Journal of Educational Sciences
Journal homepage: https://jes.ejournal.unri.ac.id/index.php/JES

P-ISSN 2581-1657
E-ISSN 2581-2203

Biomechanical Study of Smash Movement Technique in Volleyball: On the Initial Step Movement of Smash in Sports Education Students of UMKT

Vista Tama Situmorang*, Andri Tria Raharja
Program Studi Pendidikan Olahraga, Fakultas Keguruan dan Ilmu Pendidikan, Universitas Muhammadiyah Kalimantan Timur, Kalimantan Timur, 75124, Indonesia

ARTICLE INFO

Article history:

Received: 12 April 2025
Revised: 25 April 2025
Accepted: 26 April 2025
Published online: 05 May 2025

Keywords:

Volleyball
Smash
Biomechanics

* *Corresponding author:*

E-mail: vistatasitumorang@gmail.com

Article Doi:

https://doi.org/10.31258/jes.9.3.p.1047-1054

This is an open access article under the CC BY-SA license.

A B S T R A C T

This study aims to analyze the biomechanical aspects of the initial steps in the smash technique in volleyball, focusing on the distance of the steps taken by the player before the take-off phase. The smash technique is one of the main movements in volleyball that requires strength, speed, and good body coordination, including in the initial stages. This study uses a quantitative descriptive approach with an observation method through video recording of two Physical Education students who perform the smash movement. The data were analyzed using Kinovea 2023.1.2 software to measure the distance of the steps from each initial phase to the vertical push-off. The results of the analysis show that the more the number of initial steps taken, the distance of the last step tends to decrease. The shortening of the distance of the last step can be interpreted as a biomechanical strategy of the body to create stability and optimal position before pushing off. This finding is different from several previous studies which stated that the last step tends to be longer due to inertial thrust. Thus, the results of this study provide a new perspective in the study of sports biomechanics, especially in the aspect of footwork towards the smash movement. This study is expected to be the basis for developing a more efficient smash technique analysis training pattern based on purposeful movement.

1. Introduction

Volleyball game has been known since the Middle Ages. The first creator of this game was William G. Morgan in 1893. He was also a physical education teacher at the Young Man Cuistian Association (YMCA) in the city of Holioke, Massachusetts trying a game like Faust Ball which was originally a recreational sport in a closed field (indoor). Volleyball is played by two teams where each team consists of two to six people in one field measuring 30 square feet (9 square meters) for each team, the two teams are separated by a net. Victory in volleyball is very dependent on the technique, physical, tactics, and mentality of the players. Basic techniques such as service, passing, smash, and blocker are also very

important (Sovensi, 2018). One of the techniques that is very supportive is the smash technique. Smash is the main attack technique to achieve victory (Pratama and Alnedral, 2018).

Therefore, smash is the most dominant technique compared to other techniques in volleyball. Volleyball is one of the sports that requires arm muscle endurance, focus, and balance (Santoso, 2016). To achieve success in doing a smash requires a precise start and precision in hitting the ball. Speed and strength are two components of the body that can work together in explosive power, so that the muscles used can perform movements that have explosive power (Nofrizal, 2019). In the game of volleyball smash, there is something that is very influential, namely footwork or footwork movements. This movement is very important for knowing the footsteps of a volleyball player. Because the initial step pattern produces a different force, the performance of the power spike will affect the initial step pattern or trajectory (Footwork step pattern) Santoso & Setiabudi (2019). Because the presence of the role of spikers in the match is very important and must be considered, because the match will be won by the team with the highest score. Smash is an important step in attack to achieve victory (Claver, F., Jiménez, R., Gil- Arias, et., 2017).

In volleyball, spike is a type of attack that is often used to attack opponents in a match to get points. Spiking also has several steps, namely: starting, jumping, hitting and landing. In addition, it is also very important to have a professional spiker in executing the pass given by his teammates, especially the tosser. Professional spikers must have good skills and insight in reading the movement of the ball. Biomechanics is a field that studies how human movement in sports is based on mechanics and analyzes sports movements to understand them (Sugiyanto, 2017). In biological systems, biomechanics is also used as a field of applied mechanics. This science is a combination of applied mechanics, biology, and physiology.

Sports biomechanics aims to achieve goals, such as finding effective, efficient types of movements and identifying components that influence success. Therefore, biomechanics is very important for sports, so it requires caution, precise accuracy, and should not be exaggerated. Biomechanics is a science that studies internal and external forces, and how the human body acts (Daharis et al., 2022).

