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Correlation between angular kinematical variables with the performance of forehand overhead smash in badminton

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Abstract
The aim of the research was to establish the correlation between joint angles and the efficacy of executing the forehand overhead smash stroke in badminton.
Methodology: This study involved a carefully chosen sample group consisting of twelve male players, all of whom were recruited from either the inter-university or national level. The participants' ages were carefully considered, falling within a specific range from 18 to 25 years old. To ensure precision in measurement, body angles were meticulously assessed using kinovea software, with all data meticulously recorded in degrees. Furthermore, the evaluation of performance was conducted through subjective assessments administered by experienced officials. These assessments were based on a comprehensive three-judge rating system, allowing for a thorough and multifaceted analysis of each player's performance In terms of data analysis, the researchers employed the correlation test, specifically utilizing the Pearson correlation method. This statistical approach enabled them to explore the relationship between different variables, such as joint angles and proficiency in executing the Forehand Overhead Smash stroke. To maintain a high level of reliability, the significance level for the analysis was set at 0.05. This stringent criterion ensured that the results underwent thorough scrutiny, providing confidence in the validity and reliability of the findings
Conclusion: Based on the findings of the study, it is determined that there exists a notable discrepancy in the right wrist, right elbow angle concerning the execution of the forehand overhead smash stroke in badminton.

Keywords: Kinematical, forehand smash, badminton

Introduction
A common strategic move for reclaiming the center court position in badminton involves employing a high deep smash. Particularly in singles matches, when uncertainties loom, resorting to a smash is often recommended. This defensive tactic entails a powerful return that mimics the trajectory of a tennis lob. Whether executed with an underhand or overhand stroke, the objective of the smash is to force the opponent onto their forehand or backhand, pushing them towards the backcourt. Players frequently combine the smash with drop shots to compel opponents to cover all four corners of the court while on the defensive, adding complexity to their strategies.
Make it your goal to strike the shuttlecock swiftly, aiming to reduce your opponent's reaction time. Whether executing overhead or underhand returns, strive to make contact at the optimal point. When gearing up for a smash shot, raise your racket upwards as you position yourself, ensuring a flat racket meets the shuttlecock as you extend your elbow. To achieve a high and deep trajectory, swing your racket forward and upward, leading with your hand. Finish the motion with a follow-through directed towards the shuttlecock's path, maximizing the power and accuracy of your shot.
In competitive matches, utilizing the smash offers a significant advantage by placing the shuttlecock beyond your opponent's reach, forcing them to react swiftly. This strategic placement either positions the shuttlecock behind your opponent or compels them to move faster than anticipated, diminishing their available time and heightening fatigue. A precisely executed smash necessitates your opponent to hurriedly return shots for accuracy and efficiency. An offensive smash typically features a flatter and quicker trajectory, with the goal of positioning the shuttlecock behind your opponent, potentially leading to weaker returns.

Conversely, a defensive smash follows a high and deep trajectory, aimed at maintaining defensive positioning and creating opportunities for strategic play.

Objective of the study

The study aimed to investigate the joint angles correlate with the execution of the Forehand Overhead Smash during the contact phase in Badminton.

Methodology: For this specific study, the sample consisted of twelve male badminton players selected from both inter-university and national levels. The ages of the participants ranged from 18 to 25 years. Notably, the study targeted right-handed players, concentrating on their performance while executing the Forehand Overhead Smash during the contact phase in badminton.

Procedure of data collection

For data capture, two Casio EX-F1 high-speed cameras were employed, offering frame frequencies ranging from 60 to 300 frames per second (fps), depending on availability. Data collection was conducted from both the sagittal and frontal planes to ensure comprehensive analysis. The recorded data were then analyzed using Kinovea motion analysis software, facilitating in-depth examination and interpretation of the captured footage.

Statistical procedure

The study gathered data from twelve male inter university/ national Badminton players for statistical analysis. The correlation test, specifically the Pearson correlation, was employed to compute the data analysis. A significance level of 0.05 was set to evaluate the relationships obtained through the correlation test. All statistical computations were conducted using SPSS software version 20.

Findings and results of the study

The findings and results of the study were derived from its investigation. The researcher arrived at empirical results, which are depicted in Tables 1 and 2, as well as Figure 1.

