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The effectiveness of a specialized strength training regimen in enhancing explosive power among male collegiate volleyball athletes

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Abstract
Introduction. Explosive power is essential for volleyball performance, underpinning rapid movements such as spiking, blocking, and jumping. Specialized strength training to enhance explosive power is thus critical for optimal athletic performance. Aim of Study. This study examined whether a targeted strength training program could significantly improve the explosive power of male volleyball students at Vietnam National University, Ho Chi Minh City (VNU-HCM) compared to conventional training methods. Material and Methods. Twenty-four male volleyball students were randomly assigned to an experimental group (EG) or a control group (CG). The EG completed a 12-week specialized explosive strength training regimen, while the CG maintained their standard training protocol. Pre- and post-intervention performance was assessed using standardized tests: 10-second push-up, 30-meter sprint, pro-agility shuttle run, 20-second chair stand, 10-second crunch, and standing vertical jump. A two-way ANOVA evaluated the interaction between time (pre vs post) and group (EG vs CG), with paired t-tests used for within-group comparisons. Effect sizes were estimated using Cohen's d and partial η^2, with significance set at $p < 0.05$. Results. The EG demonstrated significant improvements across all tests. For instance, the 10-second push-up test increased from 13.92 ± 1.22 to 16.00 ± 1.47 repetitions ($p < 0.001$; Cohen's d = 1.50; partial $\eta^2 = 0.65$). Similar significant gains ($p < 0.001$) were observed in the 30-meter sprint, pro-agility shuttle run, chair stand test, crunch test, and standing vertical jump, while the CG showed only modest or non-significant changes. The ANOVA confirmed a significant time × group interaction, indicating that the EG outperformed the CG across all variables. Conclusions. A specialized explosive strength training regimen significantly enhances the explosive power of male volleyball players, exceeding improvements observed with conventional training. The robust statistical significance and large effect sizes support the efficacy of targeted training programs for optimizing athletic performance.

KEYWORDS: athletic performance, volleyball, physical education, strength training, training methods, explosive power.

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Introduction

Strength training has emerged as a vital component of sports training, complementing the development of speed and endurance, as Bompa's seminal work has emphasized [6]. The primary objective of strength training in sports is to meet the specific strength requirements of each sport, thereby maximizing athletic performance. In line with Haff and Triplett's [12] conceptualization, strength can be understood as the human ability to produce mechanical force through muscular effort, essentially the capacity to overcome or resist external forces through muscular exertion [11, 19].

Strength training is crucial for athletes of all levels, a fact widely recognized in the field [19]. It is not just about lifting heavy weights; it is about training the body to become a more powerful and efficient machine [27]. This is especially true for collegiate athletes who can significantly benefit from incorporating unique challenges like strongman training into their routines.

Why is strength training so important? Because it causes the body to adapt, leading to both physiological and structural changes, while also enhancing long-term physical health and psychosocial function [4]. Muscles grow larger and more efficient, directly proportional to the effort put in – the more frequent and intense the training, the greater the results. This adaptation is key for success in many sports that demand bursts of power and rapid force production. Essentially, a stronger athlete is often a more powerful and explosive athlete.

The positive impact of strength training is evident across various sports [11]. For instance, the integration of strength programs has dramatically boosted the performance of football players at all competition levels. Ultimately, the goal is to create a training program that is both safe and effective, grounded in the science of exercise physiology and biomechanics, and tailored to the specific demands of the athlete's sport. By focusing on developing strength, speed, cardiovascular fitness, and other athletic qualities, athletes can enhance their skills and reach their full potential [27].

Physical preparation and athletic performance are inextricably linked, the same way the development of physical qualities to meet the demands of a sport is critical for success in sports training, as Anderst et al. [2] emphasize [23]. Most physical activities combine elements of force, endurance, power, and strength endurance, which are genetically influenced and play a significant role in achieving high athletic performance. These physical capacities, often referred to as "dominant motor" abilities or "biomotor" capacities, are the foundation for success in many sports [23].

When a skill or sport requires a combination of one to three biomotor abilities, it is considered a dominant capacity. For example, in sports like basketball and soccer, power is the dominant capacity. Strength is always related to other physical qualities, such as speed and endurance, in sports activities. Therefore, strength capabilities are expressed in three main forms: maximum strength, strength speed, and strength endurance [23].

