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The Impact of Lower and Upper Extremity Thera-Band Exercises on Technical Skills in Volleyball Players

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Abstract

This study aimed to investigate the effect of a 10-week Thera-Band exercise program designed for the major muscle groups of the lower and upper extremities on serve speed and accuracy in male volleyball players aged 15-18. Fifty-six male volleyball players who had been involved in volleyball for at least three years and who trained regularly four days a week participated in the study. An experimental research model, one of the quantitative research methods, was used in this study. The athletes were then randomly divided into two groups. The experimental group (n=28) underwent Thera-Band exercises (VTG) before training in addition to 90 minutes of classic volleyball training four days a week for 10 weeks, while the control group (n=28) only underwent classic volleyball training (VG). Volleyball skill tests (forearm pass, overhand pass, spike, and block) were administered to both groups before and after training. The Shapiro-Wilk and Levene's tests were used to determine whether the data were normally and homogeneously distributed, while the T-test was used for independent groups (Independent Samples) and the T-test was used for dependent groups (Paired Samples) ($p<0.05$). Statistical analyses revealed significant differences in the mean pre- and post-test scores for volleyball skill tests (forearm pass, overhand pass, spike, and block) between the dependent variables in both the Thera-Band and volleyball training groups ($p<.05$). However, it was found that the percentages of improvement were higher in the Thera-Band exercise group (Table 7). In addition, a significant difference in favor of the experimental group was found in the post-test mean scores of the volleyball skill tests (forearm pass, overhand pass, spike, and block) among the independent variables ($p<.05$). In conclusion, the 10-week Thera-Band exercise program designed for young male volleyball players aged 15-18 was found to have a significant effect on the accuracy rates of forearm pass, overhand pass, spikes, and blocks among athletes.

Keywords: Volleyball, Thera-Band, Resistance, Strength, Technical Performance,

ÖZET

Bu çalışma ile 15-18 yaş aralığındaki genç erkek voleybolcularda alt ve üst ekstremite ana kas gruplarına göre dizayn edilen 10 haftalık Thera-Band egzersizlerinin servis hızı ve isabet oranı üzerindeki etkisini incelemek amaçlanmıştır. Araştırmaya en az üç yıl voleybol branşı ile ilgilenen ve haftada 4 gün düzenli olarak voleybol antrenmanı yapan 56 erkek voleybolcu katılmıştır. Bu araştırmada nicel araştırma yöntemlerinden deneysel araştırma modeli kullanılmıştır. Daha sonra sporcular rastgele iki gruba ayrılmıştır. Deney grubuna (n=28) 10 hafta boyunca haftada 4 gün 90 dk. klasik voleybol antrenmanlarına ek olarak antrenmandan önce Thera-Band egzersizleri (VTG) uygulanırken, kontrol grubuna (n=28) ise sadece klasik voleybol antrenman (VG) çalışmaları uygulamıştır. Antrenman öncesi ve sonrasında her iki gruba voleybol beceri (manşet pas, parmak pas, smaç ve blok) testleri uygulanmıştır. Verilerin normal ve homojen dağılıma uygun olup olmadığını belirlemek için Shapiro-Wilk ve Levene's testi, bağımsız grupların karşılaştırılmasında (Independent Samples) T testi, bağımlı grupların karşılaştırılmasında ise (Paired Samples) T testi kullanılmıştır ($p<0.05$). İstatistiksel analizler sonucunda bağımlı değişkenler arasında hem Thera-Band hem de voleybol antrenman grubunda voleybol beceri testleri (manşet pas, parmak pas, smaç ve blok) ön-son test puan ortalamalarında anlamlı farklılık olduğu tespit edilmiştir ($p<.05$). Ancak gelişim yüzdelerinin Thera-Band egzersiz grubunda daha fazla olduğu tespit edilmiştir (Tablo 7). Ayrıca bağımsız değişkenler arasındaki voleybol beceri testleri (manşet pas, parmak pas, smaç ve blok) son test puan ortalamalarında deney grubu lehine anlamlı farklılık olduğu tespit edilmiştir ($p<.05$). Sonuç olarak 15-18 yaş aralığındaki genç erkek voleybolcular için hazırlanan 10 haftalık Thera-Band egzersizlerinin, sporcularda manşet pas, parmak pas, smaç ve blok isabet oranları üzerinde anlamlı bir etkisi olduğu saptanmıştır.

Anahtar Kelimeler Voleybol, Thera-Band, Direnç, Kuvvet, Teknik Performans,

Introduction

Volleyball is a sport that requires strategic thinking, intense physical effort, agility, coordination and explosive strength in the game, located at the intersection of technical skills and physical capacities. In order to be successful in volleyball, it is important to exhibit technical movements quickly and at an optimal level together with different motor skills during the competition. Therefore, athletes should have strong psychological, physical and physiological capacities in order not only to apply the techniques in the game correctly, but also to reflect them to the court at an optimal level (Yel et al., 2023). In order to reach these capacities, it is important to know the muscle and energy systems required for volleyball in advance and to design according to these systems while preparing the training programmes to be applied to the athletes.

When the literature is analysed, it is seen that the upper extremity muscle groups used in volleyball play a decisive role while performing technical skills such as passing, smash and serving. For example, the rotator cuff and deltoid muscles increase the repeatability and accuracy of the movements, especially by providing shoulder stability, and the strength of the muscles in the shoulder area helps to prevent injuries that may result from repetitive upper body movements (Escamilla et al., 2009). Again, pectoralis major and triceps brachii produce explosive force at the moment when the hand touches the ball during smash and serving, which affects the speed and accuracy of the ball.

