



THE EFFECT OF 14 WEEKS STRENGTH AND SERVING EXERCISE WITH YOUNG FEMALE VOLLEYBALL PLAYERS ON TENNIS SERVING

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Abstract:

This study aims to determine the effects of strength and serving practices on serving skills performed by volleyball players who practice volleyball regularly. 30 female athletes with an average age of 16.30±0.8 years control group (CG) and 16.44±0.1 years experimental group (EG), who have been participating in volleyball practices on a regular basis for at least five years (90 min/day, three days/week), volunteered for this study. All players were randomly divided into two groups: the EG (n=15) and the CG (n=15). The participants continued attending their regular practices three times a week for 14 weeks, involving technical-tactical training and speed and agility practices required to succeed in volleyball. In addition to these practices, the EG also performed extra serving practices for another hour once a week and participated in strength workout training programs aiming to improve their upper and lower extremities on another day. At the beginning of this study, these players' anthropometric characteristics and ability to get the serve

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over the net and to serve to a target were noted before and after this 14-week program. When the physical characteristics of these groups were compared, no statistically significant differences were found ($p>0.05$). However, when the players' ability to get the serve over the net and to serve to a target were compared, statistically significant differences were found between these two groups ($p>0.05$). Finally, it was concluded that strength and serving practices, in addition to technical practices, which play a crucial role in improving performance and skills in volleyball, improved the serving skills of young female volleyball players; thus, giving extra programs to improve serving skills was found essential.

Keywords: volleyball training; female athlete; body weight exercise; skill; motor learning.

1. Introduction

Volleyball is a popular and entertaining sports branch mainly built on technical and tactical components, such as serving, setting, passing, spiking, and blocking, and involving coordination of irregular movements. The performance outcomes of this branch require high-level practicing and involvement of main and subsidiary biomotor skills. The energy sources required for technical-tactical practices and game performances in volleyball are obtained primarily from ATP-CP and anaerobic glycolysis and secondarily from aerobic systems. The serving technique plays a significant role in forming the holistic structures of the practices and achieving game performance (Silva et al., 2014).

In studies conducted with Olympic athletes, it was reported that jump serve requires 23.03 ± 3.94 m·s⁻¹ speed, tennis serve requires 12.05 ± 3.44 m·s⁻¹ speed, and jump float serve requires 11.47 ± 4.22 m·s⁻¹ speed and these all involve movements that require higher technical skills (Moras et al., 2008). The speed of the jump serve leaves less time for the opponent to take a defensive reaction. Therefore, the efficient use of jump serve has the potential and dynamics to gain points. It is reported in the literature that male players mostly prefer jump serve, and female players mostly prefer jump float serve in top leagues (Kitsiou et al., 2020). One of the primary and most significant reasons for the efficiency of this frequently preferred technique is that it is applied at maximum speed through a well-practiced and correct technique. Therefore, the efficient development of strength skills through a proper workout regimen, which is one of the main biomotor skills, is also essential. In the tennis serve, the internal rotation of the glenohumeral joint, extension speed of the elbow, strength, and torque are less efficient when compared to the jump serve (Reeser et al., 2010). On the other hand, the error rate is higher in jump serve when compared to tennis serve (Agelonidis, 2004). A successful jump serve is associated with the speed and height of the ball, while an efficient tennis serves mostly depends on the ball's course through the air and hitting the targeted point (Huang & Hu, 2007).

The neuromuscular system is highly needed within the processes of complex techniques of volleyball that require short-term higher skills (Häkkinen, 1993). When the serving technique, physiological characteristics, and the types of biomotor skills, which play a significant role in performance outcomes and game results, were analyzed, it was concluded that volleyball players need to have speed, agility, muscular upper and lower extremity strength, and maximum aerobic strength obtained from accurately planned and implemented practices (Gabbet, 2008). When the acute and chronic effects of practices were analyzed in detail, it was found that to practice the skills for hitting a target that develops in parallel with the serving speed, the training method suitable for biomotor skills to be improved, energy systems, and proper resting periods should be implemented. When the literature was reviewed considering these explanations on the main principles of the science of athletic training, it was found that there were no studies analyzing the results of combined long-term targeting practices and strength workouts based on specific age and gender groups. Therefore, this study aims to analyze the effects of technical practice sessions and strength workout programs for improving serving skills in addition to other regular volleyball practices. The hypothesis of this study is designated as follows: strength workouts and serving practices increase the rate of hitting the target with a tennis serve.

