

## **Title Page**

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Original Article

**Title of the manuscript:** Normative value for Glenohumeral Joint Rotation Range of Motion of Badminton Players and Its Correlation with Stroke Performance

**Short title/running title:** Correlation of Glenohumeral Joint Rotation Range of Motion of Badminton Players with Stroke Performance

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PV conceived and designed the study, conducted research, provided research materials. PV drafted the manuscript and AS and VE provided the content review. All the two authors approved the manuscript

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None of the authors have competing interest declared

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## **Normative Value for Glenohumeral Joint Rotation Range of Motion of Badminton Players and Its Correlation with Stroke Performance**

### **Abstract**

**Background:** Badminton is indoor games which require two to four badminton players performing a variety of movement, patterns such as, lunging, jumping powerful stroke, smash and throughout the game. For the badminton players flexibility of shoulder joint is very important due to frequent movement of the shoulder joint.

**Method:** it was a correlation study in which 58 Subjects were included on the basis of selection criteria. Subjects were recruited from the recognized badminton academies around Haryana and Punjab. The external & internal rotation range of motion in non-dominant and dominant shoulder was measured by the help of goniometer in both the groups, and compared the rotation range of motion in both the groups. The stroke velocity was calculated by the formula,  $\text{speed} = \text{distance} / \text{time}$  in playing population group, and correlated with total rotation ROM of dominant side of playing group, and the data collected by the primary examiner. Data analysis was by SPSS version 20

**Result:** There were 58 participants are recruited in the study Correlation between total range of motion of dominant hand and smash speed of Badminton players shows weak positive correlation (0.023)

**Conclusion** The result of the present study concluded that Comparison of shoulder rotation range of motion is higher in badminton players. And correlation of the total range of motion of the shoulder rotation has a weak positive correlation with smash speed.

**Key words:** Badminton, range of motion, shoulder joint, stroke

## **Introduction**

The badminton player performs different movement patterns such as jumping, lunging, smashes and powerful strokes throughout the game. The game has been made more performance oriented recently with new scientific researches. Badminton requires rhythmic over arm motion that must be well co-ordinate and in a synchronized manner<sup>1</sup>

In badminton, one variety of the 'drop shot' include the player, in a direct movement; slightly 'push' the shuttlecock utilizing the racquet to give it enough speed for it to travel right over the net and into the challenger's court. This kind of shot is different from a smash as the axis motion of the racquet head relation to the hand is critically reduced, rejected or even inclined of, and the speeds of the racquet and the shuttlecock are much reduced. particularly, for this kind of shot, the relationship of the speed of the racquet and the speed of the shuttlecock is important.<sup>2</sup>

During smash, pattern of arm movement is necessary in the completing of the stroke. In one stroke, the movement of the arm is, shoulder is in external rotation, elbow is in flexion which is followed by medial rotation of the humerus during force producing phase during this phase biomechanically a smash is a powerful inward rotation of the shoulder followed by inward rotation of the forearm and finally a flexion of the hand<sup>3</sup>.

Injuries in the shoulder are most usually found in badminton players. Playing a game of badminton need the players to grasp ideal physical fitness along with some of the factors like power, flexibility, strength, agility and speed with these connected factors, <sup>4</sup>

Player who performs overhead smash stroke have to go throughout different direction movement and patterns to reach in the optimal hitting point with stretched out entire body, which means that upper body and smashing arm will be in the most select synchronized stretch position.<sup>5</sup> diminished flexibility in the shoulder not only deteriorate the performance, but also increase the susceptibility to the injury<sup>4</sup>

## **Material and methods**

### **Subjects**

Badminton players were recruited from the Recognized Badminton courts of Haryana and Punjab and normal population were recruited from the university campus .All participants were screened by the principal investigator based on the following criteria. Inclusion criteria- Under training Female badminton players (<1 year), Age14 to19 years, physically active individuals. Exclusion criteria- Recent injury within 6 month duration, any surgical history or clinical condition of upper limb that can affect the test outcome. (E.g. subluxation of shoulder joint), Participants with neurological, psychological orthopedics, condition, Unwilling subjects. Written informed consent was obtained from each participant. The study was approved by the Ethical Committee of Maharishi Markandeshwar (Deemed to be University) Mullana Ambala Haryana with reference no MMDU/IEC113 dated 19/02/2018.In accordance with guidelines laid by ICMR (2017) and Helsinki declaration.

## **Procedures**

### **Glenohumeral joint range of motion**

The GH joint internal and external rotation range of both dominant and non-dominant shoulder was measured using a goniometer, by the primary researcher, Subjects were tested in a supine position with 90° of abduction glenohumeral joint.<sup>6</sup> Over the olecranon process the fulcrum was placed, movable arm was placed over the forearm towards the ulnar styloid process and stable arm was placed towards the ground. Investigator used one hand to support the participants forearm and the movable arm of the goniometer, and other hand of the investigator holds the stable arm of the goniometer. During measurement of internal rotation hand move towards the feet side and during external rotation hand move towards the head side. Dominant and non- dominant side that is IR and ER ROM of the players and normal population was compared after evaluation. TROM was measured in badminton player group that is sum of IR and ER (Figure 1 & 2)

### **Smash velocity**

Smash velocity performed in badminton players group. Participants were instructed to perform smash for 3 times. The examiner takes two participants at the same time and indicates as 1<sup>st</sup> and 2<sup>nd</sup> participants. First participant lift the shuttle cock and 2<sup>nd</sup> participant perform smash at that time. The first participants who lift the shuttlecock were drop the shuttlecock. At that point where the 2<sup>nd</sup> participants perform the smash, the participants position on the same point or place the distance is measured by the use of measuring tape, the distance is measure from the same point where the 2<sup>nd</sup> participants perform the smash and where the shuttlecock is drop, time is measured by the help of

stopwatch and at last the smash velocity is measured formula, **Speed=distance /time** after calculating the smash velocity, then it's correlated with TROM of the dominant side (IR and ER) of badminton players.