The results of this study aim to analyze the initial step movement in a smash to create a more effective and safe technique in performing a smash movement. This researcher tried to find and analyze information about the aspects of a smash in volleyball. In addition, the analysis of the initial step movement of a smash in volleyball is also the focus of the literature study, along with various aspects that influence the search for more detailed information to solve the problem. The focus of this study is on how to develop and implement effective smash techniques and strategies to improve volleyball team performance. This study has the main target to analyze and synthesize the results of previous studies to gain a better understanding of the components that determine the effectiveness of the initial

step motion of a smash in volleyball. The researcher tries to find out the suitability or errors that occur when calculating the initial steps in doing a volleyball smash. This study will use a systematic and planned approach to achieve this goal. The results of this research objective indicate that this study can be scientifically useful.

2. Methodology

This type of research uses quantitative methods, with a quantitative descriptive approach. Quantitative descriptive research aims to provide an accurate and precise description of a particular situation (Nurdin and Hartati 2019). The subjects of this study were taken from 2021 Sports Education students of the Muhammadiyah University of East Kalimantan. This study is basically a measurement. The instruments used are a camera for video recording, a laptop containing the Kinovea 2023.1.2 application or software, to measure the angle of the body and feet when doing a smash in volleyball.

The data collection technique in this study is a survey technique by conducting a smash test. The data collection procedure includes: (1) Taking a video using a cellphone camera, (2) Each object does a smash 3 times to do a smash; (3) After taking the video, the researcher measured the initial step distance using a laptop that has the Kinovea 2023.1.2 software application. The data analysis technique used by the researcher is a biomechanical study using Kinovea 2023.1.2 software. The biomechanical study conducted is by analyzing the relationship between biological systems and the laws of mechanics or motion science when performing the initial smash step motion in volleyball. The focus of this study is to explore the smash step motion in volleyball. (Figure 1).

Figure 1. Smash Steps on Volleyball

3. Result and Discussion

The results of this study discuss in detail the analysis of the Kinovea 2023 1.2 software application. The analysis explains the planned motion process involved in the smash technique in volleyball based on the influence of the initial steps of students of Sports Education at the Muhammadiyah University of East Kalimantan. The following are measurements when performing a smash and measurements of objects carried out using the Kinovea 2023 1.2 software application. Documentation and measurements are presented as follows: (Figure 2 and Figure 3).

A. Measurement of The Distance of The Initial Step on Object 1

Figure 2. Measurement of the Distance of the Initial Step on Object 1

B. Measurement of The Distance of The Initial Step on Object 2

Figure 3. Measurement of the Distance of the Initial Step on Object 2

The results of the study conducted by 2 objects show that the more initial steps when doing a smash, the shorter the step distance when jumping. Graph 1 illustrates the results of the calculation. The study indicates that the average maximum step distance is achieved with 2 initial steps for object 1, which is 115.67 cm. Meanwhile, the average minimum step distance appears in 1 initial step for object 2, which is 33.27 cm (Table 1).

Table 1. Results of Step Distance Measurements

Step	Object 1	Object 2
1	93,71 cm	33,27 cm
2	115, 67 cm	60,78 cm
3	41,59 cm	57,50 cm

The research graph also illustrates the tendency that the maximum distance is achieved with 2 initial steps. This is triggered by Newton's First Law which functions when taking the initial step. In a one-step movement, the force generated is small because there is no change in speed to acceleration. The initial step has initial energy that triggers or influences the player's jumping motion. The speed of the initial step will affect the power to jump. This causes a difference in the height and time of the jump so that it affects the results of the jump power. Meanwhile, in the second and third movements, there is a reduction in speed. This study found different results, namely changes that cause the emergence of Newton's Second Law which causes speed to be opposite to acceleration. As a result, the body's forward thrust is reduced, so that the last step when about to jump becomes shorter (Figure 4).

Based on the measurement results, it can be seen that the more the number of initial steps, the distance of the last step tends to decrease. This indicates a certain biomechanical strategy used by players in preparing for the push when doing a smash. This finding will be compared with the results of several previous studies to see the position and contribution of this study scientifically.