According to the research conducted by Smith [24], maximizing an athlete's performance requires a holistic approach that encompasses mental, technical, tactical, and physical development strategies. This approach emphasizes the importance of understanding the science behind athletic performance, as well as the value of a collaborative approach involving a multi-disciplinary team of experts [24]. The research suggests that while traditional training programs often focus solely on developing physical abilities, techniques, and tactics, the psychological aspects of performance are often overlooked [5]. Competencies of coaches in improving the psychological aspects of athletes, including their physical condition, cognitive function, and other psychological factors, can be crucial in enhancing athlete performance, particularly by bolstering information processing and executive function in youth [9]. Additionally, the research highlights the importance of objective evaluation of an athlete's potential, as coaches and parents may sometimes be overly focused on producing "star" athletes rather than providing a balanced assessment of an athlete's skills [10, 23]. To achieve peak athletic performance, it is crucial to optimize strength and conditioning programs. A balanced blend of strength, speed, cardiovascular fitness, and other elements of athleticism can enhance an athlete's skills and overall performance. However, it is essential to prioritize the athlete's well-being, health, and safety above all else. Training regimens should be grounded in scientific principles of exercise physiology and biomechanics, ensuring that outcomes are both safe and tailored to the specific demands of the sport [7]. Athleticism is a multifaceted construct, encompassing a diverse array of physical attributes that collectively contribute to an individual's sports performance. Among these key attributes, three distinct strength qualities stand out as particularly crucial: maximum strength, strength speed, and strength endurance. Maximum strength, defined as the highest force an athlete can generate during a maximal muscle contraction, is of paramount importance in sports involving significant external resistance, such as weightlifting, wrestling, and basketball [20]. As the external resistance decreases and the duration of exercise increases, the significance of maximum strength tends to diminish.

On the other hand, strength speed, the ability to overcome resistance with high muscle contraction velocity, is a critical determinant of performance in non-cyclical sports activities like high jump and long jump. This quality is also pivotal for achieving high power output during actions like kicking, throwing, and jumping in ball sports, as well as for rapid acceleration in short-distance running, cycling, and boat racing [11]. The third key strength quality, strength endurance, reflects an athlete's capacity to resist fatigue during prolonged strength-based activities [20]. This attribute is essential in endurance sports that require sustained application of large resistance, such as rowing, gymnastics, wrestling, and many ball sports [19]. Recognizing the significance of these strength qualities and their specific applications in different sports can inform the design of targeted training programs, ultimately enhancing athletes' overall sports performance [23].

Strength training has been widely recognized as a critical component of athletic development and performance improvement, with a growing body of research highlighting its multifaceted benefits [7], including practical applications for interdisciplinary care and musculoskeletal health preservation [16]. As emphasized by Latella et al. [15], strength training not only develops general strength but also enhances strength speed, strength endurance, injury prevention, willpower, and concentration, all of which contribute significantly to overall sports performance [25]. Incorporating strength training into an athlete's regimen is vital for developing motor abilities and providing the foundation for them to reach their highest potential [19]. The optimization of strength and conditioning programs has become a cornerstone in achieving peak athletic performance. A well-rounded approach that incorporates strength, speed, cardiorespiratory fitness, and other facets of athletic ability can significantly enhance an athlete's existing skills and overall performance [7].

The role of strength training in team sports cannot be overstated, and it has been well-documented by Mihăilă et al. [19], that exercises involving strength training are particularly essential for achieving desired outcomes and enhancing performance. Strength training contributes significantly to the development of motor skills and increased effort capacity, both of which are crucial for success in numerous sports [21]. This emphasis on sports participation, particularly in organized team settings, has been linked to the development of leadership skills and underscores the profound impact sports can have on an individual's physical and mental well-being [14]. Strength, as a foundational element in numerous sports, empowers athletes to execute high-velocity movements, agile changes in direction, explosive jumps, and effectively handle physical interactions with opponents [26]. The significance of maximizing strength and conditioning sessions is further underscored by the Inter-Association Task Force for Preventing Sudden Death in Collegiate Conditioning Sessions, which advocates for training programs rooted in scientific principles of exercise physiology and biomechanics to ensure safe and sport-specific outcomes. Furthermore, recent research supports the inclusion of strength training for preadolescent athletes, citing its benefits for both health and sports performance [11, 25].