The effective use of the shoulder girdle muscle groups while performing block, serve and smash movements in volleyball depends on the strength and flexibility of these muscle groups (McGill, 2010). Biceps and triceps muscles are involved in arm control and force production. The wrist and finger muscles are of great importance in terms of ball control and orientation while performing passing, smash, serving and blocking movements (Gabbett & Georgieff, 2007). Again, the erector spinae muscle helps to maintain body posture by providing spinal stability. Again, pelvic muscles play a critical role in maintaining body balance during sudden movements and reducing the risk of injury (Kibler, et al., 2006).

Core muscles help to keep the body in the correct position while performing movements such as smash, blocking, cuff passing and serving. The core muscles are also necessary to stabilise the body during jumping and to maintain balance during fall (Hibbs, et al., 2008). The latissimus dorsi muscle is an important muscle group that allows the arms to be lifted and pulled up for smash, blocking and serving. The trapezius muscle helps to stabilise and control shoulder movements.

Lower extremity muscle groups are the main source of movements such as jumping and sudden changes in direction (Pau, et al., 2016). For example, in volleyball, jump height has a critical role on factors that directly affect performance such as explosive power and stability. For example, the quadriceps and gluteal muscles play a primary role in force production during jumping, while the hamstring muscles provide landing and stabilisation (Tillman et al., 2004). The calf muscles (gastrocnemius and soleus) are of great importance for energy transfer, especially during rapid movement changes and contact with the ground. In addition, fast and explosive movements such as passing, smash, blocking and serving performed by volleyball players during the game are directly related to the harmonious work of the lower and upper extremity groups, strength, endurance, balance and flexibility (Sheppard & Newton, 2012).

Due to all these situations, it is of great importance that these muscles work strongly and in coordination while performing upper and lower body movements in techniques such as pass, smash and block. Imbalances or inadequacies in these muscle groups lead to loss of performance or injuries. Therefore, improving the coordination between these muscle

groups not only increases physical endurance, but also helps to optimise the technical accuracy of movements (Sheppard & Newton, 2012).

Elastic resistance bands are resistance devices that, besides strengthening the muscles, also improve players' balance and coordination between muscles by increasing proprioceptive perception. By targeting small muscle groups in the lower and upper extremities, Thera-Band exercises help to increase the player's agility and speed, as well as to practice technical skills more efficiently. For example, in one study, elastic resistance training was shown to improve players' movement speed and reaction time to the ball (Gallo-Salazar et al., 2017).

In studies on technical skill development in volleyball players, many researches have been conducted on the variety of training methods, but the effect of elastic resistance devices such as Thera-Band on these skills is still not fully understood. In order to fill this gap, this study aims to investigate the effect of Thera-Band exercises targeting lower and upper extremity muscle groups on the technical skills of young male volleyball players aged 15-18 years.

METHODS

Research Desing

A quantitative research method involving pre-post tests and an experimental research model with experimental and control groups was used to determine the effects of 10 weeks of Thera-Band exercises designed for the major muscle groups of the lower and upper extremities on volleyball skills (forearm pass, overhand pass, spike, and block) in young male volleyball players aged 15-18. The athletes were randomly divided into two groups. The experimental group underwent Thera-Band exercises in addition to volleyball training, while the participants in the control group underwent only classic volleyball training. Approval for this research was obtained from the Ethics Committee of Gazi University Rectorate with its decision dated 30.04.2025 and numbered E-77082166-604.01-1229359.

