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Comparison of the effects of yoga and self-myofascial release exercises on physical performance in 12–14-year-old female volleyball players

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Abstract

The aim of this study is to examine the effects of 8-week Yoga and Self-Myofascial Release (SMR) exercises on the physical performance of female volleyball players aged 12-14. Participants were randomly divided into three groups: those who participated in traditional volleyball training (control group (CG), SMR in addition to volleyball training, and yoga (YG) in addition to volleyball training. Vertical jump, sit-reach, flamingo balance and 20 m speed tests were applied before and after the study. During the study period, statistically significant differences were found in body mass (p=0.029) and height (p=0.002) of the control group, and only in height (p=0.003) of the yoga group. It was observed that different types of exercise modalities improved vertical jump and speed in the SMR group (p<0.05), did not affect physical performance in the yoga group (p>0.05), but volleyball training improved vertical jump and balance in the control group (p<0.05). Stretching ability did not improve in any group. The results obtained by statistically comparing the pretest-posttest difference scores between the groups revealed that there was no improvement in any of the physical parameters considered. As a result, it has been revealed that 8-week yoga exercises do not contribute to vertical jump, sit-reach, balance and 20 m sprint performance in 12-14 age group female volleyball players, while SMR exercises improve jumping and balance.

Keywords: Physical performance, self myofascial release, volleyball, yoga.

12-14 yaş bayan voleybolcularda yoga ve self-miyofasyal gevşetme egzersizlerinin fiziksel performans üzerine etkilerinin karşılaştırılması

Öz

Bu çalışmanın amacı 12-14 yaş aralığındaki kadın voleybolcuların 8 haftalık Yoga ve Kendi Kendine Miyofasyal Gevşetme (SMR) egzersizlerinin fiziksel performans üzerine etkisini incelemektir. Katılımcılar geleneksel voleybol antrenmanlarına (kontrol grubu (CG), voleybol antrenmanı dışında kendi kendine miyofasyal gevşetme antrenmanına (SMR) ve voleybol antrenmanı dışında yogaya katılan (YG) olmak üzere rastgele üç gruba ayrıldı. Çalışmanın öncesinde ve sonrasında dikey sıçrama, otur-eriş, flamingo denge ve 20 m sürat testleri uygulandı. Çalışma süresi boyunca kontrol grubunun vücut kütlesi (p=0,029) ve boy uzunluğunda (p=0,002), yoga grubunun ise sadece boy uzunluğunda (p=0,003) istatistiksel olarak anlamlı farklara rastlandı. Farklı türdeki egzersiz modalitelerinin SMR grubunda dikey sıçrama ve sürati geliştirdiği (p<0,05), yoga grubunda ise fiziksel performansı etkilemediği (p>0,05) ancak kontrol grubunda voleybol antrenmanlarının dikey sıçrama ve dengeyi geliştirdiği (p<0,05) görüldü. Esneklik yetisi hiçbir grupta gelişmedi. Yapılan gruplar arası ön test-son test fark puanlarının istatistiksel olarak karşılaştırılması ile elde edilen sonuçlar ele alınan fiziksel parametrelerin hiçbirinde gelişme olmadığını ortaya koydu. Sonuç olarak, voleybolda 12-14 yaş grubu kız voleybolcularda 8 haftalık yoga egzersizlerinin dikey sıçrama, otur-eriş, denge ve 20 m sürat performansına katkı sağlamadığı, SMR egzersizlerinin ise sıçrama ve dengeyi geliştirdiği ortaya konmuştur.

Anahtar Kelimeler: *Fiziksel performans, kendi kendine miyofasyal gevşetme, voleybol, yoga.*

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INTRODUCTION

Volleyball is a team sport where explosive movements such as agility, jumping, speed, hitting, spiking, serving and blocking are dominant and athletes from various age categories compete (Stojanović & Kostić, 2002; Marques et al., 2006; Lidor & Ziv, 2010). Volleyball, which is an intermittent sport played on a small field, with short duration and frequent player changes (Baker et al., 2015), contains having the technical, tactical, physiological and psychological competencies required for high performance. In addition, participation in high-level competitions in volleyball; It also includes the development of speed, agility, flexibility, strength, power, balance and aerobic endurance skills (Pradhan, 2017). Since volleyball is a game in which sudden-maximal running and jumping (blocking and jumping) movements are predominantly played, the strength of the leg muscles must be developed (Gabbett et al., 2006). It is known that as flexibility increases, muscle strength improves and protects the athlete from injuries (Warneke et al., 2022).