### **Statistical analysis:**

statistical package of social science, (SPSS version 20.0) was used to analyzed the data, Independent t test were used to evaluate the normality of the data and the data is not normally distribution, Mann Whitney u test were used to compare the range of motion of Glenohumeral joint between both groups and Spearman correlation coefficient test were used to Correlate the Total rotation range of motion and stroke performance in badminton players and significant level set as  $< 0.05$

**Sample size estimation:** To check the normality of the data Kolmogorov-Smirnov test was used. The sample size for this correlation study was estimated by using the formula  $n = [(z\alpha + z\beta)/c]^2 + 3$  the value of  $r = 0.411$ .<sup>4</sup> 58 sample size has been determined therefore 29 sample were required per group

### **Results**

Total 58 healthy subjects participate in the study, 29 subjects in each group. Demographic characteristics of the participants are present in (Table no. 1). Comparison of shoulder internal and external rotation range of motion between groups the result shows that there is no significant in ROM dominant internal rotation and ROM non-dominant external rotation, while significant in ROM dominant external rotation and ROM

non-dominant internal rotation and the median (IQR) are shown in (Table no.2). Correlation between total range of motion of dominant hand and smash speed of Badminton players shows weak positive correlation (0.023) (Table no.3 & figure 3)

## **Discussion**

One of the most important considerations in the structure of a badminton racket is exchange of physically powerful strokes a leading-edge. Stroke can be translated as enhance of energy exchange at effect, a few essentials add to the exchange of force with racket speed at effect. The sum speed of the racket is made out of an fixed body segment a flexible segment it is along these lines very important to look at to diversion conduct of the racket along with a stroke.<sup>7</sup> The smash is consider as the second most main stroke by the players and it is also the most active technique in badminton mainly during doubles. The major goal in smashing is to hit the shuttle as quick as possible.<sup>8</sup>

In this study we found that normative value for Glenohumeral rotation range of motion of badminton players and correlated it with stroke performance. 58 participants were included in this study, out of which 29 were normal population and 29 were badminton player. In the current study the data is not normally distributed therefore Non Parametric test are used for analyzing between groups and within group values. The demographic characters of participants reveal that the median (IQR) age was 18.0(15.0, 19.0) years; median(IQR) height was 157.4(152.0, 160.0) cm, and median (IQR) weight was 47.5 (43.0, 50.0) Kg. p value is not significant for internal rotation of dominant shoulder and external rotation of non dominant shoulder, p value is significant for external

rotation of dominant shoulder and internal rotation of non dominant in players as well as normal population, in the normal population the restriction in the range of motion of the shoulder may be due to postural adaptation and the during there work and the load of heavy bags may have affected the shoulder ranges

Higher value of shoulder IR and ER was present in badminton players group. This can be due to the fact that recurring overhead motion causes physiological variation in the shoulder

In the present study the Internal Rotation range of motion of the dominant side in players is less than the non-dominant side and the External Rotation range of motion of the dominant shoulder is greater than the non dominant shoulder. The results are in line up with the comparable literature by C. Coupe et, al where the Passive range of motion and isometric strength, in elite female and male badminton players was measured. The results of the study concluded that the Internal Rotation range of motion of dominant shoulder was less than non dominant side and the External Rotation range of motion of the dominant side was more than the dominant side in females.<sup>9</sup>

The null hypothesis was rejected, as weak positive correlation present between dominant shoulder total range of motion of in badminton players and smash speed. An increase in TROM of the shoulder can assist in improving the smash speed during overhead motion in badminton.

### **Limitation of the study**



In the present study the younger age group was taken

Participants of this study were undergoing training badminton players that to with one year or less than one year of training results may vary due to training level of the participants

## **Conclusion**

The result of the current study concluded that correlate the Total Range of Motion and smash speed in players. The result of the present study shows that the TROM of the shoulder have a weak positive correlation with smash speed. Range of IR and ER was increasing with increasing in smash speed. And range of motion is higher in badminton players group.

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**Figure 1: Measuring internal rotation range of motion of GH joint by examiner**



**Figure 2: Measuring external rotation range of motion of GH joint by examiner**

**Table no. 1: Demographic characteristics of participant**

<b>Demographic characteristics</b>	<b>Median (IQR)</b>
Age(Years)	18.0 (15.0,19.0)
Weight(Kg)	74.5 (43.0,50.0)
Height(cm)	157.7 (152.0,160.0)
BMI(Kg/m <sup>2</sup> )	18.9 (18.2,20.1)

**Table no 2: Comparison of shoulder external and internal ROM between groups**

<b>Variable</b>	<b>Median (IQR)</b>	<b>P-value</b>
ROM* Dominant Internal rotation	72.0 (70.0,75.0)	0.127
ROM* Dominant External rotation	89.0 (85.0,95.0)	0.048
ROM* Non-dominant Internal rotation	72.0 (70.0,80.0)	0.000
ROM* Non-dominant External rotation	83.0 (79.0,87.0)	0.894

ROM\* Range of motion

**Table no 3: Correlation of the Total Range of Motion and Smash Speed**

Variable 1	Variable 2	$\rho$	p-value
Smash speed	Total Range Of Motion	0.023	0.904

**Figure 3: Correlation between total range of motion of dominant hand and smash speed of Badminton players shows linear relationship**

