

"Impact of Resistance Training on Shoulder Strength and Injury Prevention in School Volleyball Players"

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Abstract

This study investigates the effectiveness of a structured resistance training program in enhancing shoulder strength and reducing injury incidence among school volleyball players. A total of 72 high school volleyball players (aged 14-18 years) were randomly assigned to three groups (n=24 per group): Group I received a comprehensive shoulder-focused resistance training program, Group II participated in traditional volleyball training with basic strengthening exercises, and Group III served as the control group with standard volleyball practice only. The intervention was conducted over a 16-week period during the competitive season, with resistance training sessions performed twice weekly. Pre- and post-intervention assessments included shoulder strength measurements (internal/external rotation, abduction, flexion), functional movement screening, and injury tracking throughout the season.

Results demonstrated significant improvements in shoulder strength parameters and a notable reduction in shoulder injury rates in the resistance training group compared to both comparison groups. The resistance training group showed a 23.5% increase in external rotation strength, 19.8% improvement in internal rotation strength, and 67% reduction in shoulder injury incidence compared to the control group. These findings indicate that implementing a targeted resistance training program can effectively enhance shoulder strength and serve as a preventive measure against common volleyball-related shoulder injuries. The study emphasizes the critical importance of incorporating evidence-based strength training protocols in school volleyball programs to optimize athletic performance while prioritizing player safety and long-term shoulder health.

Keywords: Resistance Training, Shoulder Strength, Injury Prevention, School Volleyball, Rotator Cuff, Athletic Performance

Introduction

Volleyball is a dynamic overhead sport that places significant demands on the shoulder complex, requiring repetitive overhead movements including spiking, serving, and blocking. The shoulder joint, being the most mobile joint in the human body, is particularly vulnerable to injury due to its inherent structural instability and the high-velocity, high-impact nature of volleyball movements. Among school-aged athletes, volleyball ranks among the sports with the highest incidence of shoulder injuries, with studies indicating that up to 40% of volleyball players experience shoulder pain or injury during their athletic careers.

The unique biomechanical demands of volleyball create specific stress patterns on the shoulder girdle. The overhead attack motion generates tremendous forces across the glenohumeral joint, while the repetitive nature of training and competition can lead to muscular imbalances, particularly between the internal and external rotators of the shoulder. Common injuries in volleyball players include rotator cuff impingement, labral tears, instability, and overuse syndromes. These injuries not only affect immediate performance but can also have long-term consequences on shoulder function and quality of life.

School volleyball players face additional challenges as they are still developing physically and may lack the muscular strength and coordination necessary to handle the demands of competitive play safely. The adolescent shoulder is particularly susceptible to injury due to ongoing skeletal maturation, growth plate activity, and developing neuromuscular control. Furthermore, many school programs may lack adequate strength and conditioning resources, leaving players inadequately prepared for the physical demands of the sport.

Resistance training has emerged as a fundamental component of injury prevention programs in overhead sports. Systematic strengthening of the rotator cuff muscles, scapular stabilizers, and surrounding musculature can help restore muscular balance, improve joint stability, and enhance the shoulder's ability to withstand repetitive stress. However, despite the theoretical benefits, limited research has specifically examined the effectiveness of resistance training programs in school volleyball populations, particularly regarding both performance enhancement and injury prevention outcomes.

This study aims to address this gap by investigating the impact of a structured, volleyball-specific resistance training

program on shoulder strength development and injury prevention in high school volleyball players. A 16-week intervention was implemented with three groups: a Resistance Training Group receiving comprehensive shoulder strengthening protocols, a Traditional Training Group following standard volleyball conditioning practices, and a Control Group maintaining regular volleyball training only. The research seeks to provide evidence-based guidance for coaches, athletic trainers, and sports medicine professionals working with school volleyball programs to optimize both performance and player safety.

Methodology Participants

The study included 72 high school volleyball players (45 females, 27 males) aged 14-18 years from six different schools in the metropolitan area. All participants had at least one year of organized volleyball experience and were actively participating in their school's volleyball program. Players were randomly stratified by school and playing position into three equal groups of 24 participants each: Group I (Resistance Training), Group II (Traditional Training), and Group III (Control Group). Exclusion criteria included current shoulder injury or pain, history of shoulder surgery, or inability to participate in regular volleyball activities. Written informed consent was obtained from all participants and their parents/guardians prior to study commencement.

Research Design

A randomized controlled trial design with pre-test and post-test measurements was employed over a 16-week intervention period coinciding with the competitive volleyball season. The study protocol was approved by the institutional review board and conducted in accordance with ethical guidelines for research involving minors. All training sessions were supervised by certified strength and conditioning specialists and conducted in school facilities during designated training times.

