Analysis of Forehand Smash Angles in Badminton Athletes in Banda Aceh City, Indonesia

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Abstract. Along with advances in sports science and motion analysis technology, coaches and athletes can improve game quality by adopting a more measurable, research-based approach. In badminton, players use the forehand smash technique as a primary offensive skill to score points. Therefore, it is essential to understand how the angle of the stroke can affect both the accuracy and speed of the smash. This study aims to analyse the effect of forehand smash angle on the accuracy and speed of shots in badminton. The method used in this study is a descriptive, quantitative method. The population studied included athletes from two badminton clubs in Banda Aceh City, namely PB Pasha Jaya and PB Bullodzher, with a total sampling technique. In this study, the sample consisted of 10 athletes from both clubs in Banda Aceh City selected by the total sampling method. The researchers collected data by recording smash movements from multiple angles and analysed them using Kinovea software. The study found that the most effective angle for forehand smashes, which balances speed and accuracy, lies between 70° and 78°. Within this angle range, the shuttlecock generally has a steep downward trajectory and falls into strategic areas, mainly targets 1 and 2, which are the opponent's back right and left regions. An angle of 78.48° was recorded as the most accurate for target 1, while 70.03° was recorded for target 2. The average speed measured in this angle range ranged from 103 km/h to 123 km/h, showing effectiveness at high levels of play. These angles enable players to produce shots that dive sharply, challenge opponents to return them, and reach precise targets. The results of this study emphasise that smash success depends not only on physical strength but also on the ability to adjust the angle of attack, proper timing, and strategic placement of the shuttlecock. Thus, the combination of biomechanical techniques, angle mastery, and sound decision-making is essential for creating powerful, fast, and accurate forehand smashes.

Keywords: Analysis; Hitting Angle; Forehand Smash; Accuracy; Speed.

INTRODUCTION

Badminton is a game played by two or four players who compete against each other. They use rackets, nets, and shuttlecocks as tools in this game [1]. This sport is favoured by many people because, besides being good for health, it can also bring players happiness and satisfaction. One sport favoured by people of all ages is badminton. Currently, an estimated 220 million people play badminton regularly, both professionally and as a hobby, making it the second-most-played sport in the world after soccer [2]. To achieve success in badminton, it is essential to master the basic techniques of the game.

Overhead and forehand shots are the main skills in badminton, accounting for 20% of the attack in a match. Badminton players must perform various movements during the game, including twists, jumps, leg movements, and swings, to keep the shuttlecock moving back and forth across the court. In this way, the game is characterised by a changing time structure, with actions of short duration and high or moderate intensity, accompanied by brief rest periods [3]. Badminton hitting techniques that must be mastered are

serve, lob or clear, dropshot, smash, drive or horizontal and return service. One technique to get points or numbers is smash.

Smash, according to [4], is an overhead (top) shot directed downward and performed with full power. By giving a strong, fast, and focused blow, the opponent will have difficulty countering the attack. In badminton, smash shots are the most potent technique for beating your opponent [5]. A smash is a brutal punch often used in badminton. Smash requires leg, shoulder, and arm strength, wrist flexibility, and harmonious coordination of body movements.

Smash is the primary and most powerful technique for ending a long rally and getting points, so it must be owned and mastered [6]. The power of smash shots in badminton can reach speeds of 200 km/h [7]. According to [8], a sharp, deadly smash is a blow every player must have; it is needed not only in singles but also in doubles.

This happens because the ball falls with high speed and at a sharp angle. When hitting a smash, the shuttlecock should touch in front of the body with the arm extended. When the wrist of the forearm touches, it should rotate quickly. The racket should be in a flat position and slightly facing downward. Strike the shuttlecock hard to make it fall sharply. Do not smash more than three-quarters of the back court, as this will reduce the speed of the shuttlecock to the opponent's area [9].

The hitting angle in badminton is the magnitude of the angle formed between the racket (or striking arm) and the horizontal or vertical reference line when contact between the racket and the shuttlecock occurs. In the context of biomechanics, the angle is not only affected by the position of the racket, but also by the coordination of motion of the shoulder, elbow, and wrist joints that form the kinetic chain of the upper body. Too large or too small an angle at contact can change the trajectory of the shuttlecock and reduce the efficiency of the stroke.