Stretching creates acute and chronic effects on muscle development by applying different techniques as static, dynamic or propriocepitve neuromuscular facilitation. Strength increase is supported by stretching development, and therefore stertching must first be developed in order to increase strength (Thomas et al., 2023). Some acute effects on the muscle may occur within the first few hours after stretching. Our muscles show an acute resistance to stretching. This resistance is related to the change in muscle length that occurs per unit time under the influence of stretching, and this change is caused by the viscoelasticity property of the muscles, which disappears within an hour (Fowles et al., 2000). However, increases in joint range of motion are not affected by this viscoelastic structure of the muscle, but rather by the tolerance of the muscle to stretching. As stretching tolerance increases, joint range of motion increases (Knudson, 2006). Regular stretching training has a chronic effect on joint range of motion. This effect reduces passive stiffness in the muscle by increasing stretching tolerance, intramuscular viscoelastic compliance, and serial increase in sarcomeres. The viscoelastic property of muscle is associated with passive stiffness (Ryan et al., 2008). Reducing passive stiffness in the muscle with regular stretching training increases stretching development (Guissard & Duchateau, 2004). There are many types of exercises that focus on stretching. Yoga is a popular exercise method that emphasizes stretching development. Yoga involves a variety of body positions or postures performed gently and carefully, with a smooth progression from one posture to the next, maintained over a period of time.

There are many benefits of yoga that contribute to the development of strength, fine motor coordination, flexibility, postural harmony and cardiovascular fitness (Bera & Rajapurkar, 1993; Telles et al., 1997; Telles & Srinivas, 1998; Dash & Telles, 1999; Galantino et al., 2008), and also increase attention and concentration, facilitate behavioral development and relax the body (Harrison et al., 2004; Jensen & Kenny, 2004; Powell et al., 2008; Berger et al., 2009; Kaley-Isley et al., 2010). With this, in competition or training environments, nutritional values and fluid intake for the branch are also important (Akyüz et al., 2022).

In addition to yoga being an exercise applied to adults, many yoga studies can be found in which the participant group is children. There are many long-term studies on yoga, where the age range varies between 9-18 and the duration of practice varies between 10 days and 6 months. These studies show that yoga has positive effects on hand grip strength (Dash & Telles, 1999), balance and flexibility (Berger & Stein, 2009; Donahoe-Fillmore et al., 2010; Donahoe-Fillmore & Grant, 2019), body composition, cardiovascular and respiratory health, and physical condition (Manna et al., 2023). However, the number of studies evaluating the effects of long-term yoga practices on speed is limited and the studies focused on adults (Donahoe-Fillmore & Grant, 2019).

Another popular exercise method that has positive effects on flexibility is myofascial release exercises. Myofascia is the connective tissue surrounding the muscles. If it is damaged or not active or triggered, it negatively affects strength, power and endurance by restricting the range of motion of the joints (Sullivan et al., 2013). Myofascial release movements are an exercise method applied by applying pressure on the muscle tissue, performed with cylinder foam equipment, to improve the flexibility, strength and balance characteristics of athletes. This method, which can be applied with foam rollers, massage balls, and various hand-held tools (handheld muscle stick roller, thera cane, quadballer roller, etc.), is one of the sports warming or performance enhancing tools (MacDonald et al., 2013; Cheatham et al., 2015; Beardsley & Škarabot, 2015). It is noteworthy that studies on SMR and sports performance generally focus on the effects of SMR on ROM and flexibility. It is generally accepted that SMR practices increase ROM and flexibility (Beardsley & Škarabot, 2015). Foam Rolling exercises relax the fascia tissues in the structure of bones, muscles and the organs that feed these tissues, making them soft and malleable (Madoni et al., 2018). Fascia is a connective tissue that has the ability for active cellular contraction, is found everywhere in our body and surrounds every part of our body, and transfers force between tissues. The active cellular contraction feature affects motor neuron coordination not in seconds and minutes, but rather in several minutes and longer

periods of time. Over a period of weeks, this cellular activity creates severe tissue contractions that are long-term and continuous (Schleip & Klingler, 2019).