2. Methods

2.1. Participants

30 female volleyball players with an average age of 16.30 ± 0.8 years control group (CG) and 16.44 ± 0.1 years experimental group (EG), an average height of 168 ± 5 cm CG, and 171 ± 6 cm EG, an average weight of 59.5 ± 4.6 kg CG, and 61.7 ± 8.0 kg EG, and years in active sports 5.93 ± 1.10 years CG, and 6.07 ± 1.39 years EG, who has been participating in volleyball practices on a regular basis, volunteered for this study. These players have been practicing three days a week and 90 minutes a day on a regular basis. This study was designed based on the Principles of the Helsinki Declaration and approved by the Ethics Committee of Uşak University (no: 97627247-050.99-8889 2016-08). The participants' parents were properly informed, and they signed the volunteering form.

2.2. Anthropometric Measurements

The participants' heights were measured barefoot with seca measuring tape with 1 mm precision; they were weighed only with their shorts and t-shirts on a digital scale.

2.3. Experimental Design

The experimental design of our study was structured as a randomized, controlled chronic study. The participants were randomly divided into two groups: EG (n=15) and CG (n=15). At the beginning of this study, the players' ability to get the serve over the net and to serve to a target was noted as a pre-test and post-test. All participants continued to attend their regular volleyball practices three times per week and 90 minutes per day for

14 weeks. In addition to these practices, the EG also performed extra tennis serving practices for another hour once a week and participated in 1-hour strength workout aiming to improve their upper and lower extremities on another day.

2.4. Training Program

The additional serving practices for EG were planned as follows: 5 minutes for warming up, 10 minutes for dynamic stretching, 40 minutes for the main phase, and 5 minutes for cooling down. Within the 40-minute main phase period, the players practiced on the wall to improve their arm swing techniques and continued to serve to the specified targets on the opposite side. The strength workouts mainly focused on muscular groups in the lower and upper extremities. The sets, repetitions, and rest periods of strength workouts for the upper and lower extremities are given in Table 1.

2.5. Test for Services Hitting the Target

All players went through tests with 5-minute resting times in between in order to measure their serving performances at the beginning of the study and at the end of the 14-week training program. During these tests, first, the players were asked to serve 20 times to the opposite side of the court, and the number of tennis serves going over the net was noted; then, they were asked to serve 20 times to the marked areas on the opposite side of the court (areas 1, 3, 5, and 6) and the number of tennis serves to hit the targets was noted (Figure 1).

Figure 1: The areas where the participants will serve, the positions of the targets (gray areas), and the directions of the services (dotted arrows)

