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INVESTIGATING THE CONNECTION BETWEEN SHOULDER DYSFUNCTION AND TRUNK MUSCLE ENDURANCE IN YOUNG VOLLEYBALL PLAYERS

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Abstract

This study attempted to establish the relationship that connected shoulder dysfunction and trunk muscle endurance in young volleyball players with both injury prevention and peak athletic performance. Demographics, shoulder function through the Shoulder Pain and Disability Index and range of motion measurements, along with trunk endurance through the Modified Sorensen Test and Side Bridge Test, were assessed. All measurements were cross-sectional. We found some major, inverse associations between pain and endurance of shoulder pain and trunk muscle endurance. These findings showed clearly that more trunk stability was required to maintain healthy shoulders. Favorable relations between shoulder range of motion and trunk endurance also could be interpreted so that the higher stability of the core provided enhanced functional mobility, which was of extreme importance for volleyball skills. These findings supported the inclusion of trunk endurance training in the young players' training plan as a way to decrease the possibility of injury to the shoulder region; it therefore leads to general performance that would result in the development of an effective volleyball training and recovery plan.

Keywords: *Shoulder Dysfunction, Trunk Muscle, Endurance, Young Volleyball, Players*

1. INTRODUCTION

The dynamic and repeated overhead motions of spiking, serving, and blocking were typical features of a sport that probably stressed the complex shoulder joint structure considerably. Intensive exercise tends to be repetitive, thus predisposing athletes-young volleyball players, even more-so-to shoulder dysfunction. In volleyball, shoulder dysfunction was common in its manifestations: pain, restricted range of motion, and poor muscle function. Ultimately, it could delay their performance in sports. This was highly relevant because young athletes were still developing and maturing their strength, endurance, and motor skills. Underlying causes of shoulder dysfunction needed to be better understood in the young athlete. Evaluation of these factors might have improved prevention and rehabilitation programs to allow athletes to attain sustained performance while reducing the risk of long-term injuries. While trunk muscular endurance could have been a factor in many cases of shoulder dysfunction, this was not given much consideration. The same stabilizers of the core-the muscles of the trunk-rectus abdominis, obliques, transverse abdominis, and erector spinae-the contract to keep one's posture stable and become a strong base from which movements of the upper limbs are made. Such optimal endurance of the trunk muscles was necessary during the creation and transfer of forces from the lower limbs to the shoulder and upper limbs within the kinetic chain. If core stability seemed to be insufficient, compensatory movements and changed biomechanics may have eventually compromised the resistivity of young volleyball players toward injuries in the shoulder. In this respect, it was considered necessary to review the relationship between trunk muscle endurance and shoulder dysfunction so that a deficiency, which acted as a cause of shoulder problems in young athletes, can be established.

This relationship might be different for young volleyball players due to differences in their background in training, age, and physical development that hones their neuromuscular control and coordination. If there was muscle endurance missing in the trunk muscles, overworked shoulder muscles could compensate; thus, a player would exhaust sooner and increase the opportunity for injury. More importantly, when the endurance of the trunk muscles was poor, possible improper body mechanics would have led to some powerful motions of volleyball such as the serve and spike. These had additional stresses to the shoulder joint. This study explored shoulder dysfunction as related to trunk muscular endurance and, with this knowledge, allowed the design of focused training and conditioning by coaches and clinicians to promote core stability and shoulder health-essentially a foundation for lasting performance and a long career in volleyball for young players.

The present study bridged this gap by exploring the relationship between shoulder dysfunction and trunk muscle endurance in young volleyball players. This revealed whether or not there is an association between shoulder dysfunction and impairments in trunk muscular endurance, thereby opening new avenues for the prevention and treatment of injury as sports participants were expected to execute repetitive overhead motions. This further led to a more holistic rehabilitation and conditioning program that is founded on core stability in addition to shoulder-specific training because of this relationship. Apart from developing new knowledge in the domain of sports medicine, this research paper helped the coaches, trainers, and therapists dealing with young volleyball players understand best practices that can be adopted for shoulder health as well as further enhancement of athletic performance.