It is known that joint range of motion is important in the success of sports activities. Exercises aimed at improving flexibility are exercises that cover the shortest period of the training period and require the least energy. Maximum flexibility is reached at the age of 15–16 (Pense, 2002). Although flexibility is important for volleyball players, due care is not taken during training. Studies have reported that strength and flexibility are an integral whole and develop depending on many factors. When flexibility exercises, which allow the length of connective tissues and muscles to lengthen, are applied with the correct technique, quickness can be achieved in controlling the ball on the ground in volleyball (Matvienko, 2002; Amiri et al., 2010). When the literature is examined, although there are studies focusing on the development of flexibility in volleyball players, it is seen that there are a limited number of studies addressing the flexibility development of volleyball players in the 12-14 age group (Kruse et al., 2013; Coons et al., 2017; Shenoy et al., 2018; Popelka & Pivovarniček, 2018; Durukan & Göktepe, 2020; Arı et al., 2021). This study was conducted to examine the effects of different types of exercise modalities on physical performance in 12-14 year old female volleyball players.

METHODS

Research model

In this research, an experimental research model revealing the cause and effect relationship was applied and the data obtained from the pre-test and post-test were compared with each other.

Research group

26 licensed female athletes aged 12-14, playing in a local volleyball club, participated in the study. Participants were randomly divided into three groups: those who participated in traditional volleyball training (control group (CG): n=8; age= 12.00 ± 0.00), self-myofascial release training (SMR: n=10; age = 14.10 ± 0.57) in addition to volleyball training, and yoga (YG: n=8; age = 12.00 ± 0.00) in addition to volleyball training. All three groups participated in volleyball training 3 days a week for 8 weeks. Before and after 8 weeks, vertical jump, balance, 20 m speed and flexibility (sit and reach) tests were applied to test the effects of different types of exercise modalities (Flexibility phase of traditional volleyball training for CG, Yoga exercises for YG and Self-Myofascial Release exercises for SMR group) on physical performance. Criteria for inclusion in the study for Yoga and SMR group: having at least 1 year

of regular volleyball training history in Uşak 64 Municipality Sports Club, being between the ages of 12-14; exclusion criteria: not participating in a maximum of 2 weeks of the 8-week exercise period for any reason. Before the study, Ethics committee approval was obtained from Uşak University Non-Interventional Ethics Committee (163-163-20,12.07.2023).

Data collection tools

Before the tests, the athletes were allowed to warm up for 15 minutes by jogging. Vertical jump, balance, 20 m speed and flexibility (sit-reach) tests were performed sequentially with a 5-minute rest in between. Participants were given two attempts for each test and were given 3-5 minutes of rest between trials.

Vertical Jump Test: My Jump 2 Application was used to determine changes in jumping performance (Fatih & Vedat, 2023). Participants were asked to make two maximal jumps with their hands on their hips and their best performance was recorded.

Balance Test: Participants were asked to stand on a board measuring 50×5×3 cm, keep the knee of one leg fully flexed with one hand, and maintain balance on the other leg with support from the instructor. Meanwhile, they were allowed to focus on a point and make a few familiarization attempts before measuring this test. The stopwatch was started as soon as the participant took her hand away from the instructor from whom she received support, and the stopwatch was stopped when she changed her stance. The participant took the test stance again with the support of the instructor, and the stopwatch was continued to complete the 1-minute period. The number of stopwatches stopped with each stance disturbance within 1 minute was recorded. The participant was given two attempts for this test, and the best value was recorded.

Speed Test: To reveal the effect of our study on explosive performance, participants were asked to participate in a 20 m speed test. For this purpose, Fusion Smartspeed (USA) brand two-door photocell system was used. Participants were asked to finish the 20 m track in the shortest time with maximum effort and the best of two trials was recorded.