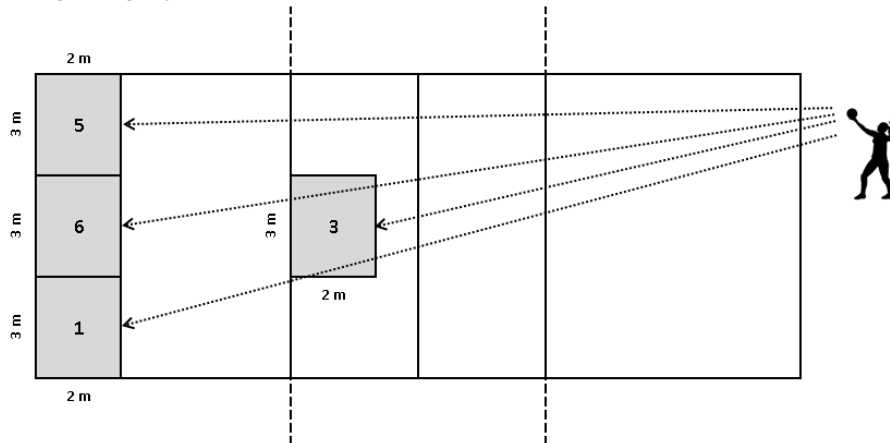


Table 1: The Strength Training Program for Lower and Upper Extremities

Exercises for Lower Extremities	1 st and 2 nd Weeks	3 rd and 4 th Weeks	5 th and 6 th Weeks	7 th and 8 th Weeks	9 th and 10 th Weeks	Between 11 th and 14 th Weeks
Vertical Jump	3 x 10 x 30 s.	3 x 15 x 30 s.	-	-	-	-
Jumping Back and Forth over a Line	3 x 10 x 30 s.	3 x 15 x 30 s.	-	-	-	-
Jumping Sideways over a Line	3 x 10 x 30 s.	3 x 15 x 30 s.	-	-	-	-
Jumping over Disc Cones	3 x 10 x 30 s.	3 x 15 x 30 s.	-	-	-	-
Jumping over Disc Cones on Right Foot	3 x 10 x 30 s.	3 x 10 x 30 s.	3 x 10 x 30 s.	3 x 10 x 30 s.	3 x 10 x 30 s.	3 x 10 x 30 s.
Jumping over Disc Cones on Left Foot	3 x 10 x 30 s.	3 x 10 x 30 s.	3 x 10 x 30 s.	3 x 10 x 30 s.	3 x 10 x 30 s.	3 x 10 x 30 s.
Jumping Forward, Rightward, and Leftward on Both Feet	3 x 10 x 30 s.	3 x 10 x 30 s.	3 x 15 x 45 s.	3 x 15 x 45 s.	3x20 x 1 min.	3 x 20 x 1 min.
Jumping Forward, Rightward, and Leftward on Right Feet	3 x 10 x 30 s.	3 x 10 x 30 s.	3 x 10 x 30 s.	3 x 10 x 30 s.	-	-
Jumping Forward, Rightward, and Leftward on Left Feet	3 x 10 x 30 s.	3 x 10 x 30 s.	3 x 10 x 30 s.	3 x 10 x 30 s.	-	-
Jumping from Hoop to Hoop	3 x 10 x 30 s.	3 x 10 x 30 s.	-	-	-	-
Jumping Forward by Using the Arm Swing	3 x 8 x 1 min.	3 x 8 x 1 min.	-	-	-	-
Jumping over the Cones	3 x 6 x 1 min.	3 x 8 x 1 min.	3 x 8 x 1 min.	3 x 8 x 1 min.	3 x 8 x 1 min.	3 x 8 x 1 min.
Box Jumps	-	-	2 x 8 x 1 min.	2 x 10 x 1 min.	3 x 10 x 1 min.	3 x 10 x 1 min.
Skip Rope	-	-	3 x 20 x 30 s.	3 x 30 x 30 s.	3 x 40 x 1 min.	3x 50 x 1 min.
Skip Rope on Right Foot	-	-	3 x 20 x 30 s.	3 x 530 x 30 s.	3 x 40 x 1 min.	3x 50 x 1 min.
Skip Rope on Left Foot	-	-	3 x 20 x 30 s.	3 x 30 x 30 min.	3 x 40 x 1 min.	3 x 50 x 1 min.
Squat	2 x 15 x 1 min.	2 x 20 x 1 min.	2 x 25 x 1 min.	2 x 25 x 1 min.	2 x 30 x 1 min.	2 x 30 x 1 min.
Squat Jumps	-	-	2 x 6 x 1 min.	2 x 7 x 1 min.	2 x 8 x 1 min.	2 x 8 x 1 min.
Split Squats	-	-	-	-	3 x 6 x 2 min.	3 x 8 x 2 min.
Exercises for Upper Extremities	1st Meso (1 kg medicine ball)		2nd Meso (2 kg medicine ball)		3rd Meso (3 kg medicine ball)	
Overhead Medicine Ball Toss Using Both Hands	2 x 10 x 2 min.		2 x 10 x 2 min.		2 x 10 x 2 min.	
Overhead Medicine Ball Toss Using the Right Hand	2 x 10 x 2 min.		2 x 10 x 2 min.		2 x 10 x 2 min.	
Overhead Medicine Ball Toss Using the Left Hand	2 x 10 x 2 min.		2 x 10 x 2 min.		2 x 10 x 2 min.	

