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Original Research Article

An observational study on the influence of latissimus dorsi length on upper limb reaction time in recreational volleyball players

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ABSTRACT

Background: Reaction time is a critical determinant of athletic performance, particularly in sports like volleyball that demand rapid upper limb responses. The latissimus dorsi muscle, essential for upper limb mobility and postural stability, may influence neuromuscular responsiveness through its length and flexibility. This observational study aimed to investigate the relationship between latissimus dorsi muscle length and upper limb reaction time in recreational volleyball players aged 18-25 years.

Methods: Eighty recreational volleyball players aged 18-25 years were recruited. Participants with a normal lumbar lordotic angle and disabilities of the arm, shoulder, and hand (DASH) scores indicating no significant upper limb disability were included. Lumbar lordosis was assessed using the flexicurve method, latissimus dorsi muscle length was measured using an inch tape, and upper limb reaction time was evaluated via the ruler drop test. Data were analyzed using SPSS version 23.0, with Spearman's correlation employed to assess associations.

Results: A weak positive correlation was observed between right latissimus dorsi length and right upper limb reaction time ($r=0.222$, $p<0.05$), while a moderate positive correlation was found between left latissimus dorsi length and left reaction time ($r=0.313$, $p<0.05$). These findings suggest that increased muscle length is associated with slightly prolonged reaction times.

Conclusions: This study found a significant weak-to-moderate positive correlation between latissimus dorsi length and upper limb reaction time. These results suggest that muscle flexibility may influence neuromuscular performance and highlight the need for further research into flexibility training to enhance athletic performance.

Keywords: Flexibility, Flexicurve, Latissimus dorsi, Muscle length, Neuromuscular performance, Reaction speed, Ruler drop test, Upper limb reaction time, Volleyball

INTRODUCTION

Volleyball is a dynamic, fast-paced sport requiring a combination of physical, cognitive, and motor abilities to ensure peak performance.[1] As an open-skill sport, volleyball demands quick decision-making and adaptability, as players must constantly react to unpredictable situations and modify their movements accordingly.[2]

Reaction time, defined as the interval between perceiving a stimulus and initiating a response, plays a crucial role in volleyball performance. Athletes with faster reaction times can anticipate and execute movements more effectively, particularly in defensive plays such as blocking and receiving.[3] Reaction time is influenced by several factors, including neural transmission speed, task complexity, and muscle group involvement.[4] Additionally, studies indicate that males typically exhibit faster reaction times than females and that right-handed individuals tend to react quicker with their dominant hand.[5] The ability to react rapidly is vital for volleyball players, as the ball can travel over 100 km/h, requiring explosive movements such as spiking, blocking, and defensive manoeuvres to maintain game control.[6]

Shoulder mobility is another essential component of volleyball performance, particularly in executing spikes and blocks. The latissimus dorsi, a large back muscle responsible for shoulder extension and adduction, plays a vital role in generating force and maintaining proper mechanics.[7] The length of the latissimus dorsi is crucial as optimal muscle length allows full shoulder flexion, enabling necessary lateral humeral rotation and scapular movement for effective overhead mechanics.[8] Muscle length assessments are useful for tracking changes over time, as variations in flexibility may arise due to training, injury, or habitual posture.[9]

Limited latissimus dorsi flexibility has been linked to restricted shoulder mobility, increasing the risk of musculoskeletal imbalances and injury.[10] Overhead athletes depend on unrestricted shoulder mobility, making optimal latissimus dorsi length a key factor for volleyball players seeking to maximize reaction time efficiency.[11] Differences in muscle structure and neuromuscular response between male and female players can influence reaction time and movement efficiency, impacting technical execution.[12]

This study examined whether latissimus dorsi muscle length affects reaction time in volleyball players. Understanding how muscle flexibility impacts arm movement speed could provide valuable insights for improving warm-up protocols, flexibility training, and injury prevention strategies. These findings may help coaches and trainers refine training methodologies, ultimately enhancing player performance and optimizing athletic longevity in volleyball competition.

METHODS

Study design and setting

This observational study was conducted over an eight-month period, from March to November 2024, at Tejasvini Physiotherapy College, Mangalore, Karnataka.

Study participants and sampling

The study involved recreational volleyball players aged 18-25 years, selected through predefined inclusion and exclusion criteria. Eligibility criteria included individuals with a normal lumbar lordotic angle and a DASH (disabilities of the arm, shoulder, and hand) score indicating no significant upper limb disability. Exclusion criteria encompassed participants with either increased or decreased lumbar lordotic angle or abnormal DASH scores.