Training Protocols

Group I (Resistance Training): Participants performed a comprehensive shoulder-focused resistance training program twice weekly on non-consecutive days. The program included progressive exercises targeting rotator cuff muscles (external/internal rotation with resistance bands and dumbbells), scapular stabilizers (rows, reverse flies, wall slides), and functional movements (overhead press variations, pull-ups/lat pulldowns). Training intensity progressed from 60% of estimated 1RM to 80% over the intervention period, with volume adjusted based on individual response and volleyball training load. **Group II (Traditional Training):** This group followed conventional volleyball conditioning practices including basic bodyweight exercises, general upper body strengthening with light weights, and sport-specific movement drills. Training frequency matched Group I but with lower intensity and less specific targeting of shoulder musculature.

Group III (Control): Participants maintained their regular volleyball practice schedule without additional strength training interventions, serving as the baseline comparison group.

Assessment Procedures

Shoulder Strength Testing: Isometric and isokinetic strength measurements were obtained using a handheld dynamometer for external rotation, internal rotation, abduction, and flexion at baseline and post-intervention. Testing positions followed standardized protocols with the shoulder at 90° abduction for rotation measurements.

Functional Movement Assessment: The Functional Movement Screen (FMS) and volleyball-specific movement assessments were conducted to evaluate movement quality and identify potential injury risk factors.

Injury Tracking: All shoulder injuries and pain episodes were documented throughout the study period using standardized injury report forms completed by certified athletic trainers. Injuries were classified by type, severity, and time loss from participation.

Statistical Analysis

Data analysis was performed using SPSS software with significance set at $p < 0.05$. Descriptive statistics were calculated for all variables. Mixed-design ANOVA was used to examine between-group and within-group changes over time. Chi-square analysis was employed to compare injury rates between groups. Effect sizes were calculated using Cohen's d to determine practical significance of observed changes.

Results

The 16-week resistance training intervention produced significant improvements in shoulder strength parameters and marked reductions in injury incidence among the experimental group. All participants in the resistance training group

(Group I) completed the full intervention without adverse events, demonstrating excellent program adherence and safety.

Shoulder Strength Outcomes: The resistance training group showed substantial improvements across all measured strength parameters. External rotation strength increased from a baseline mean of $18.4 \pm$

3.2 Nm to $22.7 \pm 3.8 \text{ Nm}$ (23.5% improvement), while internal rotation strength improved from 24.1

$\pm 4.1 \text{ Nm}$ to $28.9 \pm 4.6 \text{ Nm}$ (19.8% increase). Shoulder abduction strength demonstrated a 21.3% improvement, and flexion strength increased by 17.6%. The traditional training group (Group II) showed modest improvements ranging from 6-9% across strength measures, while the control group (Group III) exhibited minimal changes (1-3%).

Injury Prevention Results: The most striking finding was the dramatic reduction in shoulder injury rates in the resistance training group. Throughout the 16-week study period, only 2 out of 24 participants (8.3%) in the resistance training group experienced shoulder injuries requiring medical attention or time loss from activity. In contrast, the traditional training group had 7 shoulder injuries (29.2%), and the control group recorded 9 shoulder injuries (37.5%). This represents a 67% relative risk reduction for the resistance training group compared to the control group.

Functional Movement Improvements: Functional movement screen scores improved significantly in the resistance training group, with particular enhancements in shoulder mobility and stability components. The mean FMS composite score increased from 14.2 ± 2.1 to 16.8 ± 1.9 , indicating improved movement quality and reduced injury risk factors.

Table 1: Pre- and Post-Intervention Shoulder Strength Measurements (Mean $\pm$ SD)

Group	External Rotation (Nm)	External Rotation (Nm)	Internal Rotation (Nm)	Internal Rotation (Nm)
	Pre	Post	Pre	Post
Group I (Resistance)	18.4 ± 3.2	$22.7 \pm 3.8^*$	24.1 ± 4.1	$28.9 \pm 4.6^*$
Group II (Traditional)	18.1 ± 3.5	19.2 ± 3.7	23.8 ± 4.3	25.3 ± 4.5
Group III (Control)	18.3 ± 3.1	18.5 ± 3.2	24.0 ± 4.0	24.2 ± 4.1

*Significant difference from baseline ($p < 0.05$)

Table 1 demonstrates the superior strength gains achieved by the resistance training group compared to both comparison groups. The marked improvements in both external and internal rotation strength reflect the effectiveness of the targeted strengthening program in addressing the specific muscular demands of volleyball.

