

## Analysis of Badminton Techniques Smash Using a Biomechanical Approach: Systematic Literature Review

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### Abstract

**Study purpose.** The purpose of this research is to look into the use Analysis of Badminton Techniques Smash Using A Biomechanical Approach.

**Materials and methods.** The PRISMA standards for systematic reviews and meta-analyses were followed in this review investigation. The study must be published with in the prior four years, from January 2020 to Desember 2024. In the search procedure, the following keywords are used: (1) Badminton; (2) Smash. Scopus search engine was used in this research.

**Results.** The theme of this research as a whole obtained 155. Consists of 37 articles which are then taken 10 relevant articles.

**Conclusions.** Analysis of badminton smash techniques using a biomechanical approach includes the effect of smash techniques with a biomechanical approach based on relevant results includes improving smash performance, strength and speed training, muscle strength biomechanical, improving smash speed, glutamine accelerates athlete recovery, and fatigue reduces jumping smash performance.

**Keywords:** Badminton, Smash, Perfomance, Biomechanical

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## 1. INTRODUCTION

Badminton is a type of racket sport played on a rectangular court that has large net in the center. The game features powerful action and unique movement patterns, including rapid acceleration and deceleration as well as a number of explosive movements with quick changes in direction. Matches usually last with the time it takes to score each point being only a few seconds to minutes (Rusdiana et al., 2021a).

Badminton smash is one of the most powerful and sure shots in a sport that requires a combination of speed, strength, and accuracy. Biomechanically, a smash is a complex movement that involves the coordinated action of several joints and muscles, most notably the shoulders, elbows, wrists, and torso. Mastering the mechanics behind this shot is valuable for maximizing performance, reducing the risk of injury, and increasing the usability of training (Wang & Zhou, 2024).

In the sport of badminton, smash shots are crucial to determining victory or defeat, as they are performed with high speed and accuracy. A new study shows that using proper biomechanical methods in smash shots can improve speed and accuracy, which are important components (Ramli et al., 2021). In this case, the influence of biomechanics in improving the ability of badminton players is increasingly clear. Angle, body rotation, and racket speed are some of the components of smash shots that can be studied through biomechanical analysis (Edmizal, Barlian, Donie, et al., 2024).

The purpose of this systematic review and meta-analysis is to evaluate the overall biomechanical factors that affect the smash stroke. By using the current literature and conducting a meta-analysis, this study aims to find the biomechanical factors in performing an effective smash (Kumar & Das, 2024). To ensure that all relevant studies are identified and evaluated systematically, the process of searching and selecting literature in a systematic review is done carefully (Karyono et al., 2024). First, you can search for relevant articles through various sources of information, such as databases like PubMed, Scopus, and Web of Science.

While previous research has shown that conducting systematic reviews of training and match monitoring is essential, this study has emphasized the need to reach agreement on the variables associated with training (Rebelo et al., 2024). The purpose of this study was to study the motion two methods of smash strokes and backhand strokes three-dimensional badminton games. To achieve this goal, the motion biomechanics method will be used (Rusdiana et al., 2021a).

## **2. METHOD**

The research method used is a systematic literature review (SLR) to study and interpret the biomechanical analysis of badminton.

### **2.1 Study Participants**

From 2020 to 2024, the words "Badminton" and "Smash" were found in articles published by Scopus Collection (Science Citation Index Expanded; Social Science Citation Index; and Arts & Humanities Science Citation Index). The clarity and accuracy of the study selection steps are described in detail in the PRISMA flowchart (Edmizal, Barlian, Donie, et al., 2024).