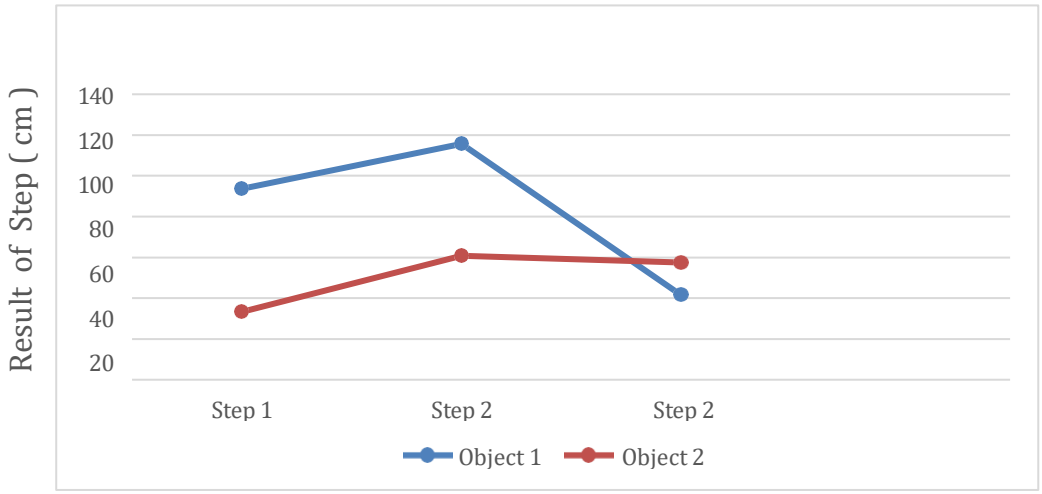

Figure 4. Stride Distance Diagram

The results of the first journal article review entitled Biomechanical Analysis of Take Off Open Spike Step Distance in Volleyball (Santoso & Qiram, 2018) that the more the number of initial steps, the distance of the last step (take-off) tends to increase due to the push of inertia force forward. This is certainly different from the findings in this study, where players actually shorten the last step. This difference can be caused by the level of individual ability or the biomechanical strategy chosen by the player to stabilize the body before making a jump.

Review Results The second journal article entitled Study of Biomechanical Analysis of Open Spike Footwork Steps in Volleyball Against Leg Muscle Power (Santoso & Irawanto, 2018). That the variation in the number of initial steps has a significant effect on leg muscle power when doing open spikes in volleyball. Although the study did not measure the distance between steps directly, it implies that the initial configuration greatly affects the performance results. Therefore, the shortening of the last step found in this study can be seen as an effort by the player to prepare a more stable push-off position.

Review Results The third journal article entitled Biomechanical Analysis of Vertical Jumps in Volleyball Smash Movements (Body Coordination Context) Kuryanto et al., 2024. Analyzes the relationship between the knee and shoulder joint angles to the height of the jump in a smash. They emphasize the importance of body posture and joint angle efficiency to produce optimal vertical push. Thus, the shortening of the final step observed in this study can be attributed to biomechanical adjustments to create a body position that allows for more effective joint coordination during take-off.

Review Results The fourth journal article entitled Analysis of Smash Techniques in Volleyball Games for Extracurricular Male Students of SMA Negeri 1 Tanah Jawa in 2018 (Hutasoit, 2018). Examining basic technique errors in the initial phase of the smash that are often made by middle-level students, including in terms of adjusting the length of the stride. The findings indicate that variations in

stride distance—including shortening—can be a reflection of technical inaccuracy. However, in the context of more experienced players such as the subjects in this study, shortening of strides can actually be part of a conscious biomechanical strategy.

Review Results The fifth journal article entitled Biomechanics Analysis of Volleyball Open Smash at Club Bina Taruna Semarang (Anwar et al., 2020). Emphasizes the importance of body coordination from the start phase to the landing. Although their research focuses more on the final phase of the smash movement, their findings remain relevant because they state that all phases must be synchronized. Therefore, the shortening of the last step in this study can also be seen as an effort to maintain rhythm and continuity of movement.

Based on the description above, it can be concluded that although the results of this study are contrary to several previous studies, this is what strengthens the importance of individual analysis of the smash start technique. Each player can have a different biomechanical strategy in achieving stability and effectiveness of the jump. Therefore, understanding the distance of the start step is very important as a basis for compiling a more personalized and efficient smash technique training program.