Sit and Reach Test: The Sit-Reach test was applied to test flexibility. Participants were asked to sit on the floor, rest their bare feet on the baseline brand sit-and-reach bench with their knees in full extension, and reach the farthest possible point on the bench with their hands together while bending forward with trunk flexion. The distance of this point on the tripod was measured, and the best of two attempts was recorded in cm.

Exercise modalities

Yoga

The weekly training frequency of the participants in our study is two. For this reason, the athletes participated in yoga exercises accompanied by a Yoga instructor two days a week. The 30-45 minute yoga session includes various individual and joint yoga postures, as well as breathing and meditation. Yoga movements (poses) were applied in two stages to ensure that the participants performed the yoga poses according to the principle of gradually increasing load and to protect the participants from possible injuries. Thus, the participants were asked to do beginner-level yoga poses in the first four weeks (Downward Dog, Cobra, Warrior-I, Spinal Twist, Pigeon, Thread the Needle, Savasana), and intermediate-level Yoga Poses in the last four weeks (Dolphin, Chair Twist, Lizard, Bow, Dolphin Plank, Camel, Savasana). The flow of yoga poses, breathing techniques and posture times were determined by the Yoga instructor. Each session began with breathing, followed by yoga poses focusing on flexibility and ended with savasana.

Sel myofascial release

SMR applications were performed twice a week after training, as in the Yoga group. Medium hardness foam (Delta brand, short foam roller) was used in the SMR sessions that lasted 30-45 minutes. Participants were asked to perform SMR movements applied to certain parts of the movement system (Thoracis/Lumbar Region, Gluteal Region, Hamstring Region, Calf Region, Pectoral Region, Quadriceps/flexor region) for 8 weeks, and the accuracy of the movements was personally monitored by the researchers of the study in each SMR session (Peacock et al., 2014).

Analysing the data

Statistical analysis was performed with IBM® SPSS® Windows Version 23.0 Statistical Package Program (IBM® Corp., 2016). Whether the data sets of the dependent variables of our research showed a normal distribution was tested with the Shapiro Wilk Test and was also checked by evaluating the normal distribution curves (Ak, 2008). For pairwise comparisons within groups, t-test for related samples (Paired Sample T-Test) was used for values that met the parametric test conditions, and for pairwise comparisons within groups that did not meet the conditions, Wilcoxon Signed Ranks test was used. Intergroup comparisons were made to determine which group was ahead based on the difference scores obtained between the pre-test and post-test values of the training sessions. In these comparisons, it was seen that the mean values of the difference scores between the pre-test and post-test of all dependent variables met

the parametric test conditions. One-Way ANOVA was performed for each dependent variable when the conditions of the One-Way Multivariate Analysis of Variance test, which is preferred to compare the mean values of the difference scores, were not met (Mahalanobis distance>9.21). Statistical analysis results were shown as mean and standard deviation values in the tables, and the difference values in pairwise comparisons within and between groups were shown as percentage difference (% Δ) between pre-test and post-test in the related tables. To demonstrate the power of the statistical analysis, effect size values for all relevant tests were included (Salkind & Green, 2005; Morgan et al., 2004). Statistical significance level was set at $p<0.05$.

FINDINGS

The ages and training ages of the participant groups are shown in Table 1.

Table 1. Demographic characteristics of the groups

	CG	**SMR**	**YG**
	Mean ± SD (n=8)	**Mean ± SD** (n=10)	**Mean ± SD** (n=10)
Age (year)	12.00 ± 0.00	14.10 ± 0.57	12.00 ± 0.00
Training age (year)	2.75 ± 0.71	2.5 ± 0.53	2.75 ± 1.17

CG: Control Group; YG: Yoga Group; SMR: Self-Myofascial Release Group; SD: standard deviation.

According to One Way ANOVA test for unrelated samples whether the training age varies between groups, it can be said that the participants of different groups are similar to each other in terms of training experience ([F(2-23)=0.285, p<0.05]).

The mean absolute difference values between demographic characteristics of different groups are shown in Table 2.