Table 2: Shoulder Injury Incidence and Characteristics

Group	Total Injuries	Injury Rate (%)	Time Loss Injuries	Overuse Injuries	Acute Injuries
Group I (Resistance)	2	8.3%	1	1	1
Group II (Traditional)	7	29.2%	4	5	2
Group III (Control)	9	37.5%	6	7	2

Table 2 clearly illustrates the protective effect of resistance training on shoulder injury occurrence. The resistance training group experienced significantly fewer total injuries, time-loss injuries, and overuse-related problems compared to both comparison groups, supporting the injury prevention benefits of structured strength training.

Discussion

The findings of this study provide compelling evidence for the dual benefits of resistance training in school volleyball players: significant enhancement of shoulder strength and substantial reduction in injury risk. The 23.5% improvement in external rotation strength observed in the resistance training group is particularly noteworthy, as external rotator weakness is a well-established risk factor for shoulder injury in overhead athletes. This improvement likely reflects enhanced rotator cuff function and improved dynamic shoulder stability during volleyball-specific movements.

The dramatic 67% reduction in shoulder injury incidence represents one of the most significant injury prevention outcomes reported in the school sports literature. This finding has profound practical implications for school volleyball programs, suggesting that implementation of structured resistance training protocols could prevent a substantial number

of season-ending injuries and associated long- term health consequences. The predominantly overuse nature of prevented injuries aligns with the understanding that resistance training helps prepare tissues to withstand repetitive stress and loading. **Mechanisms of Injury Prevention:** Several mechanisms likely contribute to the observed injury prevention benefits. First, the improved strength of the rotator cuff muscles enhances dynamic glenohumeral stability, reducing excessive translation during overhead movements. Second, strengthening of the scapular stabilizers improves scapulohumeral rhythm and reduces impingement risk. Third, the progressive loading provided by resistance training promotes adaptive tissue remodeling, increasing the load-bearing capacity of tendons and other soft tissue structures.

Practical Applications: The twice-weekly training frequency used in this study represents a realistic and sustainable approach for school programs with limited resources and time constraints. The progressive nature of the program, starting at moderate intensities and advancing based on individual response, provides a safe framework for implementation across diverse populations and skill levels. The use of relatively simple equipment (resistance bands, dumbbells, bodyweight exercises) makes the program accessible to most school settings.

Comparison with Previous Research: These results align with and extend previous findings in collegiate and professional volleyball populations, demonstrating that the benefits of resistance training extend to younger, developing athletes. The magnitude of strength improvements observed (17-24%) is consistent with expected adaptations from well-designed resistance training programs in adolescent populations.

Limitations and Future Directions: While these results are encouraging, several limitations should be acknowledged. The 16-week intervention period, while substantial, represents a single competitive season, and longer-term follow-up would be valuable to assess sustained benefits. Additionally, the study population was limited to one geographic region, and replication across diverse populations would strengthen the generalizability of findings.

Conclusion

This study demonstrates that a structured, volleyball-specific resistance training program can significantly enhance shoulder strength and provide substantial injury prevention benefits in school volleyball players. The 16-week intervention resulted in meaningful improvements in all measured strength parameters, with external rotation strength showing the most pronounced gains (23.5% improvement). Most importantly, the resistance training program reduced shoulder injury incidence by 67% compared to standard volleyball training, with only 8.3% of participants experiencing shoulder injuries versus 37.5% in the control group.

These findings have immediate practical applications for school volleyball programs seeking to optimize both performance and player safety. The twice-weekly training frequency and use of accessible equipment make the program feasible for implementation in typical school settings with limited resources. The progressive nature of the protocol ensures safe implementation across diverse populations while providing adequate stimulus for meaningful adaptations. The substantial injury prevention benefits observed in this study underscore the critical importance of incorporating evidence-based strength training into school volleyball programs. Given the high incidence of shoulder injuries in volleyball and their potential long-term consequences, the implementation of resistance training protocols should be considered a fundamental component of comprehensive athlete development programs rather than an optional enhancement.

School administrators, coaches, and athletic trainers are strongly encouraged to integrate structured shoulder strengthening programs into their volleyball training regimens. The investment in resistance training equipment and supervision represents a cost-effective strategy for reducing injury- related medical expenses, preventing lost participation time, and promoting long-term shoulder health in young athletes. Future research should focus on optimizing training parameters for different age groups and competitive levels while exploring the long-term retention of benefits following program completion.

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