4. Conclusion

The results showed that the more the number of initial steps taken by the player, the distance of the last step before take-off actually decreased. This shortening of the step indicates a biomechanical strategy carried out consciously by the player to stabilize the body before making a vertical push in the smash movement. This pattern is contrary to several previous findings which showed that the last step tends to be longer due to inertial forces. Through motion analysis using Kinovea software, this study provides initial evidence that the arrangement of the initial step distance has an important role in preparing for a jump efficiently. Therefore, coaches and players need to pay attention to the pattern of step distance as part of the development of footwork techniques in smashes. This study can be the basis for further studies that link the initial step pattern with other biomechanical outputs such as jump height, push-off speed, and smash power. This study also shows the importance of a biomechanical approach in evaluating and developing basic technique training strategies, especially in the initial phase of the movement. It is hoped that the results of this study can be used as a reference in designing more effective training methods based on objective motion analysis, so as to improve the overall performance of volleyball players.

References

Anwar, C., Kusuma, B., & Fatkhu, I. (2020). Analisis Biomekanika Open Smash Bola Voli di Club Bina Taruna Semarang. *Journal of Sport Coaching and Physical Education, 5(2), 76-82.*

Claver, F., Jiménez, R., Gil-Arias, et., A. (2017). The cognitive and motivation intervention program in youth female volleyball players. *Journal of Human Kinetics, 59, 55.*

Daharis, D., Gazali, N., & Candra, O. (2022). *Biomekanika Olahraga*. Ahli Media Press.

Hutasoit, H. (2018). *Analisis Teknik Smash Dalam Permainan Bola Voli Pada Siswa Putra Ektrakulikuler SMA Negeri 1 Tanah Jawa Tahun 2018* (Doctoral dissertation, UNIMED).

Kuryanto, M. S., Basri, M. H., & Rahman, F. A. (2024, December). Analisis Biomekanik Lompatan Vertikal dalam Gerakan Smash Bola Voli. In *Prosiding Seminar Nasional Pendidikan Jasmani dan Kesehatan Mental Peserta Didik* (pp. 567-576).

Nofrizal, D. (2019). Kontribusi Daya Ledak Otot Lengan Dan Kelentukan Terhadap Ketepatan Smash Dalam Cabang Olahraga Bulutangkis Stkip Meranti, Meranti. *Journal Of Teaching And Learning*. 4 (2), 69-83.

Nurdin, I., & Hartati, S. 2019. *Metodologi Penelitian Sosial.Surabaya*: Media Sahabat Cendekia

Pratama, E. P., & Alnedral. (2018). Kontribusi Daya Ledak Otot Tungkai dan Koordinasi Mata Tangan Terhadap Ketepatan Smash Bolavoli. *Jurnal Pendidikan dan Olahraga*. 1 (1), 135 140.

Santoso, D. A. (2016). *Analisis Tingkat Kebugaran Jasmani Atlet Bolavoli Putri Universitas Pgri Banyuwangi*. Analisis Tingkat Kebugaran Jasmani Atlet Bola Voli Putri Universitas PGRI Banyuwangi, 1(1), 37–46.

Santoso, D. A. S., & Irwanto, E. (2018). Studi Analisis Biomechanics Langkah Awalan (Footwork Step) Open Spike Dalam Bola Voli Terhadap Power Otot Tungkai. *Jorpres (Jurnal Olahraga Prestasi)*, *14*(1), 81-89.

Santoso, D. A., & Qiram, I. (2018, November). Analisis Biomekanika Jarak Langkah Take Off Open Spike Dalam Bolavoli. In *Prosiding Seminar Nasional IPTEK Olahraga (SENALOG)* (Vol. 1, No. 1).

Santoso, D. A., & Setiabudi, M. A. (2019). Analisis Biomechanics Pola Langkah Awalan (footwork step pattern) Spike Dalam Bola Voli Terhadap Performa Power Spike. *Jurnal Sportif: Jurnal Penelitian Pembelajaran*, 5(1), 29–40.

Sovensi, E. (2018). Ketepatan Smash Pemain Bolavoli Siswa Sma Ditinjau Dari Koordinasi Mata Tangan Dan Extensi Togok. *Jurnal Pendidikan Jasmani dan Olahraga*. 2 (1), 129 139.

Sugiyanto, S. (2017). Peningkatan Hasil Belajar Lompat Jangkit Peserta Didik Smk N 2 Purworejo, Melalui Analisis Biomekanika Dengan Software Kinovea. *Jurnal Pendidikan Surya Edukasi*, *3*(1), 1-18.

How to cite this article:

Situmorang, V. T., & Raharja, A. T. (2025). Biomechanical Study of Smash Movement Technique in Volleyball: On the Initial Step Movement of Smash in Sports Education Students of UMKT. *Journal of Educational Sciences*, *9(3)*, 1047-1054.