



The Effects of an 8-Week Strength Training Toward the Specific Preparation Phase on Male Volleyball Athletes' Performance

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Abstract

Background. Training programs are part of training management that need to be properly and correctly prepared and implemented.

Study purpose. The aim of the study was to evaluate the effects of an 8-week program of resistance training, carried out at a specific preparation phase, on the performance of male junior volleyball athletes.

Materials and methods. This study was conducted as experimental research, with a sample of 24 male volleyball athletes ([mean ± SD] age: 17.96 ± 1.23 years; body weight: 75.56 ± 7.80 kg; height: 180.46 ± 7.14 cm; body fat: 17.62 ± 3.36%) who were randomly divided into experimental group (EG): n = 12 and control group (CG): n = 12. The training program lasted for eight weeks and took place at a specific preparation phase.

Results. There was a significant increase in the indicators handgrip dynamometer left ($p < 0.014$), handgrip dynamometer right ($p < 0.001$), vertical jump ($p < 0.001$), sit-and-reach test ($p < 0.000$), leg dynamometer ($p < 0.000$), and back dynamometer ($p < 0.001$) in the experimental group after being given strength training treatment for eight weeks.

Conclusions. When strength training is included in volleyball training, it can increase the performance in power, strength, and flexibility, especially when carried out at a specific preparation phase. Incorporating targeted stimuli, such as strength training, into training sessions appears to be a secure method of training for this age group and may help to contribute to continuous and gradual improvements in neuromuscular adaptation.

Keywords: volleyball, performance, strength training.

Introduction

The biomotor component significantly influences performance during training and competition. In volleyball, athletes' success hinges on their biomotor components, encompassing strength, explosive power, speed, flexibility, and agility (Lehnert et al., 2017). Athletes are tasked with enhancing their performance through the development of these biomotor components (Salafi et al., 2023). According to Blumenstein & Orbach (2020), training represents a systematic process aimed at optimizing athletes' performance. A literature review suggests that achieving

Olympic champion or international athlete status in a specific sport necessitates approximately ten years or 10,000 hours of effective and structured training (Haugen, Seiler, Sandbakk, & Tønnessen, 2019). The attainment of remarkable athletic feats is inseparable from the coach's guidance, a well-designed training program, and the harmonious integration of various factors.

An effective training regimen should have well-defined objectives, encompassing the enhancement of physical, technical, and psychological skills (Blumenstein & Orbach, 2020). Schroepf & Lames (2018) emphasize that the aim of training is to elevate performance, enhance athletes' competence, and refine planning strategies and self-control (Peng, Othman, Yuan, & Liang, 2022; Wee & Dillon, 2022). Consequently, effective training entails clear goals, objectives, and systematic implementation. To ensure an ideal training process, exercises should adhere to the principles of

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periodization. Periodization is crucial for optimizing athlete performance, involving the segmentation of training phases into focused segments. It has emerged as a vital planning paradigm for advancing athlete performance, shaping beliefs and coaching traditions through the application of comprehensive scientific knowledge and significant advancements in the fields of nutrition, technical, and physical training (Kiely, 2018; Otte, Millar, & Klatt, 2019).

Bompa and Buzzichelli (2019:93) delineate that training periodization comprises two pivotal components: (1) annual training periodization planning and (2) dominant biomotor periodization. The annual training periodization encompasses three phases: (1) the preparatory phase, (2) the competition phase, and (3) the transition phase. Moreover, the preparatory phase is further divided into the general preparation phase and the specific preparation phase. During the specific preparation phase, training is concentrated on cultivating specialized physical and dominant biomotor components (Bompa & Buzzichelli, 2019).

The specific preparation period entails training that targets specific physical and technical abilities within a particular sport, with the aim of enhancing performance. As per Blumenstein & Orbach (2020), the objective of this phase is to optimize the athlete's physical development in alignment with the physiological and physical demands of the activity. This phase is characterized by substantial training loads, high training intensity, and the refinement of targeted techniques (Bompa & Buzzichelli, 2019). In team sports, the training endeavors to cultivate techniques, tactics, and physical attributes based on the sport's characteristics in readiness for the pre-competition phase. When it comes to developing physical abilities, it is acknowledged that resistance training can contribute to improved muscle adaptations, encompassing endurance, hypertrophy, strength, and muscle power. However, the extent of the impact of resistance training on muscle adaptation varies significantly based on the training modality employed, with muscle adaptation being contingent on various factors such as training intensity, volume (reps, sets), rest periods, movement rhythm, and more.