Waist Level Medicine Ball Toss	2 x 10 x 2 min.	2 x 10 x 2 min.	2 x 10 x 2 min.
Backward Medicine Ball Toss	2 x 10 x 2 min.	2 x 10 x 2 min.	2 x 10 x 2 min.
Overhead Medicine Ball Toss on the Knees	2 x 10 x 2 min.	2 x 10 x 2 min.	2 x 10 x 2 min.
Overhead Medicine Ball Toss in Sitting Position	2 x 10 x 2 min.	2 x 10 x 2 min.	2 x 10 x 2 min.
Chest Throws in a Sitting Position	2 x 10 x 2 min.	2 x 10 x 2 min.	2 x 10 x 2 min.
Bench Press with a Medicine Ball	2 x 10 x 2 min.	2 x 10 x 2 min.	2 x 10 x 2 min.
Sit-ups with a Medicine Ball	2 x 10 x 2 min.	2 x 10 x 2 min.	2 x 10 x 2 min.

(Number of sets x repetitions x rests)

2.6. Statistical Analysis

IBM SPSS (v.20) software (IBM, Armonk, NY; 2011) was used for data analysis in this study. The data's suitability for normal distribution was evaluated through the Shapiro-Wilk test, considering the skewness/kurtosis values. An unpaired Student t-test was used to find whether there were any differences among the descriptive statistics of the participants. The EG and CG participants in this study formed the intergroup factor of the study; the test time (pre-test and post-test) formed the intragroup factor of the study. Whether there was an interaction between the group and the time was evaluated by a 2x2 (group x time) generalized linear model two-factor mixed design variance analysis (ANOVA) test. The degrees of freedom were not corrected since none of the variables violated the sphericity hypothesis. The homogeneity of the variances among independent groups was tested using the Levene test. The intragroup pre-test and post-test differences were determined by paired student t-test; the intergroup differences in pre-test and post-test target hitting values were determined by unpaired student t-test. The effect sizes for these tests were reported in accordance with Cohen's classification. The statistical significance level was taken as $p \leq 0.05$ for all analyses, and the experimental strength of all statistical analyses was stated.

3. Results

When the descriptive statistics of the participants were compared, no significant differences were found between these two groups ($p > 0.05$). These results show that all players have similar physical characteristics (Table 2).

The variance analysis test results showed group and time interaction for all dependent variables (Table 3). In conclusion, the changes observed in the EG group showed a significant difference compared to those observed in the CG.

Table 2: Descriptives Statistics of Participants.

Variables	Groups	Mean±SD	<i>p</i>
Age (years)	CG	16.30±0.8	1.00
	EG	16.44±0.1	
Sport Age (years)	CG	5.93±1.10	0.773
	EG	6.07±1.39	
Height (cm)	CG	168.04±0.5	0.205
	EG	171.23±0.6	
Mass (kg)	CG	59.5±4.6	0.349
	EG	61.7±8.0	

Mean; Arithmetic average, SD; Standard deviation, CG; Control group, EG; Experimental Group