Data collection tool and technique

Participants were briefed about the study's purpose and procedures, and written informed consent was obtained prior to assessments. Demographic data, including age, gender, height, and weight, were recorded. Participants with either increased or decreased lumbar lordotic angle or abnormal DASH scores were excluded from the study. The length of the latissimus dorsi muscle was assessed using the inch tape method, with participants positioned according to standardized guidelines to ensure consistency of measurement. Upper limb reaction time was evaluated using the ruler drop method, a simple and reliable method which evaluates the time taken by an individual to respond to a visual stimulus by catching a falling ruler. All measurements were conducted by a single examiner to reduce inter-rater variability. Data collected were then analysed to examine the relationship between latissimus dorsi length and upper limb reaction time in the study population.

Outcome measures

The DASH score (disabilities of the arm, shoulder, and hand questionnaire) is a standardized tool to evaluate upper limb function and symptoms through 30 items scored on a 5-point scale. It calculates a total score out of 100, where higher scores indicate greater disability. Reliable and valid, it is widely used in clinical and research settings. In this study, it served as an exclusion criterion to ensure participants had no upper limb dysfunction affecting the assessments.[13]

The flexicurve, a flexible ruler, is used to non-invasively assess lumbar lordosis. It is moulded to the lumbar spine's contour while the subject stands upright, then transferred onto graph paper to create a two-dimensional representation. Measurements like curve length and depth are used to calculate the lumbar lordotic index. In this study, participants with abnormal lumbar lordotic angles were excluded to minimize biomechanical influences on upper limb performance.[14]

The latissimus dorsi length was measured using a non-invasive inch tape method. Participants lay supine, flexing hips and knees with feet flat to ensure lumbar spine contact with the table. Arms were positioned in maximal shoulder flexion with elbows extended and forearms neutral, stretching the latissimus dorsi. The vertical distance from the lateral epicondyle to the table was recorded, where greater distance indicated reduced muscle flexibility. Only one measurement was taken to prevent alterations in muscle length due to repeated movements. This method provided an efficient assessment of latissimus dorsi flexibility.[14]

The ruler drop test, a reliable method for assessing neuromuscular response speed, measured upper limb reaction time. Subjects sat with elbows flexed at 90° and forearms mid-pronated on a flat surface. A 30 cm ruler was held vertically above the web space of the thumb and index finger without contact. Subjects caught the ruler as quickly as possible after random release, with the distance fallen recorded. Reaction time was calculated using t=√(2d/g), where (t) is time in seconds, (d) is distance in meters, and (g) is gravity (9.81 m/s^2). Three trials per subject were averaged for analysis to ensure reliability.[15]

Statistical analysis

Statistical analysis of the data was done using SPSS 23.0. Normality of the data was established by using Kolmogorov-Smirnov test and found that data are normally distributed. Descriptive statistics were calculated by mean and standard deviation for continuous variables and frequency and percentage for categorical variables. Inferential statistics had been carried out by Karl Pearson correlation test to study the relationship between variables. Level of significance was set at p<0.05.

RESULTS

The descriptive statistics of the study participants (n=80) revealed that the age ranged from 18 to 25 years, with a mean of 20.7±1.6 years, indicating a young and homogeneous group. The mean weight was 58.6±11.8 kg, with values ranging from 38 kg to 102 kg, showing moderate variation in body mass. Heights ranged from 145 cm to 193 cm, with a mean of 166.3±9.1 cm, reflecting fair distribution in stature. These findings establish a comprehensive physical profile of the recreational volleyball players in this study (Table 1).

Table 1: Demographic data of the study participants.

Variables	Mini.	Max.	Mean	SD
Age (years)	18	25	20.7	1.6
Weight	38	102	58.6	11.8
Height	145	193	166.3	9.1

Table 2: Gender distribution of the study participants.

Gender	Frequency	Percentage (%)
Male	42	52.5
Female	38	47.5

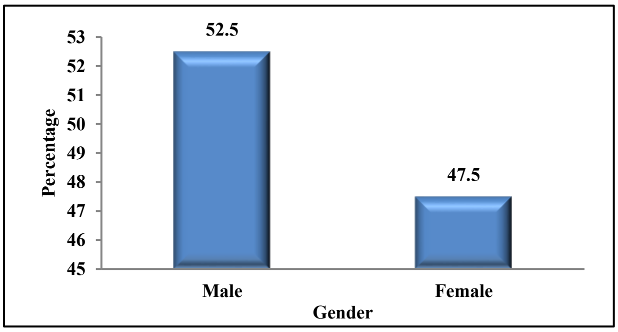

Figure 1: Percentage distribution of subjects based on basis of gender.

The gender distribution of the study participants (n=80) is depicted in Table 2 and Figure 1. Table 2 reveals that 42 participants (52.5%) were male, while 38 participants (47.5%) were female, indicating a relatively balanced gender composition with a slight predominance of male participants. Figure 1 provides a bar graph representation of this data, visually illustrating the proportion of male and female participants. The graph aligns with the numerical data, emphasizing the marginally higher percentage of male participants in the study.