The resistance training program is a crucial component of training management that must be carefully prepared and executed. A key aspect of developing a resistance training program involves determining the training dosage and adjusting the training periodization to enhance the athlete's performance and ensure it aligns with the target. At the time this research was conducted, there was a scarcity of reference sources in the field of volleyball resistance training. The existing research on volleyball resistance training predominantly focused on elite athletes or those with extensive training, resulting in a lack of literature addressing resistance training for junior athletes. Additionally, there was limited information available on the influence of resistance training across different training phases. Therefore, this study aimed to investigate whether incorporating strength training alongside technical and tactical training exercises during the specific preparation period can impact the physical performance of junior volleyball athletes. The research sought to evaluate the effects of an eight-week strength training program, conducted within a specific preparation phase, on the performance of junior male volleyball players.

Materials and methods

Participants

The sample of this study involved 24 male volleyball athletes, with the following characteristics: mean age of 17.96 ± 1.23 years, weight of 75.56 ± 7.80 kg, height of 180.46 ± 7.14 cm, and body fat percentage of $17.62 \pm 3.36\%$. The participants were randomly divided into two groups: the experimental group (EG) consisting of 12 athletes, and the control group (CG) also consisting of 12 athletes, with an equal number of athletes per position in each group. These junior athletes were in preparation for the Regional Sports Week and had completed the general preparatory phase of training.

Experimental design

This research was designed to answer two questions: (1) Is there an effect of Strength Training (ST) on the performance of male volleyball athletes in the specific preparation phase? (2) How big is the effect (ES) before and after giving the intervention to each group? To investigate these questions, the EG was given strength training interventions, technical/tactical training, and friendly matches. Meanwhile, the CG received technical/tactical training interventions and friendly matches.

During an intensive eight-week preparatory period, the study focused on a mesocycle plan that included strength training for the EG and tactical and technical training for volleyball matches. The distribution of training sessions over the eight weeks is illustrated in Table 1. The technical/tactical training model encompassed various aspects such as serving, passing, smashing, blocking, defending, and attacking. Meanwhile, the strength training model, which comprised five phases, involved gym-based exercises utilizing body weight and equipment (free-weights and machines). These phases included static and dynamic stabilization, anatomical adaptation, maximum strength, and power. To regulate exercise intensity, the researchers employed heart rate control and 1 Repetition Maximum (RM) testing. Throughout the study, the training program's intensity ranged from 40% to 80% of 1 RM.

Testing procedure

The testing session was conducted at the same place and time (± 2 hours) for each participant in the same condition, without injury, and not after a match or high-intensity training. Body composition was also measured during the testing. Throughout the exam, participants received a lot of verbal encouragement to put forth their best effort. The participants were instructed to stretch for around fifteen minutes before the exam.

Vertical Jump (VJ)

The Vertical Jump test is utilized to assess athletes' jumping performance and indirectly measure lower body strength in the vertical plane (Banda, Beitzel, Kammerer, Salazar, & Lockie, 2019). The necessary tools for conducting this test include a board attached to the wall at a height ranging from 150 to 350 cm, powdered chalk or flour, and a blackboard eraser. Initially, the fingertips are coated with lime powder or

Table 1. Training sessions distribution in the intervention period

Days	Period	Week 1-2	Week 3-4	Week 5-6	Week 7-8
Monday	Morning	ST (EG)/ TTT (CG)	TTT	ST+TTT (EG)/ TTT (CG)	ST+TTT (EG)/ TTT (CG)
	Evening	TTT	TTT	OFF	TTT
Tuesday	Morning	OFF	ST (EG)/TTT(CG)	OFF	OFF
	Evening	TTT	OFF	TTT	TTT
Wednesday	Morning	OFF	TTT	OFF	ST (EG)/ TTT (CG)
	Evening	OFF	TTT	ST (EG)/TTT(CG)	OFF
Thursday	Morning	ST (EG)/ TTT (CG)	OFF	OFF	OFF
	Evening	OFF	OFF	FM	FM
Friday	Morning	TTT	ST (EG)/TTT(CG)	OFF	OFF
	Evening	OFF	OFF	OFF	OFF
Saturday	Morning	TTT	TTT	TTT	TTT
	Evening	OFF	FM	FM	FM
Sunday	Morning	OFF	OFF	OFF	OFF
	Evening	OFF	OFF	OFF	OFF
N Sessions		6	8	6	7

