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Correlation of Upper Limb Explosive Power with Smash Velocity and Performance in Badminton Players: A Cross-sectional Study

NITIN KUMAR INDORA[1], POOJA ANAND[2], SUDESH CHETTRI[3], VIPIN KUMAR[4]

ABSTRACT

Introduction: Badminton is a popular Olympic game played in different age groups with different levels of skills. Various techniques of strokes are used by the players. Smashing is one of the offending and powerful stroke techniques used in badminton to defeat the opponent player. Various components of fitness like speed, agility, flexibility, endurance, and power plays an important role in an athlete's performance and upper limb explosive power is one such component that is utilized for a better stroke performance.

Aim: To find the correlation of upper limb explosive power with smash velocity and performance in badminton players.

Materials and Methods: This cross-sectional study including a total of 100 participants by convenient sampling was conducted in Manav Rachna International University, Faridabad, Haryana, India, from September 2017 to March 2019. Out of 100 players, only 85 participants (60 male and 25 female) completed the study. The participants were assessed for Upper Limb Explosive Power (ULEP), Smash Velocity and accuracy. Data analysis was performed using the Karl Pearson's correlation coefficient (p-value ≤0.05).

Results: Significant positive correlation was obtained for ULEP with smash velocity and of accuracy with smash velocity with a value of r-value=0.0414 and r-value=0.468, respectively.

Conclusion: The smash velocity of badminton players is related to upper limb explosive power and accuracy.

Keywords: Athlete stands, Badminton court, Shuttlecock

INTRODUCTION

Badminton is one of the most popular sports in the world, with over 200 million players. It was originated in England and China and has become the national game of many countries [1]. In India, badminton is referred to as the 2nd most common, famous, and participated game after Cricket. This game requires skills, techniques, patience, and muscular strength. Players perform their normal functional activities by using the biomechanical and anatomical principles to determine the response against visual information. This requires an alteration in position, jump and rapid upper limb movements at various postural positions. Athletes also require great physical strength, agility, aerobic strength, and explosive power to perform efficiently [2]. Badminton is a fast-paced racquet sport in which elite players strike the shuttlecock with incredible speed and precision. The kinetics chain system allows badminton players to accelerate the racquet and shuttlecock to the desired pace. The kinetic chain mechanism uses neuromuscular synchronization (body segments moving in a specific order) to transport energy from the ground to the legs, hips, lower back, upper back, arm, forearm, hand, and finally the racquet [3,4].

In the badminton game, smash performance is regarded as the most crucial component for scoring goals in various positions. During the game, the benefit for one player over another is determined by the smash stroke. Two tasks influence the efficiency of a stroke the most: smashing velocity and precision [5].

Smash velocity is defined as "the rate of speed at which shuttlecock travels during a smash or stroke". During the badminton stroke or smash, various upper limb movements in synergy play a crucial role in the game [3]. There are three types of techniques: overhead, forehand, and backhand. The overhead technique is considered the most important technique in badminton, which is further divided into three strokes drop, clear, and smash [6].

Core strength, upper and lower limb explosive powers, and other characteristics all play a role in producing high performance or raising the smash velocity of badminton players. Upper limb explosive power is the functional capability to produce or transfer muscle strength or power through upper limbs, which plays an important part in athletic activities, especially in badminton [6].

The main purpose of this study was to examine the correlation between upper limb explosive power with smash velocity, and performance in badminton players.

MATERIALS AND METHODS

This cross-sectional study including a total of 100 participants by convenient sampling was conducted in Manav Rachna International University, Faridabad, Haryana, India, from September 2017 to March 2019. Out of 100 players, only 85 participants (60 male and 25 female) completed the study. Ethical Clearance was obtained (MRIIRS/FAHS/2017/165).

Participants were recruited from Manav Rachna Sports Academy (25 players), K.L. Mehta Academy (10 players), Senior Shree Ram Model High School, Faridabad (50 players). Informed consent was obtained from the players and parents/coaches.

Inclusion and Exclusion criteria: The participants aged between 11-15 years old with a minimum of one year experience of playing badminton at the district or state level academies were included in the study. The players with any musculoskeletal injuries, neurological problems, recent fracture, and surgery before six months were excluded from the study.

Study Procedure

After collecting the demographic details {age, height, weight, Body Mass Index (BMI)}, the players were asked to do a 10-15 minutes. warm-up (jogging and dynamic stretching) followed by which they were assessed for explosive strength of upper limb, smash velocity, and accuracy.