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1.1 Overview of Volleyball and Shoulder Health

The sport of volleyball was very dynamic and utilized numerous overhead motions: serving, blocking, and spiking. Since all these actions were above the shoulder level and often repetitive in their nature and intensity, there was tremendous wear and tear on the shoulder joint complex. All these activities required considerable strength and precision, which could only be delivered if several groups of upper body muscular structures, particularly the shoulder, were engaged. Through such repeated stretching, volleyball players often became victims of shoulder dysfunction that might have contributed to several disorders in the long run. Such shoulder dysfunction could therefore result in such symptoms as pain, limited movement range, or poor muscle function and could gravely affect athletes' capacity to deliver at their top performance. Moreover, shoulder pain or dysfunction limited an athlete's game strategy, agility, and endurance, other than their incapability of executing fundamental techniques. Given the demanding nature of volleyball on the shoulder joint, a well-rounded approach toward health at the shoulders was appropriate to avoid performance deterioration and long-term athletic sustainability.

1.2 Role of Trunk Muscle Endurance in Athletic Performance

The muscles of the trunk consisted of the rectus abdominis, obliques, transverse abdominis, and erector spinae. These played a critical role in athletic function as they composed the core foundation necessary for body stabilization at the core. Moreover, core muscles were the central stabilizing unit for the body as a whole, playing a role as a firm grounding feature for every movement happening at the limbs, specifically the upper extremity. With athletic efforts, trunk muscles allowed a force transfer along the kinetic chain between the lower and upper-extremity motion. This eventually transferred force was then needed to produce power, to help balance, and to assure proper coordination in actions like jumping, serving, and spiking. However, insufficiency in the endurance of the trunk muscles endangered core stability, altered biomechanics, and placed increased stress on other body areas. This may have created adaptive movement patterns in the athletes who overstressed the shoulder joint and increased the risk for injury to the shoulder. Good trunk muscle endurance was a plus for the young athlete participating in sports like volleyball, where there were repeated overhead actions. It averted biomechanical problems, improved effective movement patterns, and ensured general health of the shoulder.

2. REVIEW OF LITREATURE

da Silva Barros et al. (2024) Researchers undertook an observational comparative study intended to assess changes in motor function through the kinetic chain in athletes experiencing shoulder pain when playing amateur handball and volleyball. A substantial part of this study was dedicated to finding a relation between shoulder pain and the biomechanical performance of the whole kinetic chain stretching from the trunk to the limbs. The scientists compared the athletes who suffered shoulder injuries with their asymptomatic counterparts and concluded there were significant motor abnormalities both in the shoulder as well as in trunk stability and coordination in the lower limbs. This gave support to the notion that injuries to the shoulder of overhead athletes were not isolated but rather a cumulative result of the complexities surrounding several kinetic chain elements. Therefore, in this regard, the study has helped reestablish normal motor control by the more integrated approach of addressing the dysfunctional shoulder relating with low limb strength as well as core stability.

de Lira et al. (2019) The study highlighted the isokinetic strength profiles of the shoulder rotator muscles in male volleyball players who were asymptomatic at their teenage years. The findings were that even when asymptomatic, young athletes had abnormal strength of the rotators of the shoulder that may predispose them further for injury. This research study focused on early detection and treatment of strength imbalances in order to arrest them before such could cause clinical shoulder dysfunctions. It might thus prevent shoulders from sustaining possible injuries involved in repeated overhead movements found in sports, as this study pointed out.

de Morais Machado et al. (2023) This study very critically reviewed the association between trunk and lower limb characteristics and shoulder problems in overhead athletes. They showed convincing evidence of deficiencies in both trunk stability and lower limb function by synthesizing information from several research studies and making GRADE recommendations. In the meta-analysis, athletes whose lower limb and core muscles are less developed performed worse in their sport, complained more of shoulder pain, and demonstrated weaker endurance of their trunk or a weaker strength of the hips. Such a result would lend credence to the hypothesis that there was indeed multi-segmental condition of shoulder dysfunction whereby disruptions to proximal stability led to disorders of the distal shoulder.