*Legend: ST: Strength Training; TTT: Tactic/Teknik Training; FM: Friendly Matches; CG: Control Group; EG: Experimental Group.

magnesium carbonate, after which the participant stands upright near the wall with feet together and scales the board to the left or right. Subsequently, the palm of the hand near the wall is placed on a calibrated board to create a reach mark, followed by raising the hand straight up. The exercise begins with participants assuming a bowed knee position, while the dominant hand or arm is raised vertically, and the other arm is held alongside the body, with any swinging motion to aid in leaping momentum strictly prohibited. The players then leap as high as possible, tapping their fingers against the board to leave a mark. The assessment involves calculating the difference between the jumping achievement and standing achievement. Each participant is given two opportunities to perform this test, and the coach records the best results.

Leg and Back Dynamometer

The leg dynamometer (LD) is an equipment used to assess the static strength of leg muscles. In the meanwhile, the back dynamometer (BD) is designed to assess the static strength of the back muscles. The method for making decisions on this test is by recording the highest weight of the three lifting occasions in kg, with an accuracy level of 0.5 kg.

Handgrip dynamometer

The handgrip dynamometer is utilized to assess hand squeeze strength in both the left and right hands. Participants begin by standing upright with their feet positioned shoulder-width apart. Subsequently, one hand grips the dynamometer in a straight position beside the body, with the palm facing toward the thigh and the dynamometer handgrip facing outward. The individual then pulls the dynamometer handgrip lever with maximum force. It is important to ensure that the hand holding the dynamometer handgrip remains straight and does not make contact with any other objects. This test may be repeated twice, with the highest recorded value in kilograms being considered each time. Both hands undergo the same test using the Handgrip Dynamometer Right (HD R) and Handgrip Dynamometer Left (HD L).

Sit and Reach (S&R)

The sit and reach test are used to assess flexibility performance. The athletes sit with their feet about hip-width apart against the testing box. Knees are stretched, right hand over left, and they gently reach forward as far as they can by sliding their hands over the measurement board. Participants get two opportunities to carry out this test and the best result from this test will be chosen.

Statistical analysis

The data analysis approach in this study includes: (1) a description test; (2) a normality test, employing the Shapiro-Wilk test to assess the normality of the data distribution; and (3) the homogeneity test was utilized to determine the uniformity of variations in the population. This test used Levene's Test with the F test to examine the comparability of variances in the pretest and posttest experimental group data. It was carried out to ascertain whether the data distribution (variance) of the two experimental groups was homogeneous and balanced for comparison. If the Levene test findings indicate a significance value of $p > 0.05$, the data distribution (variance) of the two experimental groups is considered homogeneous (4). To identify any differences in variables between the pretest and posttest in the experimental group, a t-test was conducted. A significance value smaller than 0.05 ($P < 0.05$) indicates a distinction in the results of the analysis. The pretest and posttest data underwent statistical discrete analysis using the t-test and version 27 of SPSS, with the significance level set at 5% (equivalent to 0.05). The effect scope was assessed using Cohen's d-test subsequent to the t-test analysis, both before and after the implementation of the intervention. The criteria used to evaluate the magnitude of ES (Hopkins, Marshall, Batterham, & Hanin, 2009) were: small effect= 0.2; medium effect= 0.5, and large effect= 0.8.

Table 2. Comparison of anthropometric data between the pre- and post-groups

Variables	Experimental Group (n = 12)				Control Group (n = 12)			
	Pre-Training Mean±SD	Post Training Mean±SD	P	E.S.	Pre-Training Mean±SD	Post Training Mean±SD	P	E.S.
Body Mass (kg)	76.46±7.08	74.58±7.56	0.003	1.11	74.65±8.67	74.33±8.84	0.078	0.55
Body Fat (%)	17.85±3.45	16.31±3.2	0.000	1.69	17.37±3.39	17.36±3.60	0.952	0.06
Height (cm)	181.67±6.09	-	-	-	179.25±8.13	-	-	-

Results

The body composition of the two groups at the commencement and conclusion of the intervention is presented in Table 2. The experimental group exhibited statistically significant variations in body mass and body fat. In contrast, the control group exhibits negligible alterations across all variables.

Based on measurements of the athlete's power, strength, and flexibility abilities before and after being given strength training treatment, a statistical picture was obtained as shown in Tables 3 and 4.