Research Group

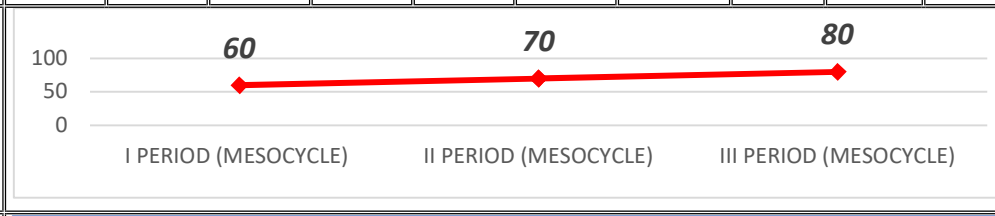
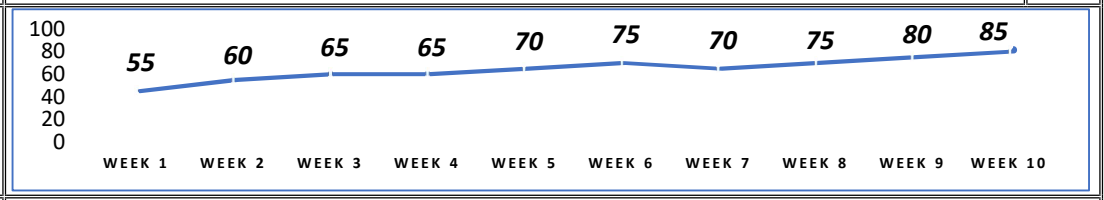
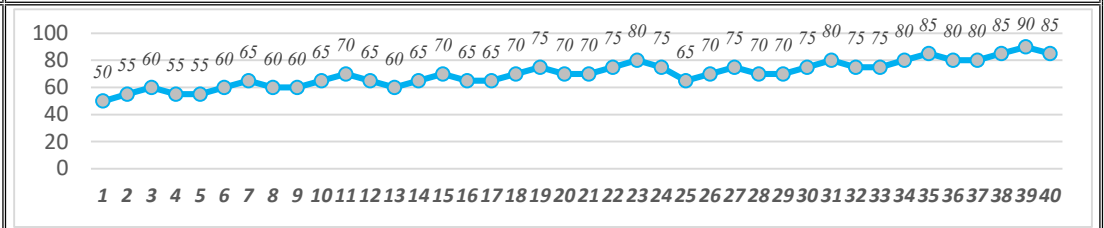
This study was conducted with the voluntary participation of 56 male volleyball players aged 15-18 who had been regularly training in volleyball for at least three years and four days a week. The population of the study consists of young male volleyball players. The G*Power (3.0.8) program was used to determine the sample size. In the G*Power analysis, the effect size was selected as 0.70, the α error margin as 0.05, and the Power (1-β error margin) as 0.80 (Yeleğen & Özkaya, 2021). The analyses concluded that a sample group of 52 individuals would be sufficient. Since the athletes in both groups were under 18 years of age, they were included in the study after obtaining signed 'Informed Consent Forms' from their parents and 'Child Consent Forms' to obtain their own consent. The experimental group (n=28) (VTG) (age; 16.85± 0.97 years, height; 189.21±3.89 cm, weight; 76.87±6.87 kg, body fat percentage; 14.90±1.50 %, sports age; 3.42±0.63, while the control group (n=28) (VG) age; 17± 0.86 years, height; 188.89±3.47 cm, weight; 75.35±5.79 kg, body fat percentage; 14.96±1.37 %, sports experience; 3.25±0.70 years.

Training Protocol:

In addition to classic volleyball training designed for athletes in the Thera-Band exercise group, the intensity of each 90-minute training session over 10 weeks will average 50-90%, athletes in the control group will only participate in classic volleyball training (90 min.). The athletes in the control group only participated in classic volleyball training

sessions (90 min.). The average intensity of the classic volleyball training sessions to be applied for 10 weeks for both groups was determined using the Polar H10 (Finland) heart rate sensor, compatible with the iPad application, and daily training plans were prepared and applied to the athletes. The 10-week training program for the VTG training group was implemented in strict accordance with the training plan and content specified in Table 1. The intensity of the training sessions for athletes in both groups was monitored using the Polar H10 (Finland) heart rate sensor, compatible with the iPad application, to ensure that target intensities were not exceeded. Thera-Band exercises were performed with a specialist fitness trainer. Classic volleyball training sessions were conducted by a specialist volleyball coach. Before and after training, both groups underwent tests on volleyball skills, including the accuracy rate of forearm pass, overhand pass, spikes, and blocks.

Table 1. Thera-Band + Volleyball Exercises Plan

PERIODS	I PERIOD (MESOCYCLE)			II PERIOD (MESOCYCLE)				III PERIOD (MESOCYCLE)			VIOLENCE (%)
WEEKS	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	
MESOCYCLE TRAİNİNG INTENSİTİES											%70
MİCROCYCLE TRAİNİNG INTENSİTİES											
DAİLY TRAİNİNG INTENSİTİES											
MİCROCYCLE TRAİNİNG PLAN	MONDEY	1	1	1	1	1	1	1	1	1	1	10 DAY
	WEDNESDAY	1	1	1	1	1	1	1	1	1	1	10 DAY
	FRIDAY	1	1	1	1	1	1	1	1	1	1	10 DAY
	SUNDAY	1	1	1	1	1	1	1	1	1	1	10 DAY
	TRAINING DAY	4	4	4	4	4	4	4	4	4	4	40 DAY
	REST DAYS	3	3	3	3	3	3	3	3	3	3	30 DAY

	THERA-BAND EXERCİSES DURATION	120-160 Min.	120-160 Min.	120-160 Min.	120-160 Min.	120-160 Min.	120-160 Min.	120-160 Min.	120-160 Min.	120-160 Min.	120-160 Min.	1600 Min.
	VOLLEYBALL TRAINING DURATION	360 Min.	360 Min.	360 Min.	360 Min.	360 Min.	360 Min.	360 Min.	360 Min.	360 Min.	360 Min.	3600 Min.
MİCROCYCLE TRAİNİNG PLAN CONTENT	15 Min.	STRETCHING										600 Min.
	5 Min.	GENERAL WARMING										200 Min.
	30-40 Min.	THERA-BAND EXERCİSES PROGRAM (PHASE 1)				THERA-BAND EXERCİSES PROGRAM (PHASE 2)			THERA-BAND EXERCİSES PROGRAM (PHASE 3)			1600 Min.
	60 Min.	DRILLS FOR TECHNICAL AND TECHNICAL SKILLS SPECIFIC TO VOLLEYBALL										2400 Min.
	10 Min.	COOLING										400 Min.