Material and Methods

Literature review and analysis

A comprehensive literature review was conducted throughout the study to analyze and synthesize existing research on explosive strength training, particularly in the context of volleyball, while acknowledging the health benefits of resistance exercise beyond hypertrophy and high loading paradigms [1]. This review served as the foundation for the theoretical framework, guiding the formulation of research hypotheses, objectives, and the discussion of findings. The literature review also enabled the identification of appropriate tests for evaluating explosive strength in male volleyball students majoring in Physical Education at Vietnam National University, Ho Chi Minh City (VNU-HCM), and facilitated the selection of targeted explosive strength exercises. The integration of relevant scientific data ensured that the study's results were examined in alignment with previous research.

Expert consultation

To ensure the validity and relevance of the selected tests and exercises, structured interviews were conducted with experts, including coaches and lecturers specializing in volleyball training. These consultations provided valuable insights and informed decisions on the most suitable assessment methods and training exercises for the study's target population.

Physical fitness testing

To objectively measure the participants' explosive strength, a battery of fitness tests was administered before and after the intervention. The following tests were used:

30-Meter Sprint: This test evaluated overall explosive strength by timing the participants' sprint over 30 meters from a standing start. Protocol: Participants sprinted a 30-meter distance from a standing start. Equipment: A digital stopwatch (accurate to 0.01 s) and starting blocks. Procedure: The sprint was conducted on an indoor track, with two trials recorded per participant, and the best time used for analysis.

20-Second Push-Up Test: Upper body explosive strength was assessed by counting the number of push-ups participants could perform in 20 seconds. Protocol: Participants performed as many push-ups as possible within 20 seconds. Equipment: A standardized gym mat. Procedure: Only repetitions performed with proper form (chest to ground, arms fully extended) were counted.

Standing Vertical Jump: This test measured lower body explosive strength and jump power, with participants performing a countermovement jump to reach a vertical jump measuring board. Protocol: Participants performed a countermovement jump with arm swing. Equipment: Vertec vertical jump measuring device. Procedure: The best of three trials was recorded.

Pro-Agility Shuttle Run: Designed to assess volleyball-specific explosive movement, this test required participants to sprint and touch lines at 9 meters, 3 meters, and the center line as quickly as possible. Protocol: Participants sprinted to a 9-meter marker, back to a 3-meter marker, and returned to the starting line. Equipment: Timing gates for precise measurement. Procedure: The best of two attempts was recorded.

10-Second Crunch Test: Abdominal explosive strength was assessed by recording the number of crunches completed in 10 seconds. Protocol: Participants performed as many abdominal crunches as possible in 10 seconds. Equipment: A standard gym mat. Procedure: Only repetitions with full range of motion were counted.

20-Second Chair Stand Test: This test measured lower body explosive strength, focusing on the quadriceps, by counting the number of times participants could stand up from a seated position in 20 seconds. Protocol: Participants performed as many chair stands as possible within 20 seconds. Equipment: A standardized chair (seat height: 43 cm). Procedure: Proper technique was ensured by requiring full hip and knee extension.

Pedagogical experiment

A 12-week training intervention was implemented, during which a specialized explosive strength training program was introduced to the experimental group. The exercises were specifically designed for volleyball players to enhance their explosive strength. This experimental method tested the effectiveness and practicality of the selected exercises in improving explosive power, which is critical for volleyball performance.

Statistical analysis

Data collected from the fitness tests were analyzed using statistical methods to assess the impact of the intervention. SPSS 20.0 software and Microsoft Excel were employed for statistical processing and analysis, ensuring rigorous examination of the results.

To analyze the differences between pre-test and post-test values across both experimental and control groups, a two-way ANOVA was conducted. This test allowed for examination of the interaction effect between the training intervention and time (pre- vs post-test).

Effect sizes: We calculated Cohen's d for paired comparisons within each group and partial eta squared (η^2) for ANOVA results to assess practical significance. Post hoc tests: Bonferroni-adjusted pairwise comparisons were conducted to determine the specific differences between conditions where significant main or interaction effects were found. Assumption checks: Normality was verified using the Shapiro–Wilk test. Homogeneity of variances was assessed via Levene's test. Sphericity was tested using Mauchly's test, and corrections (Greenhouse–Geisser) were applied where necessary.

Participants

The study involved 24 male volleyball students majoring in Physical Education at VNU-HCM. All participants passed a health screening to confirm their fitness for the study. They were then randomly divided into two groups: an experimental group (EG) (n = 12) and a control group (CG) (n = 12).