Table 3. Statistical Description of Pre-Test Score

Groups	Variables	Pre-test			
		Mean	SD	Min	Max
EG	HD (L)	44.80	8.37	30.70	55.30
	HD (R)	46.81	6.44	37.00	54.00
	VJ	23.00	2.82	19.60	28.90
	S&R	32.40	3.40	26.40	37.30
	LD	184.58	46.20	135.00	295.00
	BD	120.41	12.37	100.00	150.00
CG	HD (L)	37.45	6.62	29.00	51.00
	HD (R)	40.30	5.99	31.00	48.00
	VJ	20.32	3.19	17.00	26.20
	S&R	29.44	2.29	25.00	32.00
	LD	130.83	34.59	90.00	200.00
	BD	100.75	22.16	52.00	132.00

Table 4. Statistical Description of Post-Test Score

Groups	Variables	Post-test			
		Mean	SD	Min	Max
EG	HD (L)	49.49	11.23	25.00	65.30
	HD (R)	52.68	5.34	43.90	60.20
	VJ	26.64	2.34	22.30	30.10
	S&R	35.90	3.30	30.00	40.20
	LD	193.91	46.06	140.00	300.00
	BD	127.33	12.66	103.00	152.00
CG	HD (L)	37.63	6.31	30.00	49.90
	HD (R)	42.40	5.73	30.80	49.50
	VJ	23.59	4.27	17.50	29.70
	S&R	30.93	3.92	23.00	36.20
	LD	130.91	36.45	99.00	93.00
	BD	103.25	22.16	24.06	135.00

Normality results

The normality test used the Shapiro-Wilk test. Table 5 explains that all data were normally distributed because all results have significant values > 0.05.

Table 5. The Normality Test Results

Groups	Variables	Pre-test		Post-test	
		s-w	P	s-w	P
EG	HD (L)	0.923	0.313	0.946	0.581
	HD (R)	0.874	0.074	0.915	0.246
	VJ	0.895	0.136	0.936	0.446
	S&R	0.966	0.865	0.935	0.433
	LD	0.888	0.112	0.911	0.218
CG	BD	0.923	0.312	0.978	0.972
	HD (L)	0.940	0.503	0.931	0.392
	HD (R)	0.927	0.349	0.946	0.584
	VJ	0.869	0.064	0.924	0.325
	S&R	0.886	0.105	0.941	0.507
	LD	0.932	0.406	0.897	0.146
	BD	0.906	0.188	0.874	0.073

Homogeneity results

The homogeneity test used the Levene Statistics test. Table 6 explains that all data were homogeneously distributed because all results obtained significant values > 0.05.

Table 6. The Homogeneity Test Results

Groups	variables	Levene Statistic	P
EG	HD (L)	0.637	0.433
	HD (R)	1.616	0.217
	VJ	0.582	0.454
	S&R	0.105	0.749
	LD	0.005	0.944
CG	BD	0.062	0.805
	HD (L)	0.001	0.982
	HD (R)	0.082	0.777
	VJ	2.394	0.136
	S&R	3.740	0.066
	LD	0.098	0.758
	BD	0.010	0.923

Hypothesis Testing

After the data passed the prerequisite tests and all data were normally and homogeneously distributed, hypothesis

Table 7. The Hypothesis Test Results

Variables	Indicators	EG				CG			
		Mean	t count	P value	ES	Mean	t count	P value	ES
Strength	HD (L)	4.68	2.931	0.014	0.85	0.175	0.166	0.871	0.05
	HD (R)	5.86	4.559	0.001	1.32	2.10	2.007	0.070	0.58
	LD	9.33	6.143	0.001	1.77	0.083	0.057	0.956	0.02
	BD	6.91	4.368	0.001	1.26	2.50	1.764	0.105	0.51
Flexibilities	S&R	3.50	4.868	0.000	1.41	1.49	1.780	0.103	0.51
Power	VJ	3.64	4.541	0.001	1.31	3.27	3.467	0.005	1.00

testing was carried out. The objective of this research was to assess the impact of an eight-week strength training regimen, conducted during a specific preparation phase, on the physical performance of male junior volleyball players. The outcomes of the Paired Sample T-test, which was employed to address the research hypothesis, are as follows.

