instability resistance strengthening programs. Participants were divided into two groups as traditional and instability resistance exercise training group. In the study, which included pre-test and post-test evaluations, they reported that there was no difference between the groups in terms of strength, static balance or functional performance. However, they reported that the instability resistance training group tended to develop more strength than the traditional resistance training group in the chest press strength ratio. Negra et al., (2017) performed performance evaluation during plyometric exercises performed on stable and unstable ground in a study conducted in 33 healthy male soccer players with an average age of 12.1±0.5 years, and at the end of the study, they reported that dynamic balance was significantly higher on unstable ground than on stable ground. Kibele and Behm (2009) examined the effects of 7-week training on stable and unstable ground on strength and balance at the end of 7-week training in a study conducted with 20 males with an average age of 23±2.4 and 12 females with an average age of 22±1.8 with no training history.

At the end of the study, improvements in all strength and balance parameters were recorded in both exercise methods. (2015) examined the EMG muscle activations of the muscles around the shoulder during PU exercise with TRX on stable ground, unstable ground at a height of 10 cm. and 65 cm. in 29 healthy men with an average age of 21.3±1.5 years. The EMG activation levels of the long head of the triceps brachii muscle, upper trapezius muscle, anterior deltoid muscle and clavicular part of the pectoralis major muscle were evaluated. As a result of the study, it was reported that the activation of the triceps brachii and upper trapezius muscles was more significant during PU exercises performed on unstable ground compared to PU exercises performed on stable ground. Although there are studies in the literature with different results that are not preliminary with our study, there are also studies showing parallels. Freeman et al., (2006) had nine male and one female university students repeat each of 12 different push-up exercises three times and examined muscle activation by EMG. In this study, they concluded that push-up exercises with a bosu ball were among the three push-up methods that caused more muscle activation in general.

Conclusions & Recommendations

Our study was limited to 20 male volleyball players aged 15-18 years, who were competing in the 8th Group of the 2nd League of the Turkish Volleyball Federation. Suspended (bosu ball) and non-suspended PU exercises were added to the existing volleyball training program for 3 sessions per week for 8 weeks. Stability, strength and dynamic balance measurements were performed in the upper extremity region before and after the study.

The findings of the study showed that both training methods were effective in the development of upper extremity stability, strength and dynamic balance. However, when the superiority of the training methods was compared, it was found that PU bosu ball exercises with suspension were more effective in increasing muscle strength than PU exercise training without suspension.

In this sense, it can be stated that PU exercises with bosu ball do not create a significant situation compared to classical PU exercises, but when it is considered in terms of athletes who train regularly, routine exercises can cause boredom and decreased performance over time in athletes of all levels. In this respect, it is thought that bosu ball exercises in different forms to be applied to eliminate monotony in training will be beneficial in the field of sports.

It is thought that it would be useful to conduct studies to determine the effect of different suspended and unsuspended PU exercise exercises on sportive performance using different test batteries, to conduct studies focusing on different sports branches or to compare athletes of these branches, and to increase the number of subjects.

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