The EG participated in a detailed strength training program focused on enhancing explosive power, using exercises such as the approach jump with continuous attack, continuous target serving, and the 9-meter explosive knee tuck run. These exercises were carefully selected to target muscle groups essential for volleyball performance, with a focus on power generation and neuromuscular coordination.

The training load was progressively increased over the 12 weeks, with incremental adjustments in both volume and intensity. The volume of exercises, measured by repetitions, increased steadily, while the intensity ranged from 65% to 85% of each participant's one-repetition maximum (1RM). This periodized approach was designed to optimize neuromuscular adaptation while preventing overtraining. A detailed breakdown of the progression strategy is provided in Table 1 to clarify the design of the intervention.

The EG adhered to the following training parameters: Frequency: 3 sessions per week. Duration: 1 academic period per session (including warm-up) + 2 self-practice sessions. Exercises: 4-5 exercises per session, targeting major muscle groups and full-body movements. Organization: divided into 2-3 smaller training groups. Repetitions: 4-8 repetitions per set, adjusted weekly based on exercise and load. Intensity: 65-85% of 1RM for major muscle groups. Movement execution: explosive, maximal effort. Rest intervals: 30 seconds to 1 minute between sets, 1-3 minutes between exercises.

The CG followed the standard VNU-HCM volleyball training program, which consisted of skill-based drills and general conditioning exercises, such as passing, serving, blocking, and game simulations. While these drills are fundamental to volleyball, they do not

Table 1. Training intervention for enhanced explosive strength in male volleyball players

Exercise (sets × repetitions)	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
Supine crunch	10 × 2	10 × 3	12 × 3	15 × 3	15 × 3	17 × 3	–	–	–	–	–	–
Standard push-up	15 × 2	15 × 3	15 × 3	15 × 3	15 × 3	15 × 3	10 × 3	15 × 3	15 × 3	–	–	–
Burpee	10 × 3	10 × 3	15 × 3	–	–	–	–	–	–	–	–	–
Sprint	5 × 3	5 × 3	5 × 3	–	–	–	–	–	–	–	–	–
High knees	10 × 3	10 × 3	10 × 3	5 × 3	7 × 3	10 × 3	5 × 3	7 × 3	10 × 3	–	–	–
Approach jump with continuous attack	–	–	–	10 × 3	10 × 3	15 × 3	10 × 3	10 × 3	15 × 3	–	–	–
Blocking jump with retreat and attack	–	–	–	–	–	–	10 × 3	10 × 3	12 × 2	10 × 3	10 × 3	12 × 2
Continuous quick spikes	–	–	–	–	–	–	–	–	–	10 × 3	10 × 3	10 × 3
Continuous target serving	–	–	–	–	–	–	–	–	–	10 × 3	10 × 3	10 × 3
9-meter explosive knee tuck run	–	–	–	–	–	–	–	–	–	5 × 3	5 × 3	5 × 2

specifically target the development of explosive strength, which distinguishes the intervention applied to the EG.

This methodology provided a robust framework for evaluating the effectiveness of the explosive strength training program, ensuring that the design, execution, and evaluation of the intervention were scientifically grounded and thoroughly validated.

The research adhered to the ethical and moral standards of biomedical research as specified in the 2008 Declaration of Helsinki. The study was approved by the University Ethics Committee (Decision No. 1072), and participants voluntarily provided written consent for their involvement.

Results

The study employed a comparative group design with a 12-week intervention period. Table 2 presented in the original text demonstrates the following findings for the EG:

10-Second Push-up Test: A significant increase in repetitions was observed (13.92 ± 1.22 vs 16.00 ± 1.47, $p < 0.001$), with a growth rate (W%) of 13.90%. This improvement highlights the effectiveness of the training program in enhancing upper body explosive strength.

30-meter Sprint: A significant improvement in sprint time was observed (4.54 ± 0.19 s vs 4.41 ± 0.17 s, $p < 0.001$), with a W% of 2.74%. This finding suggests a positive impact on overall explosive strength and acceleration capabilities.

Pro-Agility Shuttle Run: The EG demonstrated a significant enhancement in agility (7.58 ± 0.27 s vs 7.46 ± 0.24 s, $p < 0.001$), with a W% of 1.57%. This result indicates improved sport-specific explosive movement and change-of-direction ability.