The experimental group experienced a substantial increase in the strength, flexibility, and power variables, as evidenced by the positive t-statistic and sig value (both less than 0.05) in Table 7. Additionally, Table 7 demonstrates that the strength, flexibility, and power variables in the control group did not experience a statistically significant increase (sig < 0.05). Thus, it can be concluded that strength training for 8 weeks, which was carried out at a specific preparation phase for the performance of junior male volleyball athletes, was proven to significantly increase the performance of junior volleyball athletes with an effect size in the large effect category.

Discussion

The study's main findings revealed notable differences in strength, flexibility, and power between the experimental group and the control group. Specifically, the experimental group demonstrated significant increases in HDL ($p = 0.014$), HDR ($p = 0.001$), LD ($p = 0.001$), BD ($p = 0.001$), S&R ($p < 0.001$), and VJ ($p = 0.001$). In contrast, the control group only exhibited a significant increase in the power or VJ variable ($p = 0.005$), with no significant increases observed for HDL ($p = 0.871$), HDR ($p = 0.070$), LD ($p = 0.956$), BD ($p = 0.105$), and S&R ($p = 0.103$). Both groups experienced a significant enhancement in the power or VJ variable, yet the experimental group's improvement surpassed that of the control group ($p = 0.001$ and $p = 0.005$, respectively). Consequently, the combination of technical/tactical training, friendly matches, and resistance training was found to be more effective in enhancing HDL, HDR, LD, BD, S&R, and VJ compared to technical/tactical training and friendly matches alone. On the other hand, engaging in only technical/tactical training and friendly matches was sufficient to enhance VJ, although this approach was not as effective as combining it with resistance training.

Haff and Triplett (2015) state that resistance training can enhance strength by promoting neuromuscular adaptation, which is contingent upon the intensity of heavy load training. This adaptation leads to improved muscle function and the ability to generate greater force. Jenkins et al. (2017) support the neuromuscular adaptation theory, demonstrating that

a 6-week resistance training program using an 80% 1RM load can enhance neural adaptation by increasing neural drive and muscle activation efficiency, resulting in greater strength gains compared to training with a 30% 1RM load. Additionally, the study suggests that gradually increasing the intensity of the exercise program contributes to similar adaptations, as evidenced by significant improvements in muscle strength in both pre-test and post-test assessments.

Various studies have shown that resistance training leads to a more significant increase in muscle strength when the training load is in the strength zone, typically exceeding 80% of 1 RM (>8 RM), compared to lower loads (Schoenfeld, Grgic, Van Every, & Plotkin, 2021). In the present study, the EG group experienced a significant increase in muscle strength following a resistance training program with light to moderate intensity (40-80% of 1 RM). Furthermore, research by Lopez et al. (2021) supports these findings by explaining that selecting a moderate load intensity (9-15 RM) is also effective in increasing muscle strength, particularly for individuals who may not tolerate heavy loads.

Strength training's impact on an athlete's flexibility is a well-documented topic (Kumar & Zemková, 2022). Flexibility, defined as the muscles' ability to stretch optimally across joints, is typically assessed through ROM (Ratamess, 2021). Despite this, the mechanisms through which resistance training influences flexibility remain a subject of widespread debate. Nonetheless, the results of this study reveal a statistically significant improvement in flexibility indicators within the experimental group compared to the control group. These findings align with the research conducted by Afonso et al. (2021) and several other studies included in their systematic review and meta-analysis, which have demonstrated that both resistance training and stretching exercises can enhance ROM. However, the specific reasons behind why resistance training enhances ROM remain unclear, possibly due to variations in contraction types, exercises, modalities, and training regimens. One compelling rationale for the increase in ROM through resistance training is its ability to induce architectural changes in muscles, as evidenced by an increase in fascicle length when exercises are performed with full ROM (Gérard et al., 2020). Furthermore, according to Valamatos et al. (2018), strength training can contribute to muscle lengthening, particularly when exercises are executed through the full range of motion. This allows the muscles to stretch and thereby enhance flexibility.

The use of free weight and machine-based resistance training programs in the resistance training program of this

study may have contributed to its impact on flexibility. It is postulated that the notable outcomes observed in the large experimental group are attributed to the incorporation of free resistance training. Free resistance training enables exercises with a wider range of motion compared to machine-based training. This notion is supported by Behm (1995), who suggests that calisthenic or machine-based resistance training may not yield the same effect in increasing range of motion as free resistance training. It is important to underscore the need for further research on the effects of resistance training with different training modalities.