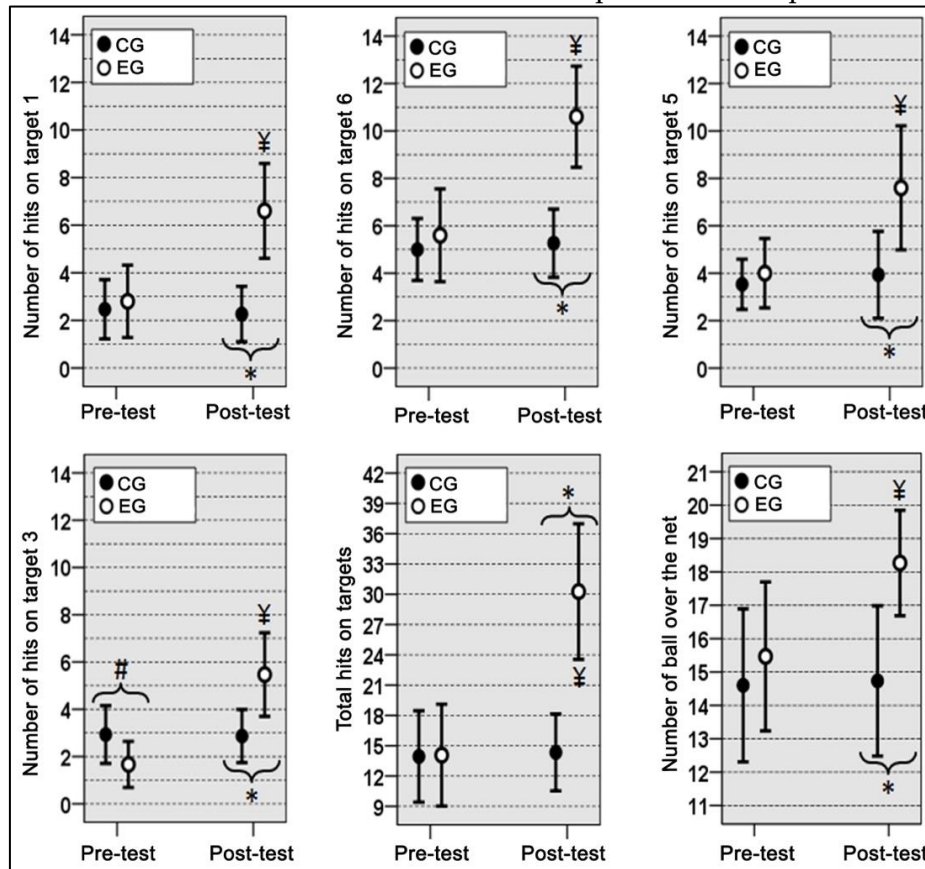
Table 3: The Statistical Analysis Results Showing the Group and Time Interaction for the Dependent Variables Analyzed.

Variable	Statistical Analysis Results
Hitting the Target in Area 1	F(1; 28) = 86.6; $p < 0.001$; $\eta_p^2 = 0.76$
Hitting the Target in Area 6	F(1; 28) = 88.9; $p < 0.001$; $\eta_p^2 = 0.76$
Hitting the Target in Area 5	F(1; 28) = 27.2; $p < 0.001$; $\eta_p^2 = 0.49$
Hitting the Target in Area 3	F(1; 28) = 72.5; $p < 0.001$; $\eta_p^2 = 0.72$
Total Hits	F(1; 28) = 26.7; $p < 0.001$; $\eta_p^2 = 0.50$
Serves over the Net	F(1; 28) = 26.7; $p < 0.001$; $\eta_p^2 = 0.5$

* $p < 0.05$. η_p^2 ; Partial Eta Effect Size

In this study, hitting the target in the area 1 parameter was found as EG 3.8±1.0 and CG 0.2±1.0. A significant difference was found in EG compared to CG ($p=0.001$; ES=3.31). In hitting the target in the area 6 parameter, EG was found to be 5.0±1.5, and CG was found to be 0.3±1.3. A statistically significant difference was found in EG compared to CG ($p=0.001$; ES=3.35). In hitting the target in the area 5 parameter, EG was found to be 3.6±1.9, and CG was found to be 0.4±1.5. A statistically significant difference was found in EG compared to CG ($p=0.001$; ES=1.85). In hitting the target in the area 3 parameter, EG was found to be 3.8±1.3, and CG was found to be -0.1±1.2. A statistically significant difference was found in EG compared to CG ($p=0.001$; ES=3.02). In total hit parameter, EG was found to be 0.4±2.8 and CG was found to be 16.0±2.5, and statistically significant increases were observed ($p=0.001$; ES= 5.78). The number of serves over the net was found as 2.8±1.1 in EG and 0.1±1.6 in CG, and a significant difference was found in favor of EG ($p=0.001$; ES_1.87). No statistically significant differences were found in CG's post-test values ($p>0.05$) (Figure 2).

Figure 2: Comparison of Pre-Practice and Post-Practice Period Performance data of Control and Experiment Groups



*; Statistically significant difference between the post-test values of the groups ($p < 0.001$), #; Statistically significant difference between the pre-test values of the groups ($p = 0.004$), ¥; Statistically significant difference between the pre and post-test values of the experiment group ($p < 0.001$). Error bars represent the “ \pm standard deviation”.

At the end of this study, the rate of change in EG's target hitting was found to be more than the rate of change in CG's target hitting. In addition, the effect size of the intergroup differences in dependent variables was also found to be higher (Table 4).