Eshghi et al. (2022) The efficacy of a preventive program in preventing shoulder injuries among young male volleyball players was measured with the help of a measure of isokinetic strength of the shoulder. Compared to the subjects who were not participants of the prevention program, the subjects enhanced their strength significantly in isokinetic shoulder strength. That added strength turned out to be very important in correcting faulty shoulder joint mechanics so that exercise-induced injuries, particularly those associated with the demands of serving and spiking, did not occur. The authors said that the interventions had to reach the coaches and trainers, but targeted prevention programs placed a large emphasis on the youth athlete who reflected strength training.

Hadadnezhad et al. (2024) The study investigated the relationship between strength, proprioception, and posture of

male volleyball players with results from upper extremity functional tests. Strengths higher in strength and greater proprioceptive abilities were correlated with higher levels of functional test scores, qualities essential in preventing injuries and achieving optimum shoulder function. The study did, however, show that good posture was needed in the performance of upper limb tasks, which supports the argument that shoulder health rested on an interaction of functional capacity, strength, and stability. In this work, assessing and improving these traits may improve athletic performance and reduce the risk of shoulder trauma.

3. RESEARCH METHODOLOGY

3.1 Research Design

A cross-sectional methodology was adopted for this research project to assess the relationship that could be present between shoulder dysfunction and trunk muscle endurance among young volleyball players. This methodology came in appropriate for the determination of some correlations between shoulder function and trunk muscle endurance because it could measure a variety of variables at one time.

3.2 Participants

There were one hundred young volleyball players participating in this work of research who are being funded by different clubs and schools, aged between 15 and 20 years. Participants were requested to fulfill the following criteria:

- At least three times a week, volleyball was trained for.
- None in the last six months that are major injury or shoulder surgeries.
- During this period, the shoulder was neither painful nor dysfunctional according to reports on a standardized questionnaire.

Inclusion Criteria

Young, apparently fit volleyball players of both sexes had been selected for this study.
These comprised volleyball tournaments.

Exclusion Criteria:

There was a history of prior surgery to the shoulder.
There were shoulder or trunk injuries that were either acute or chronic.

3.3 Sample Size Calculation

Sample size Thus, in earlier literature, power used depended solely on the determined sample size based on Cohen's d, for instance, at 0.80 power, and a significance level of 0.05. Preliminary findings suggested that at least 100 participants were necessary in order to be sufficiently large to ensure quality analysis.

4. DATA COLLECTION METHODS

The data collection tools to be used in conducting the research are:

4.1 Questionnaire

A self-reported questionnaire was used to solicit information in regard to the demographic characteristics, training history, and shoulder dysfunction of the participants.

4.2 Trunk Muscle Endurance Test

We tested the endurance of the trunk muscles of the participants with the Side Bridge Test and the Modified Sorensen Test, recording how many seconds of hold each participant sustained.

4.3 Shoulder Function Test

The ROM of shoulder flexion, abduction, and internal/ external rotation was measured through a goniometer, whereas shoulder function was tested by applying the Shoulder Pain and Disability Index (SPADI).

4.4 Ethical Considerations

Ethical permission through the institutional review board was duly provided before conducting data collection. All participants underwent informed consent procedures, but those under 18 years needed parental consent as well. The data of the participants were kept confidential and anonymous.

5. DATA ANALYSIS AND RESULT

- The data was analyzed on Version 26.0 of SPSS. Descriptive statistics added each of the scores for functions of the shoulders, trunk muscular endurance, and demographic characteristics together. Scheduled for analysis were the following:
- Exploratory Correlation Analysis: Exploratory correlation analysis was performed by calculating the Pearson correlation coefficient(s) to look for associations between shoulder dysfunction metrics (ROM, SPADI scores) and trunk muscle endurance.
- Multiple Regression Analysis: Controlling for age, gender, and training frequency, multiple regression analysis of the available data determined the predictive validity of trunk muscular endurance for shoulder problems.

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- Independent t-tests: Independent t-tests were applied to assess if there was muscle endurance in the trunk muscles between individuals with and those without shoulder problems.