Movement in kinematics is divided into three categories: linear, rotational, and general. Linear or straight movement occurs when all parts of an object move the same distance at the same time and in the same direction. Meanwhile, rotational or angular movement occurs when an object moves in a circular path, so that each part of it moves in one direction at the same angle at the same time. Angular movement occurs around a centre, called the axis of rotation, which is perpendicular to the plane of movement. The third type of motion, generalised motion, occurs when an object undergoes both translational and rotational motion simultaneously. In addition, there is parabolic motion, which is a combination of rotation and straight motion, but does not fulfil the concept of a single rotation or a full circle [10].

Biomechanical analysis of movement at each joint shows that each joint has its own range of motion; this affects whether the movement is at risk of injury or can be performed more effectively and efficiently. According to the American Academy of Orthopaedic Surgeons (AAOS), the normal range of motion for the shoulder joint is 180^0 for flexion and abduction and 90^0 for external rotation. The patella, or knee, has various functions. Its primary function is as a mechanical pulley for the quadriceps muscle, as the patella changes the direction of the extension force throughout the knee's range of motion. Its contribution increases as the extension progresses. The range of motion of the knee joint in males aged 9 to 19 years is about± 140^0. The elbow joint has a range of motion of 150^0, but in boys aged 9 to 19 years, it is 142^0 [11].

Based on observations at the Badminton Association (PB) of Banda Aceh City, researchers found that during training sessions, some athletes still performed forehand smashes incorrectly, thereby compromising their ability to execute the shot. In practice, smash shots made by some athletes are still easily cleared or returned by the opponent, and the shuttlecock is not infrequently stuck in the net or out of the field area. This phenomenon shows that there is still a lack of mastery of adequate basic techniques [12].

According to [13], there are many ways to perform smashes, including footsteps, sighting, hand movements, and body movements. These techniques form the basis for a good, effective smash movement, so mastering each element is very important for producing a difficult-to-return smash. According to [14], the position at the moment of jumping into the smash has a significant impact on the speed and accuracy of the smash. When jumping, the arrangement of the body, hands, distance to see the ball, and wrist movements are very influential and support the direction of the shuttlecock, as well as the speed and sharpness of the shuttlecock.

The forehand smash is also one of the basic techniques that is very important in badminton. In

previous studies, most of the focus remained on the accuracy of the forehand smash itself, without explicitly considering the angle factor. In fact, smash accuracy depends not only on the power of the blow but also on the techniques used, including the angle of the blow. Therefore, this research comes with a more in-depth focus on analysing the angle of the forehand smash stroke, which consists of the angle of the elbow of the arm, shoulder, racket reach with the ball, and the height of the jump when performing a forehand smash, which is expected to provide a more comprehensive understanding for athletes and coaches.

The accuracy of a smash depends not only on the power of the blow but also on the technique used, including the angle of the blow. The hitting angle referred to in this study focuses on analysing several biomechanical aspects in the forehand smash movement such as the angle at the knee, the angle at the shoulder, the angle at the elbow of the arm, the angle when hitting the shuttlecock, the highest achievement of the racket when hitting the shuttlecock, when carrying out the smash movement with the right hand. Factors such as body position, racket grip, and stroke angle can affect the precision and effectiveness of the smash.

Many coaches and athletes are constantly looking for ways to improve smash stroke performance. While hitting power is often the focus, hitting angle can be a key factor in smash success. However, this aspect may receive less attention in routine training. The purpose of this study was to analyse the angle of the forehand smash and its accuracy using biomechanical principles. This study used the Kinovea motion analysis tool to assist in the process. Thus, coaches and athletes in each PB can identify the appropriate exercises to improve each athlete's smash movements.

METHODS

This research uses a quantitative, descriptive research design. According to [15], the quantitative descriptive research method aims to objectively describe something using numbers, from data collection through interpretation, appearance, and results. The purpose of this research is to determine the angle of the forehand smash and the accuracy of the smash in badminton athletes. The research design is descriptive, describing the results of forehand smash video recordings analysed using Kinovea software. The researchers will conduct this study in February 2025 at GOR PP Pasha Jaya and the Badminton Hall of Syiah Kuala University.