Upper Limb Explosive Performance (ULEP)

Medicine ball explosive power tests were performed by using a 3 kg ball for boys and a 2 kg ball for girls. After explanation and demonstration of the test, a 10-15 minutes warm-up was performed including jogging, walking, stretching, and jumping. Before starting, participants were asked to perform several rehearsals or practices.

Medicine ball test: A 3 kg and 2 kg medicine ball, as well as a measuring tape, was utilised to test the shoulder's explosive strength. The athlete stands in front of the starting point (in a parallel stance with feet spaced sufficiently apart) with both hands holding a 3 kg medicine ball and then performs a medicine ball overhead forward throw to cover the farthest distance [Table/Fig-1]. The average of the largest two distances from all three trials was measured in meters, with a 20 second rest period between each trial [6].

Smash Stroke Performance Test

The strike accuracy was measured using the forehand smash stroke performance test. The (60×60) square target was set in the upper right corner of a single badminton court with a different color. Each color target size was 20 cm wide and 60 cm long, and each color target was marked with three different colors:

- Red colour -3 points
- Blue colour- 2 points
- Yellow colour- 1 point

After a 10-15 minute warm-up, participants executed 10 maximal forehand smash strokes with a 5-10 second pause in between, which is based on the specific demands of badminton players during competition. When the investigator's forehand is played, the player takes his ready position and moves backward to smash the shuttlecock approximately from a long service line area in singles court and toward the color targets in opposite court. Three points were awarded for a strike smash inside the red target area, two points for blue, and one point for yellow in [Table/Fig-2] [5].

[Table/Fig-1]: Medicine Ball Test. **[Table/Fig-2]:** Smash Stroke Performance Test (Three points were awarded for a strike smash inside the red target area, two points for blue, and one point for yellow). (Images from left to right)

The participants were given a total of 10 trials of forehand smash strokes were marked Red- 3, Blue- 2, and Yellow- 1. The maximum score a player could score was 10×3=30 points. For deriving the accuracy rate, the sum total of score the player makes in trials was then divided by the maximum score a player can make and then multiplied by 100. The result obtained is the accuracy rate of the player.

For example- 9 is the sum scored in 10 trials. Then the accuracy rate is the following, 9/30×100=30%.

Hence, 30% is the accuracy rate of the player.

Smash Velocity Test

A radar gun was used to measure smash velocity. The radar gun was positioned 2 meters at the back of the subject. Outside the badminton court's back-line and strike area, the radar gun was aligned with the shuttlecock's approximate height and pointed straight ahead to the colored square mark in the upper right corner of the other court where the shuttlecock landed. After a 10-15 minute warm-up session, the individuals were asked to perform three strokes with a 5-10 second pause in between. We look for colored targets directly in the right service court (on the black point) and behind the left service court [Table/Fig-3]. Participants were asked to perform several rehearsals or practices before the test [5].

[Table/Fig-3]: Smash Velocity Test.

STATISTICAL ANALYSIS

Data was Analysed using IBM Statistical Package for Social Sciences (SPSS) statistics 2009, version 21.0. The Karl pearson's correlation coefficient was used to calculate the correlation between ULEP with smash velocity and performance in badminton player.

RESULTS

The study included a total of 100 participants, only 85 participants (60 male and 25 female) completed the study and 15 participants did not complete the study. The participant's mean age was 13.45±1.09 [Table/Fig-4].

Variables	Mean±SD
Age (years)	13.45±1.09
Experience (years)	2.71±0.92
Height (cm)	2.44±0.36
Weight (kg)	43.20±9.14
Body mass index (kg/m²)	17.68±2.81

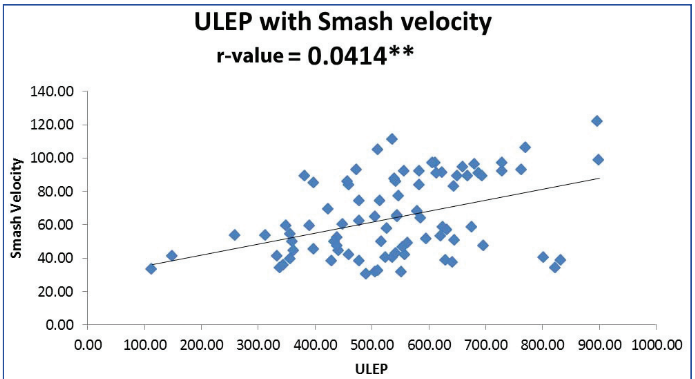
[Table/Fig-4]: Demographic details.

The mean values of upper limb explosive power, smash velocity and accuracy were 538.58±149.37 meters, 64.25±23.77 km/hr, 18.90±12.48. [Table/Fig-5].