Table 2. Average absolute difference values between demographic characteristics of different groups

	CG		**SMR**		**YG**	
	Pre test – Post test **Mean ± SD** (n=8)	**p**	Pre test – Post test **Mean ± SD** (n=10)	**p**	Pre test – Post test **Mean ± SD** (n=8)	**p**
BM (kg)	Pre 46.54 ± 5.61 Post 48.25 ± 5.66 Δ1= 1.71 ± 1.76	0.029*	Pre 57.35 ± 12.98 Post 57.07 ± 12.66 Δ2= – 0.28 ± 3.44	0.649	Pre 47.87 ± 9.39 Post 48.56 ± 9.16 Δ3= 0.69 ± 1.91	0.339
H (cm)	Pre 155.1 ± 5.29 Post 157.8 ± 4.72 Δ1= 2.68 ± 1.53	0.002*	Pre 166.3 ± 7.58 Post 166.6 ± 7.48 Δ2= 0.28 ± 1.26	0.501	Pre 156.9 ± 8.27 Post 159.6 ± 8.59 Δ3= 1.44 ± 4.60	0.003*

CG: Control Group; YG: Yoga Group; SMR: Self-Myofascial Release Group; SD: Standard deviation; BM: Body mass; H: Height; Δ; Absolute difference between pretest and posttest.
*p<0.05.

In the intra-group statistical analysis conducted to determine whether the mass and height values of the participant groups differed between the pre-test and post-test, participants in the control group showed a significant increase in both mass and height, while there was a significant increase only in height in the yoga group, but the SMR group showed a significant increase in both mass and height. It was observed that there was no statistically significant difference in neither mass nor height values (Table 2).

The mean absolute difference values between pretest-posttest data of different groups are shown in Table 3.

Table 3. Average absolute difference values between pretest-posttest data of different groups

	CG		**SMR**		**YG**	
	Pre test – Post test **Mean ± SD** (n=8)	**p**	Pre test – Post test **Mean ± SD** (n=10)	**p**	Pre test – Post test **Mean ± SD** (n=8)	**p**
VJ (cm)	Pre 28.39 ± 3.30 Post 31.48 ± 4.86	0.021*	Pre 29.76 ± 4.71 Post 31.44 ± 4.46	0.042*	Pre 31.00 ± 5.79 Post 30.50 ± 6.97	0.725
	Δ1= 3.09 ± 2.96		Δ2= 1.68 ± 2.23		Δ3= –0.50 ± 3.89	
SR (cm)	Pre 31.19 ± 6.83 Post 34.00 ± 6.16	0.098	Pre 30.16 ± 5.26 Post 31.50 ± 5.39	0.295	Pre 28.38 ± 8.69 Post 29.81 ± 6.29	0.406
	Δ1= 2.81 ± 4.16		Δ2= 1.34 ± 3.81		Δ3= 1.44 ± 4.60	
Balance	Pre 16.13 ± 4.19 Post 11.25 ± 3.92	0.034*	Pre 15.20 ± 5.79 Post 13.10 ± 6.19	0.137	Pre 16.63 ± 6.12 Post 13.00 ± 3.63	0.068
	Δ1= –4.88 ± 5.06		Δ2= -2.1 ± 4.12		Δ3= –3.63 ± 4.90	
Speed (s)	Pre 3.82 ± 0.18 Post 3.81 ± 0.23	0.815	Pre 3.84 ± 0.21 Post 3.67 ± 0.14	0.001*	Pre 3.92 ± 0.31 Post 3.81 ± 0.27	0.143
	Δ1= –0.01 ± 0.11		Δ2= –0.18 ± 0.12		Δ3= –0.10 ± 0.18	

CG: Control Group; YG: Yoga Group; SMR: Self-Myofascial Release Group; SD: standard deviation; VJ: Vertical jump; SR: sit-and-reach test; Δ; Absolute difference between pretest and posttest.

*p<0.05.