20-Second Chair Stand Test: A significant increase in repetitions was observed (22.16 ± 1.62 vs 24.64 ± 1.63, $p < 0.001$), with a W% of 10.60%. This finding suggests enhanced lower body explosive strength, particularly in the quadriceps.

10-Second Crunch Test: The EG demonstrated a significant improvement in repetitions (13.28 ± 0.61 vs 15.48 ± 1.16, $p < 0.001$), with a W% of 15.30%. This result highlights the positive impact of the training program on abdominal explosive strength.

Standing Vertical Jump: A significant increase in jump height was observed (291.12 ± 10.03 cm vs 302.01 ± 10.00 cm, $p < 0.001$), with a W% of 2.60%. This finding indicates enhanced lower body power and jump performance.

These results demonstrate that the implemented training program had a significant positive effect on all six measures of explosive strength in the EG ($p < 0.001$). The calculated t-values for all tests exceeded the critical t-value (4.437), confirming the significance of the observed improvements.

The CG also exhibits some improvements in explosive strength; however, these were less pronounced and not consistently significant. Notably, only the 10-second push-up test and the 30-meter sprint showed significant improvements ($p < 0.05$). The remaining tests did not demonstrate significant changes, suggesting that the natural progression within the timeframe of the study was not sufficient to elicit significant adaptations in these areas.

Table 2. Pre- and post-intervention results for the experimental and control group

Test	Pre-experiment		Post-experiment		W%	t	F	P	Cohen's d; partial η^2
	M	SD	M	SD					
Experimental group									
Push-ups in 10 seconds (repetitions)	13.92	1.22	16.00	1.47	13.90	9.66	28.3	<0.001	1.50; 0.65
30-meter sprint (s)	4.54	0.19	4.41	0.17	2.74	9.60	30.1	<0.001	1.30; 0.60
Pro-agility shuttle run (s)	7.58	0.27	7.46	0.24	1.57	5.31	20.4	<0.001	1.20; 0.55
Chair stand test in 20 seconds (repetitions)	22.16	1.62	24.64	1.63	10.60	9.58	25.8	<0.001	1.40; 0.62
Crunches in 10 seconds (repetitions)	13.28	0.61	15.48	1.16	15.30	9.84	32.5	<0.001	1.60; 0.68
Standing vertical jump (cm)	291.12	10.03	302.01	10.00	2.60	14.47	15.2	<0.001	0.90; 0.50
Control group									
Push-ups in 10 seconds (repetitions)	13.95	1.47	14.60	1.68	4.77	4.24	18.0	<0.05	0.40; 0.15
30-meter sprint (s)	4.52	0.21	4.47	0.21	1.60	7.49	22.0	<0.001	0.45; 0.18
Pro-agility shuttle run (s)	7.56	0.43	7.54	0.43	0.50	2.00	4.0	>0.05	0.20; 0.05
Chair stand test in 20 seconds (repetitions)	22.20	1.76	22.92	1.85	3.19	3.27	7.0	<0.05	0.35; 0.12
Crunches in 10 seconds (repetitions)	13.31	0.74	13.96	1.37	4.99	3.18	6.5	<0.05	0.30; 0.10
Standing vertical jump (cm)	292.02	10.90	296.05	11.34	0.25	0.97	1.0	>0.05	0.10; 0.03

Note: $t_{0.05} = 2.201$; $t_{0.01} = 3.106$; $t_{0.001} = 4.437$; M – mean value; SD – standard deviation; W% – growth rate percentage; t – t-statistic from paired comparisons; F – F-value from the two-way ANOVA assessing the interaction between time (pre vs post) and group (EG vs CG); effect size – Cohen's d (magnitude of change for paired comparisons) and partial η^2 (proportion of variance explained by the intervention)

The findings of this study provide compelling evidence for the effectiveness of the implemented training program in enhancing various aspects of explosive strength in male volleyball students. The significant improvements observed in the EG across all six tests highlight the program's comprehensive impact.

Discussion

The primary objective of this study was to determine whether a specialized strength training program could significantly improve the explosive power of male volleyball students at VNU-HCM. The results indicate that the EG, which followed the specialized strength training regimen, showed significant improvements in explosive strength compared to the CG, which followed the standard training regimen. This aligns with the study's initial hypothesis that targeted strength training programs are more effective than traditional methods in enhancing explosive power [13, 22].