Table 4: Intergroup Comparison of the Changes Found in Post-Practice Period Target Hitting Values

Variables	Group	Δ (Mean \pm SD)	p	ES	[%95 CI]	1- β
Target Hit at Area 1	CG	-0.2 \pm 1.0	0.001*	3.31	2.21 – 4.41	1.00
	EG	3.8 \pm 1.3				
Target Hit at Area 6	CG	0.3 \pm 1.3	0.001*	3.35	2.24 – 4.46	1.00
	EG	5.0 \pm 1.5				
Target Hit at Area 5	CG	0.4 \pm 1.5	0.001*	1.85	1.02 – 2.69	0.99
	EG	3.6 \pm 1.9				
Target Hit at Area 3	CG	-0.1 \pm 1.2	0.001*	3.02	1.99 – 4.06	1.00
	EG	3.8 \pm 1.3				

Total Target Hit	CG	0.4±2.8	0.001*	5.78	3.90 – 7.67	1.00
	EG	16.0±2.5				
Serves Over the Net	CG	0.1±1.6	0.001*	1.87	1.03 – 2.7	0.99
	EG	2.8±1.1				

*; Statistically significant difference, Δ ; change in the number of hits (post-test - pre-test), Mean; Arithmetic average, SD; Standard deviation, ES = Effect size (Hedge's d ; < 0.2 = insignificant, $0.2 \leq d \leq 0.5$ = minor, $0.5 \leq d \leq 0.8$ = medium, > 0.8 = high impact level), CI = confidence interval, $1-\beta$ = experimental power.

4. Discussion

This study aims to analyze the effects of additional strength and tennis serve practices on tennis serve target hit performance in young female volleyball players who practice volleyball regularly. The hypothesis of this study is designated as follows: various strength workouts targeting the lower and upper extremities and tennis serving practices, in addition to regular volleyball practices, will increase the rate of tennis serve target hitting. Our findings showed statistically significant differences between serving to targets at area 1, area 6, area 5, and area 3, total hits, and serves over the net parameters between EG and CG ($p < 0.05$).

Various researchers suggested that the timing/scheduling and contents of the practice sessions should include a lot of repetitions in order to create a high-level motor learning infrastructure (D'Isanto et al., 2017). When the distribution of various biomotor skills that form serving techniques was analyzed, the importance of strength and strength workouts became prominent. When it comes to serving the ball to a specific target, it becomes necessary to use explosive strength in the upper extremities, work for the primary and secondary muscular groups together, and ensure intramuscular and intermuscular coordination. The main acquisition of strength workouts is to minimize the number of technical mistakes made by young athletes. The reasons for these mistakes were reported as the failure to teach these technical properties accurately and the inadequacy of strength skills in muscular groups used in coordination and movements (Marques et al., 2009; de Villarreal et al., 2008).

In their long-term research on skills development, Gabbett et al. (2006) detected an improvement in serves hitting the target. At the same time, they also reported that they could not find any significant differences in upper and lower extremity muscle strength. In another study, which focused only on strength skills, it was reported that forearm strength skills were not always related to effective serving skills, and thus, complex outcomes were found (Czarny et al., 2014).

In addition to these studies, another study focused on tennis serving skills practiced under changing and permanent conditions reported that the practices under changing conditions were more effective in target hitting and speed parameters (Hernández-Davo et al., 2014). Technical practices performed under changing conditions

provide better improvements than fixed conditions because of foot support soles, the player's position on the court, and spatial orientation, which are considered significant data (Hernández-Davo et al., 2014). In another study, where the effects of games played in a confined space and instructive practice methods on young female volleyball players were studied, it was reported that the games played in a confined place were found more effective than traditional instructive practices for serving and other skills parameters (Trajkovic et al., 2017). Finally, another study focused on core workout programs reported significant improvements in services hitting the target and serving speed (Yapıcı, 2019).

The structural integrities of overall strength, muscular endurance, and core workout programs performed by the participants for fourteen weeks were built on the long-term effects of these practices. The results obtained from the integrations with experience processes and serving skills provide an academic explanation of the interaction between improved strength and serving skills. Strength and other similar skills, which are important biomotor skills to increase individual and team performances, should be practiced accurately within the annual practice plans for volleyball. Forming the kinetic chains, particularly for young athletes, and developing different strength skills together with postural integrity play a significant role in obtaining higher performance outcomes.