According to the population, it is a generalisation area consisting of objects or subjects that have certain qualities and characteristics, as defined by researchers, for study and the drawing of conclusions. The population in this study consisted of PB Pasha Jaya athletes and PB Buldozher, totalling 10 athletes. The researchers selected this population because it represents the characteristics relevant to the research objectives, particularly regarding forehand smash technique. The sample is part of the population under study. The sample is part of the population's number and characteristics. In this study, the sample will be PB Pasha Jaya athletes and also PB Buldozher. The sampling technique is Total Sampling, namely by taking the whole sample.
The data collection techniques in this study are:

1) Data collection is done by recording video from three angles: left, front, and target. Each athlete is given ten opportunities to hit forehand smashes at a predetermined target. To analyse the forehand smash technique, the researchers used Kinovea software. The forehand smash movement is divided into three analytical phases: preparation, acceleration, and follow-through. Each athlete is allowed to complete five trials before ten, which will be recorded for data collection on the movement of the forehand smash using the Kinovea application. The purpose of this study is to analyse and present information systematically for easy understanding. In addition, this study aims to provide an overview of the success of forehand smash techniques by analysing videos using Kinovea. For data analysis, the researchers apply biomechanical principles using Kinovea as a measurement tool. The researchers will transfer the camera recordings of forehand smash movements to a laptop and immediately analyse the videos to determine the angles of the arm, elbow, and shoulder, as well as the racket height at shuttlecock impact. The focus of the analysis is on movements during the phases of the smash technique, namely the angles of the knee joint, shoulder, elbow, and arm when the shuttlecock is hit, and the highest racket position during a forehand smash.

2) The smash accuracy test in this study is a measuring tool used by researchers to measure the validity and reliability of research variables. A test is a series of questions, exercises, or other

tools used to calculate the skills, intelligence, knowledge, abilities, or talents of individuals or groups. In this context, tests are used to determine the extent of the athlete's ability to perform a forehand smash, including accuracy, speed, and the basic techniques mastered. The data collection technique uses tests and measurements; once the sample is obtained, the researcher can conduct the research. In this study, the researchers' data collection instrument is the test score from this test instrument, serving as a benchmark or equivalent to test scores.

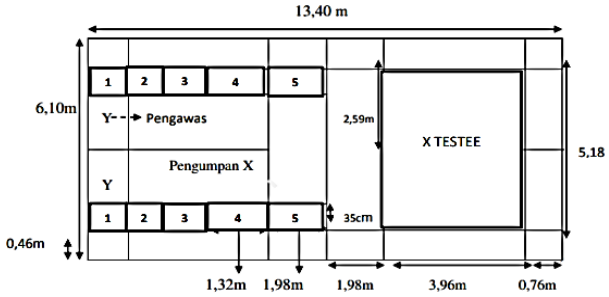

Figure 1 – Field smash accuracy test

Figure 2 – Example of the Angle Points of the Forehand Smash Accuracy and Speed Blows

RESULTS AND DISCUSSION

This study involved ten players from two badminton clubs located in Banda Aceh City, namely PB Pasha Jaya and PB Bulldozher. Each athlete performed 10 forehand smash shots, five from the right and five from the left. To obtain precise data, the study recorded videos from multiple viewpoints, which were then analysed using Kinovea. The researchers used the software to measure several biomechanical variables, including stroke angle, elbow angle, jump height, shuttlecock speed, and ball drop accuracy. Based on the initial data, they observed that most athletes directed the shuttlecock toward the predetermined target zone, although their precision and consistency varied.

The collected data was then analysed by dividing the shot accuracy scores into five categories: excellent, good, fair, deficient, and very deficient. The analysis showed that five athletes, or 50% of the total sample, fell into the fair category, indicating that their ability to place the shuttlecock remained at a medium level. Meanwhile, three athletes (30%) were in the good category, indicating better mastery of their techniques. On the other hand, one athlete (10%) fell into the 'less' and 'significantly less' categories, reflecting the low accuracy of their shots. None of the athletes reached the excellent category in this test, indicating that the overall forehand smash technique needs improvement.

From a biomechanical perspective, athletes in the good category generally have a stable hitting angle and are within the optimal range of 70° to 78°. Within this angle range, the shuttlecock usually glides sharply and falls on strategic target areas on the back right and left sides of the opponent's court. In addition to the ideal angle, the stroke speed of athletes in the good category is also relatively high, ranging from 115 to 123 km/h. Athletes in this category show a stable posture when jumping and interacting with the ball, as well as good visual coordination of the shuttlecock's movement. In contrast, athletes classified as deficient and very deficient had inconsistent hitting angles, either too narrow or too wide, as well as lower shuttlecock speeds, which ranged from 108 to 113 km/h. In this group, the shuttlecock tended to miss the target or hit the net more frequently, indicating weaknesses in mastery of basic techniques and in controlling body movements during smashes.