Thera-band Training Program Design

A review of the literature indicates that regular Thera-Band exercises improve performance in athletes. It is emphasized that 2-3 training sessions per week for 8 to 12 weeks increase performance in athletes, while only 1 training session per week maintains performance (Potier, Alexander & Seynnes, 2009; Roig et al., 2009; Wakahara et al., 2012). Meta-analysis studies conducted on young athletes emphasize that an average resistance training program should consist of 6 to 8 movements with an intensity of 60% to 80% of 1 RM every 2 to 4 weeks, with each movement consisting of 2 to 3 sets and 8 to 15 repetitions (Kraemer & Fleck, 2005); Behringer et al., 2010). In light of this information, a literature review indicates that when designing an exercise program, the selected exercises should target the primary muscle groups of the upper and lower extremities required in volleyball, specifically the muscles used in the game (Primary muscles: Quadriceps, Glutes, Hamstrings, Adductors, Calves, Abdominals, Erectors, Latissimus dorsi, Deltoids, Pectorals, Triceps, Biceps) and secondary muscles (Rotator Cuff, Traps, Rhomboids, Tibialis Anterior, Tibialis Posterior, Forearm extensors/flexors) used in volleyball. Eight movements were selected for each exercise program (Table 3).

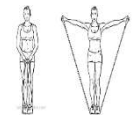
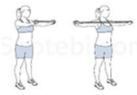
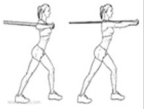
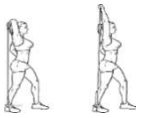
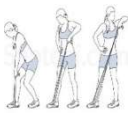
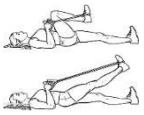
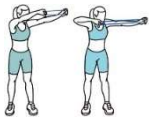
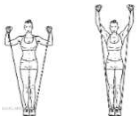
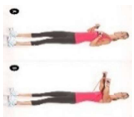
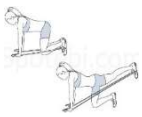
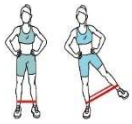
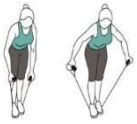
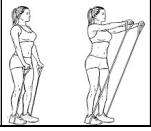
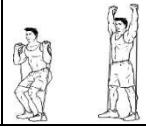
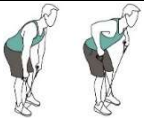
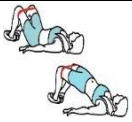
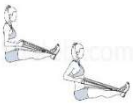
Table 2. Thera-Band Exercises Program Design

PHASE-1 (Weeks 1-2-3)			PHASE-2 (Weeks 4-5)			PHASE-3 (Weeks 6-7)			PHASE-3 (Weeks 8-9-10)		
1RM/AVG	*SETS*	*REST*	*1RM/AVG*	*SETS*	*REST*	*1RM/AVG*	*SETS*	*REST*	*1RM/AVG*	*SETS*	*REST*
Green	3 x 12	120 Sec	Blue	3 x 12	120 Sec	Blue	3 x 12	120 Sec	Black	3 x 12	120 Sec
Exercise Number: 1			**Exercise Number: 2**			**Exercise Number: 3**			**Exercise Number: 4**		

The intensity levels of the training applied to athletes were designed by changing the color of the Thera-Band, which signifies a change in the band's resistance. Athletes were asked to perform 15 repetitions of each exercise movement in the exercise program when selecting a band, and it was determined that green bands were appropriate for the beginning. After using the green band, it was recommended that athletes transition to the blue band and then the black band as their fitness level progressed (Buscher, Cumming & Ratajczyk, 2006; Escamilla et al., 2010). Therefore, the intensity of the training was set to green Thera-Band for the 1st, 2nd, and 3rd weeks, blue Thera-Band for the 4th and 5th weeks, and blue Thera-Band for the 6th and 7th weeks. -Band, exercise program 2 with blue Thera-Band in weeks 4 and 5, exercise program 3 with blue Thera-Band in weeks 6 and 7, and exercise program 4 with black Thera-Band in weeks 8, 9, and 10. Each movement in the exercise programs was designed to be performed in 3 sets of 12 repetitions. The rest interval between exercises was given as a 1:1 work-to-rest ratio, while 2-3 minutes of active rest time was given between movements (Table 2).

Athletes were encouraged to exert maximum effort during all sets, and movements were performed with 100% band resistance.

Table 3. Thera-Band Exercises Program Content

Exercise Program Number; 1							
1- Resistance Band Lateral Raises	***2- Resistance Band Squats***	***3- Resistance Band Mid Back Band Pull***	***4- Resistance Band Ankle Plantar Flexion***	***5- Resistance Band Chest Press***	***6- Resistance Band Knee Flexion (Prone)***	***7- Resistance Band Dublee Triceps***	***8- Resistance Band Bicep Curls***
							
Exercise Program Number; 2							
1- Resistance Band Lawnmower Band Pull	***2- Resistance Band Lying Leg Extensions***	***3- Resistance Band Sholder and Trapezius Press***	***4- Resistance Band Sumo Squat***	***5- Resistance Band Overhead Press***	***6- Resistance Band Lunge Tubing***	***7- Resistance Band Lying Chest Press***	***8- Resistance Band Donkey Kicks***
							
Exercise Program Number; 3							
1- Resistance Band Straight Pulldown Arm	***2- Resistance Band Front Squats***	***3- Resistance Band Incline Chest Press***	***4- Resistance Band Standing Leg Abductions***	***5- Resistance Band Reverse Fly***	***6-Resistance Band Deadlift***	***7- Resistance Band Sholder Front Raise***	***8- Standing Resistance Band Calf Raise***
							