Intra-group statistical analysis was performed to reveal the effect of athlete groups participating in different types of exercise modalities for 8 weeks on their physical features such as vertical jump, flexibility, balance and speed. Statistically significant differences were obtained between the pre-test and post-test values in the vertical jump values of the control and SMR groups. It was observed that balance performance revealed a statistically significant difference (z= -1.49, p<0.05) only in the control group. The fact that the difference scores were in favor of negative ranks (pre-test measurement) showed that the 8-week study period had a

significant effect on the balance values of the control group. It was determined that there was a statistically significant increase in speed performance only in the SMR group ($p<0.05$). As a result, it can be said that yoga does not have a significant effect on vertical jump, flexibility, balance and speed, SMR exercises have a statistically significant effect on vertical jump and speed and increase performance, but do not develop any significant effect on balance and flexibility. It can be said that traditional volleyball training applied for eight weeks increased vertical jump and balance in the control group, but did not have a significant effect on flexibility and speed (Table 3).

Pairwise comparisons between groups regarding the pretest-posttest differences of three different groups are shown in Table 4.

Table 4. Pairwise comparisons between groups regarding pre and post test differences of different groups

	Mean ± SD	p	ANOVA p	ES
VJ (cm)	ΔG1- ΔG2 = 2.18 ± 1.44	0.372	2.848	0.2[d]
	ΔG1- ΔG3= - 1.41 ± 0.72	0.709		
	ΔG2- ΔG3= - 3.59 ± 1.52	0.078		
SR (cm)	ΔG1- ΔG2=-0.10 ± 0.02	1.000	0.326	0.03[d]
	ΔG1- ΔG3= - 1.48 ± 1.01	0.846		
	ΔG2- ΔG3= - 1.38 ± 1.12	0.887		
Balance	ΔG1- ΔG2= -1.53 ± 1.18	0.873	0.799	0.06[d]
	ΔG1- ΔG3= 2.78 ± 1.75	0.529		
	ΔG2- ΔG3= 1.25 ± 1.09	0.934		
Speed (s)	ΔG1- ΔG2= - 0.08 ± 0.04	0.600	3.26	0.2[d]
	ΔG1- ΔG3= - 0.17 ± 0.12	0.052		
	ΔG2- ΔG3= - 0.09 ± 0.06	0.479		

VJ: Vertical jump; SR: sit-and-reach test; SMR: Self-Myofascial Release; Δ; absolute difference between pretest and posttest; G1: SMR Group; G2: Yoga Group; G3: Control Group; SR: sit-and-reach test; ES: unbiased effect size (Cohen's d for One Way ANOVA; 0.2 = small, 0.5 = medium, 0.8 = large effect size);
$p<0.05$.

In the groups where the athletes participating in our study were randomly distributed, pairwise comparisons regarding which group's pre-test-post-test difference score was the superior concluded that there was no difference between the groups regarding any dependent variable (Table 4). According to this result, it can be said that no significant conclusion was reached regarding the values of the physical parameters discussed in our study before and after different types of exercise modalities in female athletes playing volleyball in the 12-14 age group, and the values obtained were similar to each other.

DISCUSSION AND CONCLUSION

General results show that regular yoga exercises performed for 8 weeks do not have an effect on vertical jump, sit-reach, balance and speed in volleyball players in the 12-14 age group, while SMR exercises are effective on vertical jump and speed. Although there are studies

in the literature examining the effects of certain-term (chronic) SMR and yoga practices on performance, no study comparing the effects of SMR and yoga practices has been found (Patial et al., 2019; Martínez-Aranda et al., 2024).

During the literature review, no study was found addressing the chronic effects of long-term SMR exercises on jumping performance. When studies examining the acute effects of SMR exercises on jumping performance are evaluated, it is possible to come across studies reporting that SMR exercises do not improve vertical row performance (Jones et al., 2015; Behara & Jacobson, 2017; Sağiroğlu et al., 2017; Rey et al., 2019; Romero-Franco et al., 2019; Aune et al., 2019; Chen et al., 2021; Koźlenia & Domaradzki, 2022; Barrenetxea-García et al., 2023), as well as studies showing that SMR exercises improve jumping performance (Peacock et al., 2014; Sağiroğlu 2017; Giovanelli et al., 2018; Biscardi & Acrn 2018; Biscardi et al., 2021; Wang et al., 2022; Kurt et al., 2023). The fact that SMR increases jumping performance may be due to the fact that it increases the skin temperature and the temperature of the blood flow to the muscles during exercise, just like a warm-up tool, thus preventing movement restriction, supporting ROM and increasing jumping performance (Hotfiel et al., 2017).