Table 3: Correlation of right l. dorsi length and right reaction time.

Variables	Mean	SD	r value	P value
Right l. dorsi length	9.1	2.7	0.222	0.048*
Right reaction time	0.175	0.021		

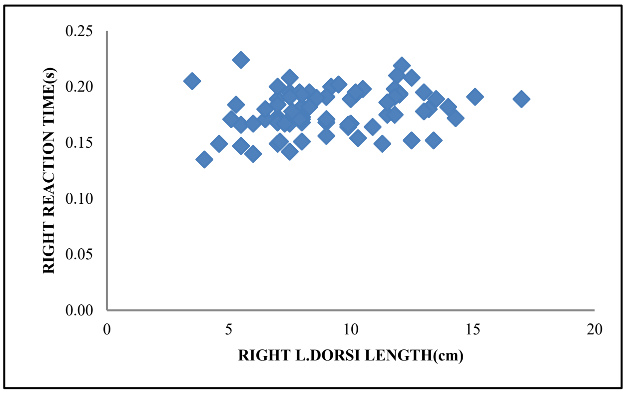

Figure 2: Scatter diagram of right l. dorsi length and right reaction time.

Table 3 and Figure 2 collectively demonstrate the relationship between right latissimus dorsi (l. dorsi) length and right upper limb reaction time among participants (n=80). The mean muscle length was 9.1±2.7 cm, while the mean reaction time was 0.175±0.021 seconds. Pearson correlation analysis revealed a weak but statistically significant positive correlation (r=0.222, p=0.048), suggesting that increased latissimus dorsi length is slightly associated with prolonged reaction time. The scatter plot in Figure 2 visually supports this finding, showing a weak positive trend. The scattered data points highlight the weak strength of the correlation, while the trend line confirms the overall direction of the relationship. These findings suggest a potential influence of muscle length on neuromuscular responsiveness in the upper limb.

Table 4: Correlation of left l. dorsi length and left reaction time.

Variables	Mean	SD	r value	P value
Left l. dorsi length	9.12	2.9	0.313	0.005*
Left reaction time	0.178	0.019		

*Statistically significant.

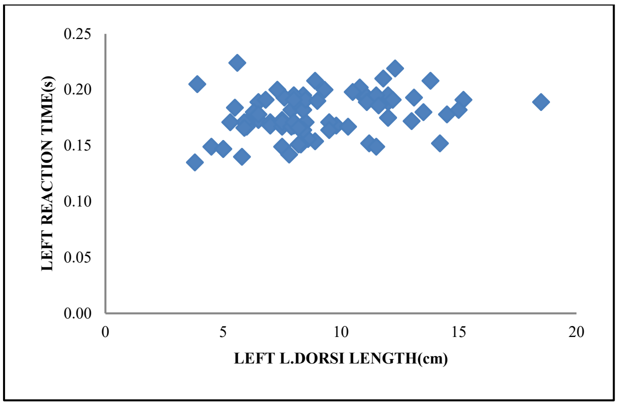

Figure 2: Scatter diagram of left l. dorsi length and left reaction time.

Table 4 and Figure 3 collectively present the relationship between left latissimus dorsi (l. dorsi) length and left upper limb reaction time among the study participants (n=80). The mean length of the left latissimus dorsi was 9.12±2.9 cm, while the mean reaction time was 0.178±0.019 seconds. Pearson correlation analysis revealed a moderate positive correlation (r=0.313, p=0.005), indicating a statistically significant association between increased muscle length and prolonged reaction time.

Figure 3 visually reinforces these findings, displaying a scatter plot with a moderate positive trend. The upward trend line reflects the direction of the relationship, showing that as latissimus dorsi length increases, reaction time also tends to increase. The scattered data points further confirm the statistical results, highlighting a significant moderate correlation between these variables. These findings suggest a functional link between muscle length and neuromotor responsiveness in the upper limb.

DISCUSSION

This study explored the relationship between latissimus dorsi muscle length and upper limb reaction time in recreational volleyball players aged 18-25 years. The findings revealed a weak positive correlation between right latissimus dorsi length and right reaction time, and a moderate positive correlation between left latissimus dorsi length and left reaction time. These results suggest a weak-to-moderate association between longer l. dorsi muscle length and prolonged reaction time. This relationship is particularly relevant for volleyball players, where swift upper limb reactions are critical for skills like blocking, setting, and spiking. The latissimus dorsi, being integral to shoulder extension, adduction, and internal rotation, affects scapulohumeral rhythm and overall shoulder mobility. Tightness or reduced flexibility in this muscle could impair motor patterns and limit shoulder elevation, potentially slowing reaction times to visual cues.