Exercise Program Number; 4							
1- Resistance Band Push-ups / Pushups	***2- Resistance Band Squat and Over Hand Press***	***3- Resistance Band Bent Over Row***	***4- Resistance Band Bridge Thrust***	***5- Resistance Band Seated Row***	***6- Resistance Band Overhead Pulls***	***7- Resistance Band Biceps After Triceps***	***8- Resistance Band Lunge + Front Raise***
							

Classic Volleyball Training Program

When preparing classic volleyball training programs, 48 technical and tactical drills were created with input from national team coaches, national team fitness trainers, and child development experts who are specialists in their fields. To determine at which level each technical drill should be applied, Polar H10 (Finland) heart rate sensors, compatible with the iPad application, were attached to different athletes in the target age group before starting the research. The technical drills were then applied, and the average intensity of each technical drill was determined. After determining the average target intensity for each drill, the content of each unit (90 min.) of the classic volleyball training program to be applied to both groups was designed as follows: the first 15 minutes of the training consisted of stretching, 5 minutes of general warm-up, 60 minutes of volleyball-specific technical (forearm pass, overhand pass, serve, smash and block) and tactical

skills, and 10 minutes of cool-down. The intensity of each training unit was designed to be between 50-90% on average and was applied to the athletes. The intensities of the classic volleyball training program applied each week are shown in Table 1, and the content of the training is shown in Table 4.

Table 4. Volleyball Training Program Content

PERIODS	DAILY TRAINING PLAN CONTENT			
	MONDAY	WEDNESDAY	FRIDAY	SUNDAY
I- II AND III PERIOD (MESOCYCLES) (1,2,3,4,5,6,7,8,9,10. WEEK)	Stretching 15' min	Stretching 15' min	Stretching 15' min	Stretching 15'min
	General Warming 5' min	General Warming 5' min	General Warming 5' min	General Warming 5'min
	Smash Drills 10' min	Pass Drills 10' min	Serve Drills 10' min	Pass Drills 10'min
	Block Drills 10' min	Smash Drills 10' min	Block Drills 10' min	Smash Drills 10'min
	Serve Drills 10' min	Serve Drills 10' min	Pass Drills 10' min	Block Drills 10'min
	Team Work Drills 30'min	Team Work Drills 30'min	Team Work Drills 30' min	Team Work Drills 30'min
	Cooling 10' min	Cooling 10' min	Cooling 10' min	Cooling 10' min

Data Collection Method:

Age, height, and body weight measurements; Athletes' height was measured using a stadiometer (SECA, Germany) with a sensitivity of ±1 mm while participants were barefoot and wearing shorts. Body weights and body fat percentages were measured using a BIA device, the TANITA-BC 418 MA (Tokyo, Japan) brand device, and the values determined by the device were recorded as computer output.

VOLLEYBALL SKILL TESTS;

Forearm pass (See Figure 1. B), and Overhand Pass tests (See Figure 1. C); In order to determine the subjects' branch-specific overhand pass and forearm pass, skill levels, overhand pass and forearm pass, accuracy tests were used in the "Volleyball Skill Tests" developed by Bartlett, Smith, Davis and Peel (1991) (Bartlett et al., 1991).

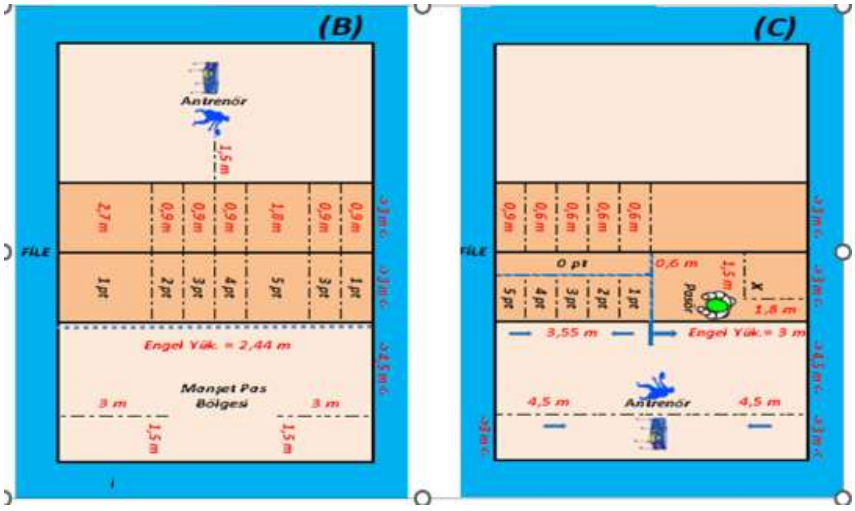


Figure 1: Volleyball skill tests (B= Forearm Pass) - (C= Overhand Pass).

Smash (See Figure 2. B), and Block tests (See Figure 2. C); In order to determine the subjects' branch-specific smash and block skill levels, the smash and block accuracy test developed by Zonifa, 2020 was used (Zonifa, 2020).