Miller and Rocky (2006) reported in their study where they applied 8-week (24 sessions) SMR exercises for the hamstring muscles that there was no improvement in the joint range of motion of the hip flexors. The results of this research are similar to the results of our study. However, it seems difficult to draw conclusions about the results of this study, as the researchers reported that both the control and SMR groups showed increased flexibility, and the participant group was between the ages of 18 and 32. Aune et al. (2019) in their study on the effects of 4-week SMR exercises on dosriflexion ROM, report that eccentric exercise applications are more effective on ROM than SMR applications. Another study reported that 7-week SMR application to 17-year-old male rugby players increased ROM. Researchers attribute this result to not controlling the FR tempo (Bakar et al., 2020). It can be said that a similar limitation exists in our study. Apart from this study, it appears that there are a limited number of chronic SMR studies in the literature. These SMR studies report that the applications were made for 1-4 weeks and improved flexibility (Ebrahim & Elghany, 2013; Mohr et al., 2014; Bushell et al., 2015; Junker & Stöggl, 2015). Researchers explain the development in flexibility; It is attributed to the increase in blood flow and the resulting intramuscular tissue temperature, and the changes in the tensile strength of the muscle to the decrease in intramuscular viscosity. However, studies addressing the acute effects of SMR applications report that SMR has no significant effect on flexibility 24 hours after the application (Markovic, 2015). As a result, studies have shown that

SMR improves flexibility, but it is recommended that athletes use it together with exercises such as dynamic flexibility or moderate intensity running (Martínez-Aranda, 2024).

Shalamzari et al. (2020) report that 8 weeks of SMR therapy improved dynamic balance. However, no other study was found in the literature examining the effects of long-term SMR exercises on balance. In the literature, there are studies that deal with balance performance being acutely affected by SMR exercises, while there are studies reporting that balance improves (Peacock et al., 2014; Lyu et al., 2020) and that it does not improve or is not affected (Wang et al., (2022). The contradictory results of the studies draw attention to the need for more research on this subject.

During the literature review, no study was found addressing the chronic effects of SMR exercises on speed. In this part of the study, studies examining the speed of SMR were evaluated (Peacock et al., 2014; D'Amico & Paolone 2017; Giovanelli et al., 2018; Rey et al., 2019; Rahimi et al., 2020; Lopez-Samanes et al., 2021; Wang et al., 2022; Barrenetxea-García et al., 2023). Only two of these studies show that SMR creates a statistically significant increase in speed (Peacock et al., 2014, Paolone, 2017). However, since the 800 m and 37 m speed performances of the participants were evaluated in these studies, it can be said that the results of these studies are not homogeneous and making inferences from the results may not be scientifically correct.

In our study, the main reason why the jumping performance of both the control and SMR groups improved, but not in the Yoga group; It may be that the control group showed a more motivational approach and related performance results in training in order not to fall behind the group participating in different exercise modalities.

It is possible to come across many studies examining the long-term effect of yoga on flexibility. Studies that provide evidence that it improves flexibility mostly give results for adults (Chen et al., 2010; Gonçalves et al., 2011; Gothe et al., 2014; Grabara, 2016; Wang et al., 2016; Sadler et al., 2017), Studies with adolescent participant groups, which are rare in the literature, report that long-term Yoga practices improve flexibility (Donahoe-Fillmore & Grant, 2019). It is reported that 7 weeks (2 session per week) of yoga training improves flexibility in healthy women in the 14-18 age group (Donahoe-Fillmore et al., 2010). It is stated that 8-week yoga training improves flexibility in fencers aged 10-18 (Patial et al., 2019). It is reported that 6-week yoga training improves flexibility in adolescents aged 12-14 (Nayek & Chatterjee, 2016). There appear to be contradictory results with our study. The reason for this may be that

there are no studies on trained volleyball players in the literature, and there is no study design similar to the participant group. It can be said that the flexibility development provided by regular yoga training in adolescents will not be superior to traditional flexibility exercises in volleyball.