Variables	Mean±SD
Upper limb explosive power (meters)	538.58±149.37
Smash Velocity (km/hr)	64.25±23.77
Accuracy (Smash stroke performance)	18.90±12.48

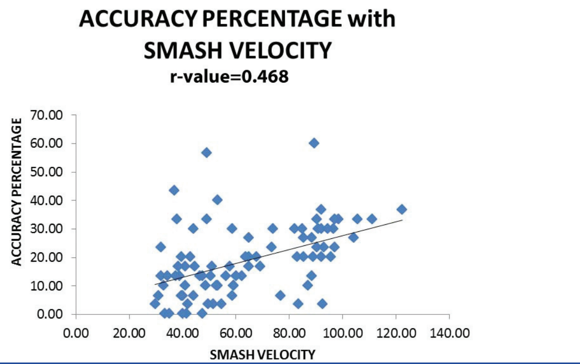
[Table/Fig-5]: Mean and standard deviation of ULEP, Smash Velocity, and accuracy.

The correlation value for ULEP Test and smash velocity test was (r-value=0.0414). This shows that there was a statistically significant (p-value ≤0.001) positive correlation between ULEP with Smash Velocity [Table/Fig-6].



[Table/Fig-6]: Scatter graph correlation between ULEP with smash velocity.
**Significant

The correlation value for accuracy test and smash velocity test (r-value=0.468). This shows that there is a statistically significant (p-value ≤0.001) positive and strong correlation between accuracy with smash velocity [Table/Fig-7].



[Table/Fig-7]: Scatter graph correlation between Accuracy test and Smash Velocity.
**Significant

DISCUSSION

Badminton is a complex, physically enduring sport that requires an extensive amount of core strength as well as upper and lower body strength to produce powerful smashes, agility, good balance, and coordination during rapid postural movement around the court [7]. There is a correlation between height and smashing accuracy in male badminton players. As a result, when selecting badminton players for the squad during competitive events, height and sports technique are taken into account [8]. In this study, there was a statistically significant positive "correlation between upper limb explosive power with smash velocity and performance".

Akbari M et al., found a positive correlation between arm muscle power and badminton smash skills. A player's badminton performance is determined by his or her smash skills. The arm action during the smash will be explosive, allowing the shuttlecock to slide swiftly and kill the opponent's game [9].

Pratama F, also did a correlation study of arm muscle explosive power towards smash of badminton players and found a significant relationship between the two. The muscle explosive power is the physical condition element, and the muscle should have the ability to receive the stress while working. Therefore, arm muscle explosive power needs to be trained to increase the smash performance in badminton [10].

Also, a study was done by Marpaung HI and Priyonoadi B. on volleyball players with arm muscle power as a variable showed a positive correlation with the smash velocity. Good arm muscle power is influenced by the ability of the arm muscles to use an anaerobic system that enables them to do strong and sharp strokes with the ball falling at high speed towards the opponent to gain points [11]. A study by Awatani T et al., concluded that racket velocity was significantly correlated to internal rotation torque of the shoulder in the abducted external rotation position. The study suggested that angular specificity existed and to increase shuttle velocity the physical ability related to the racket velocity needs to be improved [12].

Tiwari LM et al., also reported that badminton performance is significantly correlated with shoulder strength, which allows the muscle to overcome resistance or act against it, to perform effective smashing [13]. Further study can be done to compare the difference in smash velocity and accuracy of male and female players of different age groups and levels of participation.

Limitation(s)

The study only considered the age group between 11 to 15 years. Measurement, type, and texture of racket and footwear were not considered in this study. The gender difference was not taken into consideration for the study.

CONCLUSION(S)

Based on the result of the present study it can be concluded that the smash velocity of the badminton player is related to the explosive power of the upper limb. So, to improve the smash performance of the athlete, the upper limb should be trained properly to gain strength and improve its explosive power.

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PARTICULARS OF CONTRIBUTORS:
1. Research Scholar, Department of Physiotherapy, Guru Jambheshwar University of Science Technology, Hisar, Haryana, India.
2. Professor and Dean, Faculty of Physiotherapy, SGT University, Gurugram, Haryana, India.
3. Sports Physiotherapist, Department of Physiotherapy, Sukun Physiotherapy, Faridabad, Haryana, India.
4. President, Department of Physiotherapy, Sukun Physiotherapy, Faridabad, Haryana, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Nitin Kumar Indora,
Research Scholar, Department of Physiotherapy, Guru Jambheshwar University of Science Technology, Hisar, Haryana, India.
E-mail: drnitinindora166@gmail.com

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