The findings of this study are consistent with recent literature emphasizing the importance of strength training in sports performance [3]. Previous studies have demonstrated that specific strength exercises can lead to substantial improvements in athletic performance by enhancing muscle power and force generation capabilities. This study adds to the growing body of evidence by providing empirical data supporting the effectiveness of specialized strength training programs in volleyball, a sport that heavily relies on explosive movements [22]. The results of this study have important implications for volleyball coaches and trainers, as they suggest that implementing a targeted strength training regimen can significantly enhance the explosive power of male volleyball players. Moreover, the findings highlight the need for tailored training programs that address the unique physical demands of volleyball, rather than relying solely on traditional training methods [13].

Volleyball is a sport that demands a high level of explosive power, particularly in actions such as spiking, blocking, and jumping. Explosive strength is a critical component of volleyball performance, as players must generate substantial force in a short period of time to achieve success in these key game actions [17], with the goal of identifying practical and effective interventions. The current study examined the effects of specific exercises on the explosive strength of volleyball players. The researchers found that exercises such as continuous quick spikes, 9-meter target serving, explosive knee tuck runs, and jump block and backward spikes were particularly effective in enhancing the explosive power of the participants. These findings provide valuable insights for volleyball coaches and trainers, offering a practical contribution to the development of training methodologies aimed at improving player performance.

Volleyball is a sport that relies heavily on anaerobic energy systems, with a significant portion of the energy demands during high-intensity play being met through anaerobic metabolism [18]. The ability to generate and sustain explosive power is crucial for success in the sport, as players must perform numerous maximum-effort jumps and quick, short sprints throughout the course of a match.

Existing literature supports the benefits of strength training for athletes, and this study provides a focused examination of its application to male volleyball players. The detailed insights into effective training exercises help refine and optimize training programs tailored to the specific demands of volleyball, ensuring that athletes can achieve peak performance through scientifically validated methods [17]. The confirmation of these results in the context of volleyball provides a valuable addition to the understanding of how to enhance explosive strength in this sport. The study's findings indicate that the variation of leg muscle strength exercises has a significant impact on the jumping results of extracurricular volleyball players. Furthermore, plyometric training, which involves exercises that mimic the nature of many sports activities, has been shown to be an effective approach for enhancing vertical jump and sprint speed in volleyball players [8].

Recent research has confirmed that a specialized strength training program can significantly improve explosive power among male volleyball students [13]. The findings underscore the importance of integrating specific strength exercises into training regimens to optimize athletic performance [13].

Notably, exercises such as quick spikes, target serving, and explosive knee tuck runs proved highly effective [13]. These exercises target the development of lower-body power, which is a critical component of volleyball performance [22]. Plyometric training, in particular, has been shown to enhance vertical jump and sprint speed – two essential skills for volleyball players [8]. The results corroborate previous studies highlighting the role of targeted strength development in volleyball [17]. Vertical jump is a key indicator of performance, as volleyball players can perform up to 40,000 spikes in a single year. Additionally, the demands of the sport, which are largely alactic-aerobic in nature, necessitate the cultivation of effective power, speed, and the ability to repeat these high-intensity efforts [17]. The practical applications of these findings are significant, as they provide a roadmap for volleyball coaches and trainers to optimize their athletes' physical preparation. By integrating specialized strength exercises into their training regimens, volleyball programs can enhance their players' explosive power, ultimately leading to improved athletic performance and success on the court.

Based on the findings, the following recommendations are proposed: (1) incorporate specific exercises: volleyball coaches should integrate exercises like quick spikes, target serving, and explosive knee tuck runs into training routines to enhance explosive strength; (2) tailored training programs: develop and implement strength training programs tailored to the specific needs of volleyball players to maximize performance; (3) continuous assessment: regularly assess the effectiveness of training exercises and accordingly adjust programs to ensure continuous improvement and adaptation; (4) expand research: further research should explore the long-term effects of these exercises and their impact on different demographics and skill levels within volleyball.

Conclusions

The study conclusively demonstrates that a targeted strength training regimen significantly enhances explosive power in male collegiate volleyball players, surpassing traditional training methods. Over a 12-week intervention, the EG exhibited marked improvements across multiple metrics, including upper and lower body strength, agility, and jump performance. These findings validate the effectiveness of tailored training programs in addressing sport-specific demands, highlighting their potential to elevate athletic performance. The results advocate for the integration of specialized strength exercises into volleyball training routines, underscoring their critical role in optimizing physical preparation and achieving peak performance.

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Conflict of Interest

The author has no conflicts of interest to report.

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