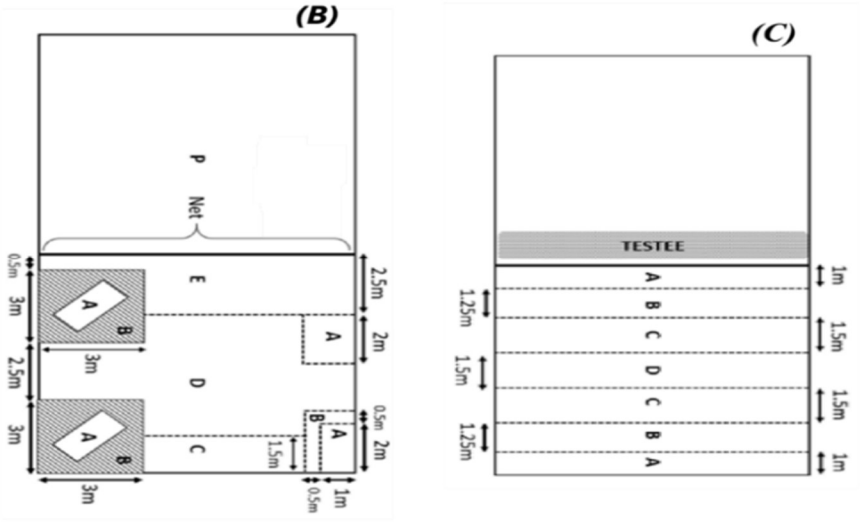


Figure 2: Volleyball skill tests (B= Smash) - (C= Block).

Statistical Analysis

Shapiro-Wilk and Levene's test were used to determine whether the data showed a normal and homogeneous distribution. Since it was determined that the data showed normal distribution according to the statistical results between the control and experimental groups, Independent Samples T test was used in the comparison of independent groups, while Paired Samples T test was used in the comparison of dependent groups ($p<0.05$).

Results

Table 5. Physical Characteristics of the Athletes Participating in the Study

Physical Characteristics	*Groups*	*n*	*Age (year) X±Ss*	*Height (cm) X±Ss*	*Weight (kg) X±Ss*	*Body Fat Percentage (%)*	*Sport Age (year) X±Ss*
Subjects	*VTG*	*28*	16,85± 0,97	189,21±3,89	76,87±6,87	14,90±1,50	3,42±0,63
	VG	*28*	17± 0,86	188,89±3,47	75,35±5,79	14,96±1,37	3,25±0,70

According to Table 5, the mean age of VTG (n=28) was 16.85± 0.97 (years), sport age was 3.42±0.63 (years), height was 189.21±3.89 (cm), body weight was 76.87±6.87 (kg) and body fat percentage was 14.90±1.50 (%). In VG (n=28), mean age was 17± 0.86 (years), sport age was 3.25±0.70 (years), height was 188.89±3.47 (cm), body weight was 75.35±5.79 (kg) and body fat percentage was 14.96±1.37 (%).

Table 6. Pre-test - post-test independent variables comparison results of participants' technical skill values

Technical Skills	*Groups*	*n*	*Pre-Test X±Ss*	*t*	*p*	*Post Test X±Ss*	*t*	*p*
Smash Accuracy Rate (p)	*VTG*	*28*	*11,32±2,00*	*-,648*	*,520*	*16,64±1,83*	*8,009*	*,000*
	VG	*28*	*11,61±1,20*			*13,25±1,29*		
Block Accuracy Rate (p)	*VTG*	*28*	*9,61±1,95*	*-2,494*	*,016*	*16,93±1,84*	*6,164*	*,000*
	VG	*28*	*11,25±2,89*			*13,46±2,33*		
Forearm Pass Accuracy Rate (p)	*VTG*	*28*	*23,29±3,92*	*-,608*	*,546*	*33,54±3,94*	*7,389*	*,000*
	VG	*28*	*23,82±2,52*			*26,96±2,57*		
Overhand Pass Accuracy Rate (p)	*VTG*	*28*	*23,57±3,93*	*,416*	*,679*	*33,93±3,72*	*6,179*	*,000*
	VG	*28*	*23,04±5,57*			*26,32±5,35*		

When examining the results of the pre-post test comparison of the volleyball skill test (forearm pass, overhand pass, spike, and block) ratios in Table 6, no significant difference was found in the participants' pre-test mean scores (p>.05). These results indicate that the groups were equivalent. Additionally, a significant difference in favor of the experimental group was found in the post-test serve accuracy and speed ratio mean scores (p<.05).

Table 7. Pre-test - post-test comparison results of participants' technical skill values

Technical Skills	*Groups*	*N*	*Pre-Test X±Ss*	*Post Test X±Ss*	*The Difference*	*Intra-Group Change (%)*	*t*	*p*
Smash Accuracy Rate (p)	*VTG*	*28*	*11,32±2,00*	*16,64±1,83*	*5,32*	*31,97*	*-42,050*	*,000*
	VG	*28*	*11,61±1,20*	*13,25±1,29*	*1,64*	*12,37*	*-11,145*	*,000*
Block Accuracy Rate (p)	*VTG*	*28*	*9,61±1,95*	*16,93±1,84*	*7,32*	*43,23*	*-42,814*	*,000*
	VG	*28*	*11,25±2,89*	*13,46±2,33*	*2,21*	*16,41*	*-10,986*	*,000*
Forearm Pass Accuracy Rate (p)	*VTG*	*28*	*23,29±3,92*	*33,54±3,94*	*10,25*	*30,56*	*-44,985*	*,000*
	VG	*28*	*23,82±2,52*	*26,96±2,57*	*3,14*	*11,64*	*-11,210*	*,000*
Overhand Pass Accuracy Rate (p)	*VTG*	*28*	*23,57±3,93*	*33,93±3.72*	*10,36*	*30,53*	*-34,426*	*,000*
	VG	*28*	*23,04±5,57*	*26,32±5,35*	*3,28*	*12,46*	*-10,382*	*,000*

When examining the comparison results of the pre-post test dependent variables in Table 7 for the volleyball skill test (forearm pass, overhand pass, spike, and block), it was found that there was a significant difference in the pre-test and post-test mean scores for the forearm pass, overhand pass, spike, and block accuracy test values for both the VTG and VG training group participants (p<.05). However, when looking at the development percentages, it is seen that the development percentages of the VTG exercise group are higher than those of the VG. These results indicate that Thera-Band exercises are more effective than classic volleyball training in terms of the percentage of development of selected technical skills.