According to Caputo et al. (2017) an increase in strength is linked to a decrease in pain. Consequently, reduced sensitivity to muscle pain may contribute to the improvement in range of motion (ROM). Additionally, there is a theory suggesting that an increase in agonist-antagonist muscle coactivation can influence the mechanism through which resistance training enhances ROM by promoting a better or more balanced force ratio (Wyon, Smith, & Koutedakis, 2013). Given that weak muscle strength is associated with a reduction in ROM (Frasson et al., 2020), it follows that resistance training, which primarily aims to enhance muscle strength, can concurrently increase ROM (Moscão, Vilaça-Alves, & Afonso, 2020).

It is crucial to recognize that the extent of the effect on flexibility may be shaped by the particular type of strength training chosen and how it is carried out. Strength training involving full range of motion typically proves to be more effective in enhancing flexibility, as evidenced in this study. Furthermore, the researchers suggest the inclusion of specific flexibility exercises in the training program to achieve the best possible results.

Currently, there is a research trend focusing on plyometric training and its impact on power performance in various sports for increasing athlete power (Silva et al., 2019). Numerous studies indicate that plyometric training is an effective exercise for optimizing athlete power compared to other forms of training. In addition to plyometric training, several studies have shown significant increases in power through vertical jump (VJ) when combining resistance training loading in one session with contrast strength training (Cormier, Freitas, Rubio-Arias, & Alcaraz, 2020; Hammami, Gaamouri, Shephard, & Chelly, 2019; Schneiker, Fyfe, Teo, & Bishop, 2023). Interestingly, our study revealed that resistance training combined with volleyball skills training alone (EG), or skills training alone (CG), were sufficient to enhance athletes' power, as evidenced by the VJ results, without involving plyometrics or contrast training methods. The increase in power in the EG group may be attributed to the notable improvement in muscle strength test results. According to Taber et al. (2016), the foundation for developing power lies in maximum strength. Therefore, the substantial increase in power in the EG group, compared to the CG, was likely due to a greater potential to develop power through increased muscle strength.

Moreover, the researchers believe that the enhancement of power can occur through a combination of resistance training and volleyball skill training, as this training provides athletes with the opportunity to translate their muscle strength into vertical jumping and other volleyball skills such as blocking, jump serve, spikes, and other movements involving jumping. Additionally, the power exhibited by

the EG group may also have been influenced by decreased changes in body mass at the end of the intervention in this study. It is known that lower body mass is associated with improved vertical jump performance in volleyball players compared to those with higher body mass, as indicated by BMI (Nikolaidis, 2013). Supported by the research of Ben Brahim et al. (2023), BMI is a fairly strong predictor in determining vertical jump test performance.

In contrast, even though there was no significant change in body mass between the pre-test and post-test results of the CG group, the increase in power in this group may have been a result of improved vertical jumping performance due to volleyball skills training. The proficient execution of jumping movements in technical/tactical training within the CG group could be the primary reason for the observed increase in VJ performance. Put differently, it is highly probable that this increase is significantly influenced by the enhancement of the athlete's jumping technique or jumping quality, rather than directly from an increase in power.

In general, strength training can enhance strength, flexibility, and muscle power when the training program is specifically tailored to facilitate adaptation in these areas. Developments in all these components adhere to the principle of specificity, which dictates that the body will adapt to training based on the manner in which it is trained (Reiman & Lorenz, 2011). Furthermore, the training program employed in this study is a specific preparatory training program aimed at enhancing physical abilities tailored to the demands of volleyball and in support of volleyball movements. While general preparatory training places greater emphasis on exercises prepared for the athlete's physical adaptation to training, specific preparatory training is dedicated to providing opportunities for athletes to integrate physical abilities with volleyball movements. It is important to note that the effects of strength training on strength can vary depending on various factors, including training intensity, volume, frequency, execution technique, and individual genetics. A well-designed strength training program takes all of these factors into account to achieve optimal results. Meanwhile, further research into the impact of resistance training regimens on the adaptation of volleyball athletes' physical abilities requires additional investigation.

This study aimed to provide valuable insights for the selection of resistance training during the specific preparatory phase and as a foundation for further research. Furthermore, the researchers advocated for greater emphasis on resistance training programs, particularly during the specific preparatory phase. Implementing resistance training during this phase enables athletes to optimize their muscle strength and flexibility compared to those who only engage in resistance training during the general preparatory phase. Moreover, achieving a balance between strength and flexibility is crucial for an athlete's performance. Well-rounded strength training combined with flexibility exercises can aid in injury prevention and enhance overall athletic performance. Furthermore, the harmonious development of strength and flexibility may be fundamental to improved power performance.