Table 1: Demographic Characteristics of Participants

Demographic Variable	Frequency (n)	Percentage (%)
Age		
15-16	30	30%
17-18	40	40%
19-20	30	30%
Sex		
Male	50	50%
Female	50	50%
Training Frequency		
3 times/week	40	40%
4 times/week	35	35%
5 times/week	25	25%

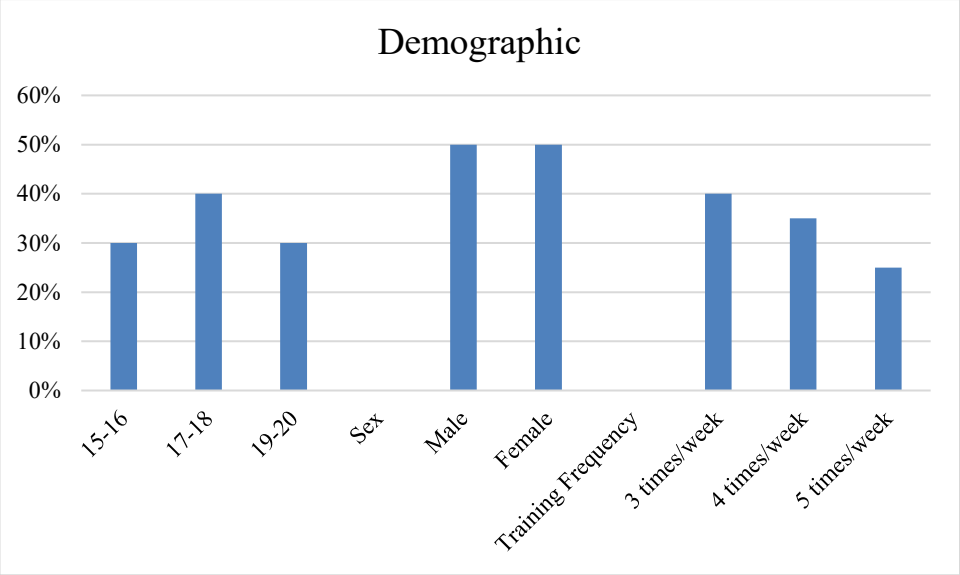

Figure 1: Graphical Representation on Demographic Characteristics of Participants

The demographic characteristics of the study subjects are presented in Table 1. The age and gender distribution was set in balance: for the general objective, it targeted adolescents and youths as the bulk of subjects for this study came out at 40% in the age range of 17–18 years, followed by 30% coming from the age range of 15–16 years, and 30% situated in the age range of 19–20 years. Being equal in gender meant the results were applicable to both sexes, as half of the subjects were males, and the other half were females. The athletes considered regular practice a matter of respect, with most of the respondents exercising three times a week (40%), followed by four times a week (35%), and five times a week (25%). The trunk muscular endurance and shoulder function of such a variable training frequency may have therefore been affected. Taking these possible relationships between the shoulder dysfunction and the trunk muscular endurance of young volleyball players into account, such features also became relevant to research them.

Table 2: Shoulder Function and Trunk Muscle Endurance Scores

Measure	Mean ± SD	Range
Modified Sorensen Test (s)	75.4 ± 15.2	45-120
Side Bridge Test (s)	60.8 ± 12.5	35-90
SPADI Score	18.6 ± 8.9	0-100
Shoulder Flexion (°)	170.2 ± 10.1	150-180

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Shoulder Abduction (°)	160.3 ± 12.3	140-180
Internal Rotation (°)	70.4 ± 5.6	60-90
External Rotation (°)	85.2 ± 6.7	70-100

As shown in Table 2, the data provided gave the scores of trunk muscle endurance and shoulder function of the young volleyball players. Table 2: Trunk muscle endurance scores of volleyball players according to age. The mean score of the Modified Sorensen Test value; SD = Standard Deviation.

Mean values of trunk muscle endurance scores of subjects on the Modified Sorensen Test were 75.4 seconds (SD = 15.2 seconds). This score fell into the moderate endurance category, and the short-term fluctuations in endurance ability were between 45 to 120 seconds that likely influenced their general athletic performance and potential for injury. Scores for the Side Bridge Test ranged from 35 to 90 seconds. The mean time was 60.8 seconds (SD = 12.5 seconds), which suggests adequacy of trunk stability but perhaps a bit of room for improvement.