Table 1: Descriptive statistics of male Badminton players in relation to Right angular kinematical variables of forehand overhead Smash stroke in Badminton

Variable	N	Min.	Max.	Mean	Std. Error	Std. Deviation	Range
Right wrist	12	166.00	195.00	178.00	2.47	8.50	29.00
Right elbow	12	135.00	164.00	150.08	2.90	10.03	29.00
Right shoulder	12	128.00	140.00	133.33	1.08	3.75	12.00
Right hip	12	175.00	193.00	183.33	1.61	5.58	18.00
Right knee	12	131.00	170.00	148.17	2.91	10.06	39.00
Right ankle	12	99.00	133.00	111.17	3.01	10.43	34.00

Table 1 provides smash insights into the mean and standard deviation scores of right angular kinematic variables measured in degrees during the forehand overhead smash stroke in Badminton. Specifically, the mean values for various angles are as follows: right wrist angle at 178.00 degrees and Std. 8.50, right elbow angle at 150.08 degrees and Std. 9.95, right shoulder angle at 133.33 degrees and Std. 3.75, right hip angle at 183.33 degrees and Std. 5.58, right knee angle at 148.17 degrees and Std. 10.06, and right ankle angle at 111.17 degrees and Std. 10.43.

Fig 1: Graphical representation of male Badminton player in relation to right angular Kinematical variables of forehand overhead smash stroke in Badminton

Table 2: Descriptive statistics of male Badminton players in relation to Left angular kinematical variables of forehand overhead Smash stroke in Badminton

Variable	N	Min.	Max.	Mean	Std. Error	Std. Deviation	Range
Left wrist	12	135.00	223.00	195.67	6.43	22.28	88.00
Left elbow	12	75.00	106.00	87.92	2.96	10.25	31.00
Left shoulder	12	23.00	104.00	46.33	6.80	23.56	81.00
Left hip	12	190.00	220.00	200.42	2.36	8.17	30.00
Left knee	12	150.00	174.00	163.33	1.87	6.48	24.00
Left ankle	12	91.00	137.00	100.33	3.56	12.34	46.00

Table 2 provides smash insights into the mean and standard deviation scores of right angular kinematic variables measured in degrees during the forehand overhead smash stroke in Badminton. Specifically, the mean values for various angles are as follows: left wrist angle at 195.67 degrees and Std. 22.28, left elbow angle at 87.92 degrees and Std. 10.25, left shoulder angle at 46.33 degrees and Std. 23.56, left hip angle at 200.42 degrees and Std. 8.17, left knee angle at 163.33 degrees and Std. 6.48, and left ankle angle at 100.33 degrees and Std. 12.34.

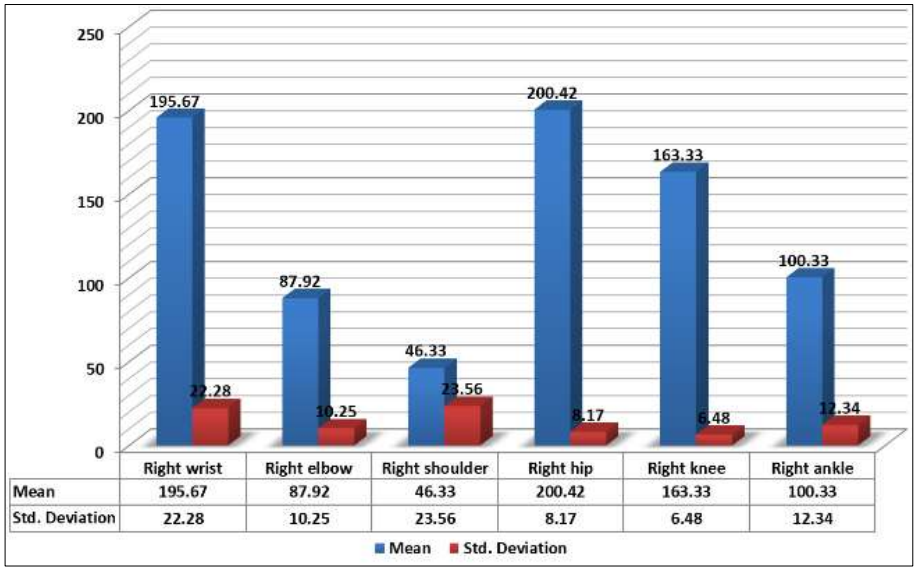

Fig 2: Graphical representation of male Badminton player in relation to left angular Kinematical variables of forehand overhead smash stroke in Badminton.