These results emphasize the importance of maintaining latissimus dorsi flexibility for optimal upper limb mechanics and neuromuscular response, aligning with existing literature that highlights the role of flexibility in athletic performance. Incorporating stretching and myofascial release targeting the latissimus dorsi into sports conditioning programs may enhance reaction speed and reduce injury risks. Although limited research directly examines the relationship between latissimus dorsi length and reaction time, the findings here contribute meaningful insight into this relatively unexplored area.

Reeser et al emphasized the significant stress on the shoulder joint during volleyball spiking, particularly in cross-body and straight-ahead techniques, compared to lower-intensity movements. They highlighted the vital role of upper limb musculature, including the latissimus dorsi, in managing the high torques and angular velocities of overhead movements. Although their study focused on kinetic loads, repeated spiking may lead to adaptive changes in muscle flexibility or length, influencing reaction time and neuromuscular coordination. Building on this rationale, the present study highlights the importance of assessing latissimus dorsi length in volleyball players. Altered muscle mechanics from prolonged exposure to high-intensity movements could impact upper limb responsiveness, reinforcing the need for targeted conditioning programs to optimize flexibility and enhance performance in dynamic sports like volleyball.[16]

The findings by Miranda et al provide insight into postural adaptations during adolescence, particularly in relation to sex and BMI. Their study highlighted that lumbar lordosis was significantly greater in females and obese adolescents, whereas thoracic kyphosis remained unaffected by these variables. Although the current study focused on a different population recreational volleyball players aged 18-25 years and a different variable latissimus dorsi length, the relevance lies in the relationship between postural alignment and musculoskeletal function. Since our study excluded participants with abnormal lumbar lordotic angles, Miranda et al's findings support the need for such exclusion criteria, as altered spinal curvature can influence the length-tension relationship of surrounding muscles, including the latissimus dorsi. Furthermore, their use of the flexi curve method and its reliability metrics complements our methodological rigor, especially in emphasizing the importance of validated tools when assessing structural components.[17]

Similarly, Herrington and Horsley demonstrated that latissimus dorsi length varies significantly across elite athletes in sports like canoeing, swimming, and rugby, influenced by the physical demands and repetitive movements specific to each sport. Similarly, the present study observed that latissimus dorsi length impacts upper limb reaction time in recreational volleyball players, highlighting its role in dynamic neuromuscular performance. While Herrington and Horsley emphasized shoulder flexion range of motion, this study extends their findings by showing that latissimus dorsi flexibility may also influence reaction time- a critical factor in volleyball.

This reinforces the importance of sport-specific training to optimize muscle function and enhance athletic performance.[8]

Comparisons by Shejwal and Kumar found that football players exhibited faster reaction times compared to volleyball athletes, highlighting the influence of sport-specific demands on neuromuscular responsiveness. In volleyball, slower reaction times may stem from the broader range of upper limb movements, which are influenced by musculoskeletal flexibility, particularly of the latissimus dorsi. Restricted flexibility in this muscle could limit shoulder mobility and delay motor responses, emphasizing the importance of considering biomechanical factors like muscle length when evaluating athletic performance in volleyball.[18]

The contribution of latissimus dorsi flexibility to reaction time remains underexplored, despite its biomechanical significance. This study bridges that gap by demonstrating a relationship between latissimus dorsi length and upper limb reaction time in recreational volleyball players, with longer muscles linked to faster reaction times. These findings suggest that flexibility-focused interventions, such as stretching, myofascial release, and dynamic exercises, could enhance neuromotor efficiency and improve reaction performance. Future research should investigate the mechanisms underlying this relationship and explore training strategies to optimize athletic performance in volleyball.

This study has several limitations that may affect the generalizability and interpretation of the findings. The sample size of 80 participants may not fully represent the broader population of recreational volleyball players, limiting the validity of the results. External factors, such as fatigue, recent physical activity, environmental distractions, and psychological state, could have influenced measurement accuracy. The use of DASH score and lumbar lordotic angle as exclusion criteria may have overlooked other musculoskeletal or neurological factors impacting performance. Additionally, the cross-sectional design only captures data at a single point in time, preventing assessment of long-term changes or training effects. Lastly, the focus on recreational volleyball players aged 18-25 restricts the applicability of the findings to other age groups, skill levels, or sports disciplines.

CONCLUSION

This study revealed a weak positive correlation between right latissimus dorsi length and right reaction time, and a moderate positive correlation on the left side. These findings indicate a weak-to-moderate association between longer latissimus dorsi length and prolonged reaction time in recreational volleyball players aged 18-25. However, greater flexibility in this muscle was linked to faster reaction times, highlighting its role in enhancing neuromuscular performance. The results emphasize the importance of targeted flexibility training, particularly for the latissimus dorsi, to improve reaction speed and upper limb function in volleyball athletes.

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