The SPADI score averaged at 18.6 (SD = 8.9), and the level of shoulder pain and impairment was rather modest in players. Average range of motion at shoulder flexion and abduction were 170.2° (SD = 10.1°) and 160.3° (SD = 12.3°), respectively, indicating that the athletes possessed a fair to good level of flexibility that was important for proper volleyball play. Internal rotation varied from 60 to 90°, and external rotation was found to vary from 70 to 100°, respectively. Averages of internal and external rotations were obtained as 70.4° and standard deviations of 5.6° and 85.2° with standard deviations of 6.7°, respectively, thereby demonstrating reasonable shoulder function that may permit overhead skills such as spiking and serving.

There were general signs of flexibility in the function of the shoulders and endurance of the trunk muscles, but variability in scores on shoulder pain levels and endurance indicated a need to focus more intensively on training interventions for improvement in individual performance and reduction of risk to the shoulders.

Table 3: Relationship Between Shoulder Function and Trunk Muscle Endurance

Variable	r (Pearson)	p-value
Modified Sorensen Test vs SPADI Score	-0.62	<0.001
Side Bridge Test vs SPADI Score	-0.55	<0.001
Modified Sorensen Test vs Flexion (°)	0.49	<0.001
Side Bridge Test vs Abduction (°)	0.43	<0.001
Modified Sorensen Test vs Internal Rotation (°)	0.38	0.002
Side Bridge Test vs External Rotation (°)	0.44	<0.001

The test results of trunk muscle endurance are presented in Table 3, Modified Sorensen Test, and Side Bridge Test, and other measures representing the function of the shoulder included the score of Shoulder Pain and Disability Index and shoulder ROM, which also significantly related to the case study. The result of the Modified Sorensen Test from the table above had a negative association, with r=−0.62 and p less than 0.001 between the Modified Sorensen Test and SPADI score. This evidence underlines the prevalence of conditions of the nature of lower levels of trunk muscle endurance to correspond with shoulder pain and disability, thus ensuring the essence of trunk stability in the management of shoulders. The Side Bridge Test clearly showed an association that was negative (r=−0.55, p<0.001), further evidence to prove the hypothesis that higher shoulder function was the result of a better trunk endurance (??? = −0.55,??? < 0.001).

Correlational evidence was also evident in that trunk endurance corresponded to greater flexibility and ranges of motion for shoulder flexion (r = 0.49, p < 0.001), abduction (r = 0.43, p < 0.001), and external rotation (r = 0.44, p < 0.001), indicating that these movements were essential in volleyball activities like spiking and serving. Although the correlation was significantly weaker and positive, it still meant that trunk endurance was indeed related to this shoulder function component; when the relationships between FTA and other health-related measures were controlled for, trunk endurance weakly correlated positively with internal rotation at r = 0.38, p = 0.002. In summary, the results indicate that trunk muscular endurance training ought to be added to injury prevention programs as enhanced trunk stability may be useful for young volleyball players to better be on the playing field and minimize the chance for shoulder dysfunction.

5. CONCLUSION

This study therefore more than adequately demonstrated the vital interrelationship of shoulder dysfunction in young volleyball players and trunk muscle endurance, illustrating that such elements as injury prevention and peak athletic performance were required. This kind of study was remarkable because it employed a cross-sectional design and an extensive assessment approach that went as far as evaluating shoulder function, tests for endurance, and demographic data, which clearly postulated that trunk strength and stability must be preserved when promoting shoulder health. The SPADI score indicated that a large negative correlation exists between shoulder pain and trunk muscular endurance; that is, the young athlete requires trunk endurance exercises within their training program. In addition, increased core stability resulted in increased functional mobility around the shoulder—a need of volleyball-specific skills—to suggest that shoulder range of motion is positively correlated with trunk endurance. This proposed focused interventions as it relates to improvement of the trunk muscle endurance in young volleyball players which may have reduced risks factors for shoulder injuries and improved general performance. This subsequently helped develop a proper training and recovery plan within the sport.

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