Balance appears as a physical parameter associated with the fear of falling in old age. Therefore, the fear of falling is associated with movement restriction. Many studies can be found that approach long-term Yoga practices to overcome the fear of falling in old age (Loewenthal et al., 2023). Apart from this, long-term yoga studies consisting of adults are also reported to improve balance (Schmid et al., 2010; Hovsepian et al., 2013; Polsgrove et al., 2016). However, the number of studies that focus on balance performance and whose participants are adolescents is limited. It is reported that yoga practices performed for 8 weeks (1-3 times a week) improve balance in participants in the 10-12 age group (Donahoe-Fillmore & Grant, 2019). Another study reports that 8 weeks of yoga training improved the balance of fencers aged 10-18 (Patial et al., 2018). Another study reports that 12 weeks (1 hour per week) of yoga training applied to children aged 9-11 improved balance and flexibility skills (Berger & Stein, 2009). Research on assessing balance, strength, coordination, and flexibility after yoga practice is limited, and most studies have focused on adults (Donahoe-Fillmore & Grant, 2019). A review of the literature shows that there are contradictory results with our study. This may be because the participant group in similar studies in the literature did not consist of trained volleyball players. In our study, the main reason why balance improved in the control group but not in the Yoga group was; It may be that the control group showed a more motivational approach and related performance results in training in order not to fall behind the group participating in different exercise modalities.

The fact that yoga has a philosophy that targets a calm energy puts yoga in the background when it comes to speed development. However, it is still possible to come across studies that discuss its contribution to the development of speed. It is reported that 8-week Yoga training improves the speed of fencers aged 14-18 (Patial et al., 2019). The results of our study show that speed is not affected by regular yoga training, which is why the results are contradictory with the literature. It can be said that there is a need for more studies on this subject due to limited resources on this subject in the literature.

As a result, our study showed that yoga exercises performed regularly for 8 weeks did not contribute to vertical jump, sit-reach, balance and 20 m sprint performance in volleyball girls

aged 12-14, while self-myofascial release exercises improved jumping and balance. The number of studies examining the physical performance of long-term yoga practices in adolescents was less than 50 until 2015. However, the small number of samples in these studies and the contradictory results indicate that more studies need to be done on this subject (Khalsa & Butzer, 2016). One of the limitations of our study was the small number of athletes. Although all athletes training in the same team participated, the highest number of participants was twenty six.

Recommendations

There are no studies addressing the effects of both yoga and SMR in volleyball. More studies on this subject may contribute to the literature. Considering that if future studies are conducted with a larger number of women volleyball players, the results may be different, it may be recommended to include more studies on this subject with more participants. Trying SMR and yoga practices for different periods of durations may provide different results in the physical performance of volleyball players. In the light of the information obtained, the effects of SMR and yoga on the recovery of volleyball players can be investigated in future studies.

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CONTRIBUTION RATE	EXPLANATION	CONTRIBUTORS
Idea or Notion	*Form the research hypothesis or idea*	Hatice Aslı UYUMAZ İlbilge ÖZSU NEBİOĞLU
Design	*To design the method and research design.*	Hatice Aslı UYUMAZ İlbilge ÖZSU NEBİOĞLU
Literature Review	*Review the literature required for the study*	Hatice Aslı UYUMAZ İlbilge ÖZSU NEBİOĞLU
Data Collecting and Processing	*Collecting, organizing and reporting data*	Hatice Aslı UYUMAZ İlbilge ÖZSU NEBİOĞLU
Discussion and Commentary	*Evaluation of the obtained finding*	Hatice Aslı UYUMAZ İlbilge ÖZSU NEBİOĞLU

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Statement of Conflict

Researchers do not have any personal or financial conflicts of interest with other people and institutions related to the research.

Statement of Ethics Committee

This research was conducted with the decision of Usak University Ethics Committee numbered 163-163-20, 12.07.2023