5. Conclusion

As a result, combining strength training and serving practices instead of focusing on only one of these practices in volleyball had a positive effect on reaching the goal with tennis service. We believe that this results from the effects of balanced and gradual strength workouts on the neuromuscular system and motor learning. Therefore, strength workouts and service practices in volleyball should be planned daily, weekly, monthly, and yearly, considering the exercise-rest relationships. The results obtained from these protocols should be checked and maintained through different tests on the court.

Conflict of Interest Statement

The authors declare that they have no conflicts of interest.

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References

- Ageloniadis, Y. (2004). The jump serve in volleyball: From oblivion to dominance. *Journal of Human Movement Studies*, 47(3), 205-214.
- Czarny, W., Bajorek, W., Król, P., Rzepko, M., Bobula, G., & Hałoń, P. (2014). Effect of strength on serving effectiveness in volleyball. *Scientific Review of Physical Culture*, 4(1), 31-37.
- D'Isanto, T., Altavilla, G., & Raiola, G. (2017). Teaching method in volleyball service: intensive and extensive tools in cognitive and ecological approach. *Journal of Physical Education and Sport*, 17, 2222-2227.
- de Villarreal, E. S. S., González-Badillo, J. J., & Izquierdo, M. (2008). Low and moderate plyometric training frequency produces greater jumping and sprinting gains compared with high frequency. *The Journal of Strength & Conditioning Research*, 22(3), 715-725.
- Gabbett, T. J. (2008). Do skill-based conditioning games offer a specific training stimulus for junior elite volleyball players? *The Journal of Strength & Conditioning Research*, 22(2), 509-517.
- Gabbett, T., Georgieff, B., Anderson, S., Cotton, B., Savovic, D., & Nicholson, L. (2006). Changes in skill and physical fitness following training in talent-identified volleyball players. *The Journal of Strength & Conditioning Research*, 20(1), 29-35.
- Häkkinen, K. (1993). Changes in physical fitness profile in female volleyball players during the competitive season. *The Journal of Sports Medicine and Physical Fitness*, 33(3), 223-232.
- Hernández-Davo, H., Urbán, T., Sarabia, J. M., Juan-Recio, C., & Javier Moreno, F. (2014). Variable training: effects on velocity and accuracy in the tennis serve. *Journal of Sports Sciences*, 32(14), 1383-1388.
- Huang, C., & Hu, L. H. (2007, December). Kinematic analysis of volleyball jump topspin and float serve. *In ISBS-Conference Proceedings Archive*.
- Kitsiou, A., Sotiropoulos, K., Drikos, S., Barzouka, K., & Malousaris, G. (2020). Tendencies of the volleyball serving skill with respect to the serve type across genders. *Journal of Physical Education and Sport*, 20(2), 564-570.
- Marques, M. C., Van den Tillaar, R., Gabbett, T. J., Reis, V. M., & González-Badillo, J. J. (2009). Physical fitness qualities of professional volleyball players: determination

- of positional differences. *The Journal of Strength & Conditioning Research*, 23(4), 1106-1111.
- Moras, G., Peña, J., Rodríguez, S., Vallejo, L., Tous-Fajardo, J., & Mujika, I. (2008). A comparative study between serve mode and speed and its effectiveness in a high-level volleyball tournament. *Journal of Sports Medicine and Physical Fitness*, 48(1), 31.
- Reeser, J. C., Fleisig, G. S., Bolt, B., & Ruan, M. (2010). Upper limb biomechanics during the volleyball serve and spike. *Sports Health*, 2(5), 368-374.
- Silva, M., Lacerda, D., & João, P. V. (2014). Game-related volleyball skills that influence victory. *Journal of Human Kinetics*, 41, 173.
- Trajkovic, N., Kristicevic, T., & Sporis, G. (2017). Small-sided games vs. instructional training for improving skill accuracy in young female volleyball players. *Acta Kinesiologica*, 11(2), 72-76.
- Yapıcı, A. (2019). Effects of 6 weeks core training on balance, strength and service performance in volleyball players. *European Journal of Physical Education and Sport Science*.

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