Discussion

This study was conducted to determine the effects of Thera-Band training on some technical parameters of young male volleyball players between the ages of 15-18 years, which was designed according to the main muscle groups of the lower and upper extremities required in volleyball, and the current findings were supported by the literatüre.

In sports, optimum level of technical and tactical skills are critical in terms of both changing the flow of the game and increasing the pressure on the opposing team. In recent years, the effects of Thera-band and resistance exercises on the conditioning skills of athletes in different sports have been investigated by researchers and important findings have been obtained. Thanks to resistance training such as Thera-band, it improves athletes‘ neuromuscular control, dynamic stability (Andersen, et al., 2019), muscle strength, endurance and coordination (Saeterbakken, et al., 2020), allowing muscles to work at different angles of movement, improving athletes’ physical capacity, body awareness and joint mobility (Papadopoulos et al., 2018).

When the literature is examined, it has been reported that the development of technical skills is more effective by increasing physical and physiological capacity in athletes (Vargas, et al., 2020). The results of the study show that both Thera-Band resistance training and traditional volleyball training improve volleyball technical skills

in athletes. However, it is noteworthy that the technical skill development percentages of the Thera-Band group participants were higher than the volleyball group. There are several main reasons why Thera-Band training has more effect than technical training. The first of these is that Thera-Band training allows working with different resistance levels, which increases the body's balance, coordination and proprioception (body awareness) (Andersen, et al., 2019), creating positive effects on muscle strength, balance, coordination and neuromuscular adaptation behind technical skill mechanisms.

In particular, skills such as smash, blocking, forearm passing and overhand passing require athletes to work both fast and coordinated muscles in order to hit accurately on time. Thera-Band trainings increase the effectiveness of technical skills by allowing the muscles to better adapt to such fast movements. At the same time, it can also improve movement efficiency by reducing unnecessary energy expenditure during the execution of technical movements. While technical training usually aims to improve skills through repetition of specific movements, resistance training, such as Thera-Band, increases muscle strength and helps to perform these skills in a more powerful and controlled manner (Saeterbakken, et al., 2020; Papadopoulos, et al., 2018).

Another reason for the development is that Thera-Band training in combination with volleyball training has positive effects not only on muscle development but also on movement control and muscle synergy. The small muscle groups that are active during resistance training improve the balance and economy of movement of the athlete, and the faster development of the Thera-Band group in skill tests can be explained by these physiological adaptations. Because the muscles and nervous system must work in harmony in order to perform the movements at the right time and with the right force (Vargas, et al., 2020). Technical movements in volleyball (forearm passing, overhand passing, smash and block) are all movements that require simultaneous neuromuscular coordination of different muscle groups.

Especially in skills that require precise timing and strength, such as smash and blocking, it is of great importance that the athlete's body is in the correct position and applies the correct force. Thera-Band training can allow the muscles and joints to move in different directions, allowing athletes to perform these movements more effectively (Papadopoulos, et al., 2018). Low-intensity elastic resistance training, such as Thera-Band, stimulates the central nervous system, helping to develop the fine motor control necessary for technical skills.

In addition, in sports such as volleyball that require fast decision-making and correct technical execution, it is thought that such training accelerates neuromuscular adaptations and increases dynamic stability, enabling the athlete to learn technical skills in a shorter time (Saeterbakken, et al., 2020). In sports that require both explosive power and precise technique, such as volleyball, the findings observed in this study that Thera-Band training supports skill development also coincide with different and similar studies in the literature.

In studies on young basketball players, it was reported that Thera-Band training had an effect on shooting performance (Canlı, 2017; Safçı, 2018). In another study on tennis players, positive improvements were reported in forehand, backhand and service accuracy values (Öner, 2021; Balkanlı, et al., 2020). In studies on swimming athletes, significant improvements were reported in swimming degrees (Aktuğ, et al., 2019; Yapıcı, et al., 2016), 100 m freestyle swimming performance (Gönener, et al., 2017), 25-50-100-200 m swimming performance (Selçuk, 2013; Deyirmenci & Karacan, 2017) and swimming performances (Şenol & Gülmez, 2017; Sadowski, et al., 2015). Studies on football athletes also reported significant improvements in shooting performance in football (Özturk & Gelen, 2015). In another study conducted on table tennis athletes, it was reported that there were positive improvements in the performance of the athletes

in front of the hand overhand sloping stroke performance due to the increase in stroke accuracy and success (Nikolakakis, et al., (2020).