While this research presents a novel contribution to the existing body of knowledge, it is not without limitations. Firstly, the scarcity of relevant studies investigating resistance training alongside technical and tactical training in volleyball posed challenges in comparing the findings with those of

another research. Most existing research primarily focuses on resistance training combined with plyometric training. Secondly, the results should ideally have been confined to a comparable sample of participants. A comprehensive comprehension of strength training requires a grasp of anatomy, human physiology, and neuromuscular adaptation. Additionally, this research lacked a comparison of the technical abilities and performance of junior male volleyball athletes, which could be valuable for future investigations given the potential variations in the implementation of volleyball strategies and tactics among junior athletes. Moreover, comparisons between other periods, such as the specific preparatory and pre-competition periods, were not conducted. Notably, the athletes in this study had undergone general preparatory phase resistance training, underscoring the need for a brief overview of the necessity of specific preparatory resistance training. For future research, it may be necessary to conduct a comparison between resistance training alone, combining resistance training with skill and tactical exercises in volleyball, and skill and tactical training alone. Additionally, a comparison with plyometric training may also be warranted. Such comparisons could potentially reveal differences in adaptive responses and training effects. Lastly, the sample sizes for each group were relatively small, indicating that this study remains in its preliminary phase. Recruiting a substantial sample within this age cohort is challenging and nearly unattainable. Therefore, the researchers recommend that future research give careful consideration to the limitations identified in this study.

Conclusions

The researchers concluded that strength training, when incorporated into volleyball training, especially at specific preparation phases, can increase power, strength, and flexibility. Incorporating targeted stimuli, such as strength training, into training sessions can promote continuous progressive neuromuscular adaptation and be a safe training modality for this age group. To optimize the performance of junior volleyball players, coaches should incorporate specific strength training, such as integrating strength training with technical and tactical training during the specific preparation phase. In addition, these results suggest that coaches should consider specific adaptations when developing training programs for volleyball players with the goal of enhancing their athletic performance; this may necessitate a tailored approach to program design.

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Conflict of interest

The authors guarantee that no conflicts of interest exist.

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Вплив 8-тижневого силового тренування на етапі спеціальної підготовки на показники результативності волейболістів чоловічої статі

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 9 с., 7 табл., 33 джерела.

Історія питання. Тренувальні програми є частиною забезпечення навчального процесу, що потребує правильної та коректної підготовки та реалізації.

Мета дослідження. Метою дослідження була оцінка впливу 8-тижневої програми силових тренувань, проведеної на певному етапі підготовки, на показники результативності волейболістів чоловічої статі юнацького віку.

Матеріали та методи. Даний аналіз був проведений у якості експериментального дослідження, у якому взяли участь 24 волейболісти чоловічої статі (середній \pm СВ) вік: $17,96 \pm 1,23$ років; маса тіла: $75,56 \pm 7,80$ кг; зріст: $180,46 \pm 7,14$ см; вміст жиру в організмі: $17,62 \pm 3,36\%$), які були рандомізовані до експериментальної групи (ЕГ): $n = 12$, та контрольної групи (КГ): $n = 12$. Програма тренувань тривала вісім тижнів і проходила на спеціальному підготовчому етапі.

Результати. В експериментальній групі після восьми тижнів силових тренувань спостерігалось суттєве зростання показників динамометрії лівої руки ($p < 0,014$), динамометрії правої руки ($p < 0,001$), вертикального стрибка ($p < 0,001$), тесту на гнучність sit-and-reach (спосіб вимірювання загальної гнучності тіла при згинанні тулуба вперед, сидячи на підлозі з витягнутими вперед руками) ($p < 0,000$), динамометрії ніг ($p < 0,000$) і динамометрії м'язів спини ($p < 0,001$).

Висновки. При впровадженні силових тренувань до програми підготовки волейболістів, вони можуть покращити показники результативності, сили та гнучності, особливо, якщо їх проводити на певному етапі підготовки. Включення цілеспрямованих стимулів, таких як силові навантаження, до тренувальних занять є безпечним методом тренування для даної вікової групи і може сприяти безперервному та поступовому поліпшенню адаптації нервово-м'язової системи.

Ключові слова: волейбол, результативність, силове тренування.

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