This finding confirms that the hitting angle plays a vital role in the success of forehand smashes. An ideal angle allows the shuttlecock to land in a spot that is difficult for the opponent to reach, and increases the chances of scoring points. In this study, an angle of 78.48° proved most effective when the shuttlecock was aimed at the back-

right target (target 1), while an angle of 70.03° was most accurate for the back-left target (target 2). When the angle was outside of the ideal range, the shuttlecock was more likely to fall in the neutral area, out of court, or not even make it over the net. There were no hits on target 5, and the number of hits on targets 3 and 4 was also very few, indicating that these positions are less effective as primary targets.

In addition to accuracy, shot speed is greatly influenced by biomechanical techniques and the angle of attack. Athletes with good technique can combine the right stroke power, angle, and contact time to achieve high speed. Although in this study the shuttlecock speed has not reached the levels of world-class professional athletes, who can exceed 300 km/h, speeds between 115 and 123 km/h are enough to compete at the regional level and can put pressure on the opponent. Variables such as elbow angle, jump height, and ball sight also play an essential role in producing powerful, precise smashes.

Overall, this study revealed that to successfully perform a forehand smash, not only are muscle strength and playing experience required, but also the athlete's ability to control the stroke angle, maintain posture stability, and direct the shuttlecock precisely. Therefore, coaches and athletes need to focus on fundamental movement biomechanics, especially during smash training. Deepening the understanding and mastery of this aspect can help athletes achieve their best performance and improve attack effectiveness in real matches.

CONCLUSIONS

Based on research conducted on 10 badminton players from two clubs in Banda Aceh, the study concludes that the angle of the forehand smash significantly affects the speed and accuracy of the shuttlecock. The hitting angle between 70° and 78° proved to be the most effective to produce fast, diving, and accurate smashes. At an angle of 78.48°, the highest accuracy was obtained when the shuttlecock hit the back right side of the court, while an angle of 70.03° was most effective for the back left side.

Athletes who have good biomechanical techniques, including coordination of elbow angle, jump height, shuttlecock viewing angle, and position at contact, tend to produce shots at speeds between 115 and 123 km/h. This speed aligns with the principle that the better the coordination between body segments, the greater the thrust and momentum transfer to the shuttlecock. This finding reinforces the notion of the critical role of the shoulder, elbow and wrist joints in determining the angle and speed of the shot, as discussed in various sports biomechanics studies.

The results of this study also support the view that an efficient forehand smash depends not only on muscle strength but also on efficiency in overall body movement. Aspects such as shoulder internal rotation, elbow flexion, and wrist movement greatly influence the quality of the smash. The better the coordination of movements, the greater the chance the shuttlecock will achieve a sharp trajectory and be difficult for the opponent to reply; this is in accordance with the findings showing that the correct contact angle and maximum speed can increase the possibility of the shuttlecock falling in an area that the opponent cannot reach.

This study also supports the view that there is a positive relationship between hitting angle, speed, and smash accuracy, as shown in several previous studies. In addition, some believe that experienced players are better able to control the angle and direction of the shuttlecock than beginners, as evidenced by their performance. In addition, the use of technology, such as video analysis, has proven effective in finding the ideal angle, body position, and speed for smashing.

From these results, it can be concluded that success in performing forehand smashes depends heavily on the combination of biomechanical factors, basic techniques, and body coordination. Training that focuses on increasing awareness of movement angles and efficient use of body strength will directly improve smash performance. Therefore, mastery of technique based on biomechanical principles not only supports effectiveness in matches but also serves as an essential foundation for an athlete's overall performance.

REFERENCES

1. Ade, A. I., Andiana, O., & Abdullah, A. (2022). *Analisis Gerak Smash Forehand Terhadap Ketepatan Sasaran Pada Atlet Bulu Tangkis Remaja Putra* [Analysis of Forehand Smash Movement on Target Accuracy in Male Junior Badminton Athletes]. *Journal of Sport Science, 12*(1), 12. doi: 10.17977/um057v12i1p12-20 (in Indonesian).