When similar studies were examined, Demir (2018) reported that pilates mat exercises applied for 12 weeks in addition to volleyball training had a positive effect on the forearm passing and smash technical performances of athletes. Eller, (2013) reported that strength training applied for 8 weeks in addition to volleyball training contributed positively to the technical and motoric skills of athletes. Similarly, Demir, et al., (2022) reported that training using Thera-Band increased the overall performance of athletes and played an important role in the development of technical skills. When the values we determined in young male volleyball players in our study are compared with the results in the literature, the results of the study and the literature information are similar. In this context, our study shows that Thera-Band trainings provide more efficient application of technical skills by effectively training these muscle groups.

The Thera-Band training protocol used in this study was found to be an effective method to improve the technical skills of players. However, as stated by Colado and Triplett (2008), in order for Thera-Band training to be effective, it should be applied regularly and for a long time. Our study supports this view and shows that Thera-Band training should be continuous in order to contribute to the technical skills of volleyball players.

CONCLUSİON AND RECOMMENDATİONS

The findings revealed that a 10-week Thera-Band exercise program designed for the major muscle groups of the upper and lower extremities, in addition to volleyball training, had a significant effect on the accuracy rates of forearm pass, overhand pass, spikes, and blocks in male volleyball players aged 15-18. This study demonstrates that Thera-Band exercises are an effective, safe, and feasible method for improving the accuracy of forearm pass, overhand pass, spikes, and blocks in volleyball players. Therefore, it is recommended that coaches and sports scientists consider this method in their training planning. Additionally, volleyball coaches should systematically incorporate Thera-Band exercises into their training programs during pre-season and in-season preparation periods. Thera-Band exercises should be incorporated into volleyball training programs to support improvements forearm pass, overhand pass, spike, and block performance. Regular Thera-Band training can be implemented to support strength development in youth athletes and enhance the effectiveness of technical skills. Future research should examine the effects of Thera-Band exercises on athletes of different age groups, genders, and performance levels; their contribution to other technical skills such as spikes, blocks, forearm pass and overhand pass, can also be investigated. The effects on technical skills can be examined in athletes of different age groups, genders, and performance levels across different sports. Longitudinal studies with larger sample groups can be conducted to reveal the long-term effects of Thera-Band exercises.

Kısaltmalar / Abbreviations

SD	Standart sapma (Standard deviation)
X	Ortalama (Mean)
SPSS	Sosyal bilimler için istatistik paketi (Statistical package for the social sciences)
p value	Anlamlılık değeri (Significant value)
n	Katılımcı sayısı (Number of participant)

Beyanlar / Declarations

Etik Onay ve Katılım Onayı / Ethics approval and consent to participate

Bu çalışmanın hazırlanma ve yazım sürecinde "Yükseköğretim Kurumları Bilimsel Araştırma ve Yayın Etiği Yönergesi" kapsamında bilimsel, etik ve alıntı kurallarına uyulmuş olup; toplanan veriler üzerinde herhangi bir tahrifat yapılmamış ve bu çalışma herhangi başka bir akademik yayın ortamına değerlendirme için gönderilmemiştir. Makale ile ilgili doğabilecek her türlü ihlallerde sorumluluk yazara aittir. Katılımcılar için, etik kurallara uygun olarak katılımcıların ebeveynlerinden veya yasal vasilerinden bilgilendirilmiş onam alınmış ve tüm katılımcılar bu çalışmaya gönüllü olarak katılmıştır. /

During the preparation and writing of this study, scientific, ethical and citation rules were followed in accordance with the 'Higher Education Institutions Scientific Research and Publication Ethics Guidelines'; no alterations were made to the collected data, and this study has not been submitted for evaluation to any other academic publication medium. The author is solely responsible for any violations that may arise in connection with this article. For participants, informed consent was obtained from the participants' parents or legal guardians following ethical guidelines, and all participants voluntarily participated in this study

Veri Ve Materyal Erişilebilirliği / Availability of data and material

Bu çalışmanın bulgularını destekleyen veriler, makul talepler üzerine sorumlu yazardan temin edilebilir. Veri seti yalnızca akademik amaçlar için erişilebilir olacak ve verilerin herhangi bir kullanımı, orijinal çalışmayı referans gösterecek ve katılımcıların gizliliğini koruyacaktır.

The data that support the findings of this study are available from the corresponding author upon reasonable request. The dataset will be accessible only for academic purposes, and any use of the data will recognize the original study and maintain the confdentiality of the participants.

Çıkar Çatışması / Competing interests

Yazarlar, bu makalede sunulan çalışmayı etkileyebilecek herhangi bir çıkar çatışması veya kişisel ilişkiye sahip olmadıklarını beyan etmektedirler.

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Yazar Katkıları / Authors' Contribution Statement

Çalışmanın tasarımı ve planlanması: S.A.; Veri toplama, analizi veya yorumlanması: S.A.; Makalenin yazımı: S.A.; Veri düzenleme, yöntem belirleme, yazım – özgün taslak, yazım – gözden geçirme ve düzenleme: S.A.; Tüm yazarlar, makalenin önemli noktalarını eleştirel bir şekilde gözden geçirmiştir. Tüm yazarlar makalenin son halini onaylamıştır. /

Design and planning of the study: S.A.; Data collection, analysis or interpretation: S.A.; Manuscript preparation: S.A.; Data organization, methodology development, writing - original draft, writing – review and editing: S.A.; All authors critically reviewed the key points of the manuscript and approved the final version.

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