Table 3: Relationship of Right Angular Kinematical Variables with the Performance of Forehand Overhead Smash Stroke in Badminton

	Right wrist	Right elbow	Right shoulder	Right hip	Right knee	Right ankle	Performance
Right wrist	1	.391	.074	.932**	.056	-.204	.640*
Right elbow		1	-.008	.410	-.446	-.350	.782**
Right shoulder			1	.103	.155	.071	-.110
Right hip				1	-.139	-.354	.622*
Right knee					1	.322	-.056
Right ankle						1	-.562
Performance							1

*Significant at 0.05 level

Table 3 reveals that in case of wrist right, elbow right, hip right and obtained value (.640*), (.782**) (.622*) is greater than tabulated value of (.549) therefore it shows significant relationship of this independent variable with forehand overhead smash stroke performance in Badminton. Whereas, in case of, shoulder right, knee right, ankle right, the obtained values (-.110), (-.056), (-.526), are lower than tabulated value of (.549) therefore it shows insignificant relationship of these independent variables with performance of forehand overhead smash in Badminton. Since the significant relationship was found between angle of right wrist and angle of right hip among independent variables as calculated 'r' (932**) is found greater than the required tabulated value of (.549) at 0.05 level of significance.

Table 4: Relationship of Left Angular Kinematical Variables with the Performance of Forehand Overhead Smash Stroke in Badminton

	Left wrist	Left elbow	Left shoulder	Left hip	Left knee	Left ankle	Performance
Left Wrist	1	-.147	.244	.268	-.012	.209	-.378
Left Elbow		1	.032	-.356	-.496	-.226	-.007
Left Shoulder			1	-.222	.327	.016	-.505
Left Hip				1	.165	.721**	-.149
Left Knee					1	.251	.100
Left Ankle						1	.095
Performance							1

*Significant at 0.05 level

Table 4 reveals that the significant relationship was found between angle of left hip and angle of left ankle among independent variables as calculated 'r' (.721**) is found greater than the required tabulated value of (.549) at 0.05 level of significance

Discussion of the study: The main goal of this study was to explore how joint angles relate to the skillful execution of the Forehand Overhead Smash stroke during the contact phase in Badminton. The researchers aimed to understand how different angles in the joints, particularly in the wrist, affect the players' ability to perform this stroke effectively.

After conducting a thorough investigation, it became evident that there was a significant variation in the right wrist angle among players specifically during the contact phase of the Forehand Overhead Smash stroke. This variation was not just

a minor difference; it had a substantial impact on the players' performance. The study found that the angle of the right wrist at the moment of contact with the shuttlecock played a crucial role in determining the success of the stroke. Players with optimal wrist angles were able to execute the Forehand Overhead Smash more proficiently, resulting in better overall performance. This insight highlights the importance of proper wrist positioning and its direct influence on a player's effectiveness in performing this critical Badminton stroke.

This observation is closely related to the characteristics of the Forehand Overhead Smash stroke, which is primarily viewed as a defensive maneuver in badminton. The main purpose of this stroke is to send the shuttlecock deep into the opponent's rear boundary area, thereby creating space and allowing the player to reposition themselves towards the center of the court.

During the contact phase of the Forehand Overhead Smash, the mechanics of the wrist joint become critically important. The wrist joint plays a key role in the movement of the hitting hand, significantly influencing the power and accuracy of the stroke. To optimize performance, players are often instructed to employ a technique that includes a lengthy backswing combined with a locked wrist and a flexed elbow. This technique is designed to generate the necessary force and precision required for an effective smash shot. By maintaining these specific joint positions, players can maximize the efficiency of their strokes, ensuring that the shuttlecock is propelled with the desired speed and direction.

Conclusion

The conclusions drawn from the present study shed light on several significant findings. Firstly, a notable correlation was identified in the right wrist angle specifically during the contact phase of the Forehand Overhead Smash stroke among badminton players. This implies that variations in the right wrist angle significantly affect the execution of the stroke.

Moreover, the study underscores the pivotal role played by the right wrist during the contact phase of the Forehand Overhead Smash stroke. This highlights the importance of proper wrist positioning and control in achieving optimal performance in this particular badminton technique.

In essence, the study emphasizes the critical relationship between the right wrist angle and the proficiency of executing the Forehand Overhead Smash stroke, providing valuable insights for players and coaches aiming to enhance their skills in this aspect of the game.

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