2. Aksan, H. (2012). *Mahir Bulu Tangkis* [Skilled in Badminton]. Nuansa Cendekia (in Indonesian).

3. Arikunto, S. (2010). *Research Procedure: A Practical Approach*. Rineka Cipta.

4. Gill, T. K., Shanahan, E. M., Tucker, G. R., Buchbinder, R., & Hill, C. L. (2020). Shoulder range of movement in the general population: age and gender stratified normative data using a community-based cohort. *BMC Musculoskeletal Disorders, 21*(1), 676. doi: 10.1186/s12891-020-03665-9

5. Hassan, I. H. I. (2017). The effect of core stability training on dynamic balance and smash stroke performance in badminton players. *International Journal of Sports Science and Physical Education, 2*(3), 44. doi: 10.11648/j.ijsspe.20170203.12

6. Junanda, H. A., Rusdiana, A., & Rahayu, N. I. (2016). *Kecepatandan Akurasi Shuttlecock pada Jump Smash dengan Loncatan Vertikal dan Parabol Depan dalam Bulutangkis* [Shuttlecock Speed and Accuracy in Jump Smashes with Vertical and Forward Parabolic Jumps in Badminton]. *Jurnal Terapan Ilmu Keolahragaan, 1*(1), 17. doi: 10.17509/jtikor.v1i1.1548 (in Indonesian).

7. Karana, D. A., & Wismanadi, H. (2020). *Analisis Keberhasilan Kento Momota Pemain Jepang Menjadi Peringkat Satu Dunia Dilihat Dari Jumping Smash Dan Speed Smash* [Analysis of Kento Momota's Success in Becoming World Number One Based on His Jumping Smash and Speed Smash]. *Kesehatan Olahraga, 8*(2) (in Indonesian).

8. Li, S., Zhang, Z., Wan, B., Wilde, B., & Shan, G. (2016). The relevance of body positioning and its training effect on the badminton smash. *Journal of Sports Sciences, 35*(4), 310–316. doi: 10.1080/02640414.2016.1164332

9. Maulina, M. (2018). *Profil Antropometri Dan Somatotipe Pada Atlet Bulutangkis* [Anthropometric Profile and Somatotype of Badminton Athletes]. *Averrous Jurnal Kedokteran Dan Kesehatan Malikussaleh, 1*(2), 69. doi: 10.29103/averrous.v1i2.413 (in Indonesian)

10. Özkaya, N., Nordin, M., Goldsheyder, D., & Leger, D. (2012). *Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation.* Springer Science & Business Media.

11. Putri, H. N. (2013). *Analisis Pertandingan Bulutangkis Final Tunggal Putra Pada Olimpiade Musim Panas XXX Di London 2012* [Analysis of the Men's Singles Badminton Final at the XXX Summer Olympics in London 2012]. *Kesehatan Olahraga, 1*(1) (in Indonesian).

12. Azi Faiz Ridlo, A. F. (2016). *Hubungan Kemampuan Belajar Gerak (Motor Educability) Dengan Keterampilan Shooting Dalam Permainan Futsal Pada Tim Ukm Futsal Universitas Islam 45 Bekasi* [The Relationship Between Motor Educability and Shooting Skills in Futsal Among the Futsal Team of the Islamic University 45 Bekasi]. *Journal Riset Physical Education, 7*(2), 213-225.

13. Setiawan, A., Effendi, F., & Toha, M. (2020). *Akurasi Smash Forehand Bulutangkis Dikaitkan dengan Kekuatan Otot Lengan dan Koordinasi Mata-Tangan* [The Accuracy of Badminton Forehand Smashes is Linked to Arm Muscle Strength and Hand-Eye Coordination]. *Jurnal MAENPO Jurnal Pendidikan Jasmani Kesehatan Dan Rekreasi, 10*(1), 50. doi: 10.35194/jm.v10i1.949 (in Indonesian).

14. Shan, N. C. Z., Ming, E. S. L., Rahman, H. A., & Fai, N. Y. C. (2015). Investigation of upper limb movement during badminton smash. *10th Asian Control Conference (ASCC)*, 1–6. doi: 10.1109/ascc.2015.7244605

15. Sugiyono. (2013). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D* [Quantitative, Qualitative, and R&D Research Methods]. Alfabeta (in Indonesian).