### **2.2 Organization Study**

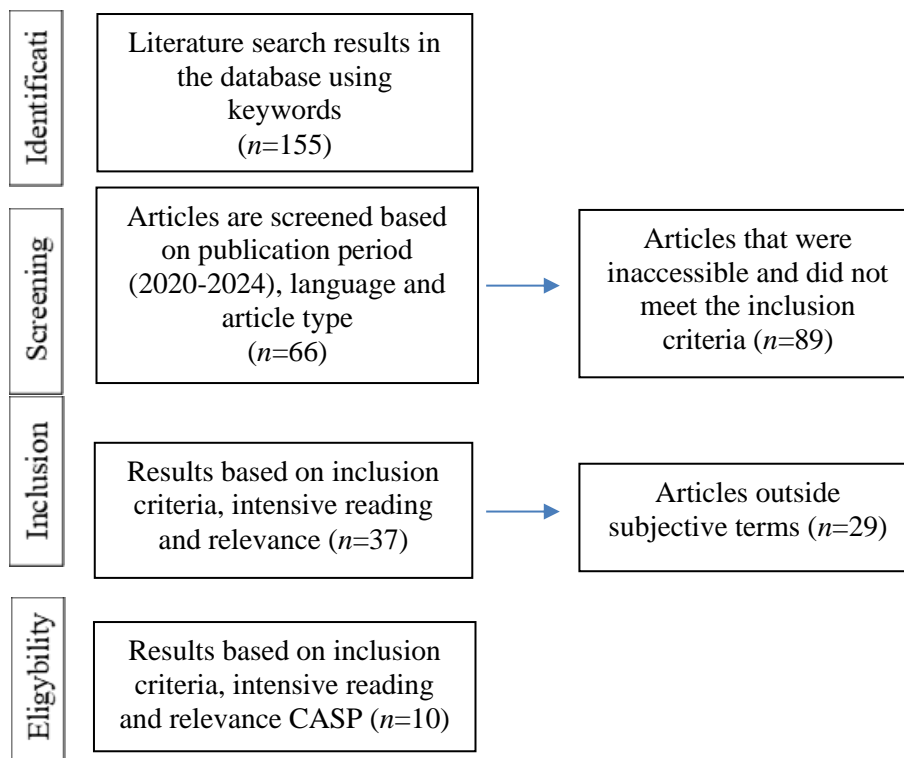
The variables selected for the Scopus search were: (1) number of databases contained in the keyword search; (2) selected years of published articles from 2020 to 2024; (3) relevant articles; (4) field (sport, training, education, or mixed); (5) type of research (discovery, experimental, descriptive, quantitative, qualitative); (6) selection of positive articles.

### 2.3 Statistical analysis

Since the title, abstract, and keywords of an article are enough to create a reliable and viable core for analysis and use, this study concentrates on them. This study is only publicly accessible articles. The authors wanted their research be available to the public. To select only relevant people who could speak on a particular topic, the following inclusion and exclusion criteria were used.

### 3. RESULTS

Identification of literature search result in the database using keyword ( $n=155$ ), from the entire database will be filtered from 2020 to 2024 and selected article categories ( $n=66$ ), Inaccessible articles that did not meet the inclusion criteria ( $n=89$ ). Then from the filtered articles will be selected to use keywords that are in accordance with the theme of badminton, smash ( $n=37$ ). Then the electability that will be included in the results ( $n=10$ ) relevant articles.



The following table shows the total number of publications published during the selected time period. Year published.

**Table 1.**

Evolution of the number of publication of year

Year of Publications	Number Of Articles	Percentage
2020	10	27%
2021	7	19%
2022	4	11%
2023	6	16%
2024	10	27%
Total	37	100%

In table 1 will be shown the number of various time periods of article publication each year, as shown in the evolution table. Explanation of the table above includes; from 2020 to 2024 there has been an increase in scientific publications 2020 (10 articles), 2021 (7 articles), 2022 (4 articles), 2023 (6 articles), 2024 (10 articles).

**Table 2.**

According to the literature, the analysis that can be applied in badminton smash techniques using a biomechanical approach is shown in the table:

Title/source	Sample	Result
The effect of a training program using speed-specific strength exercises on sensory-motor perception in learning stroke forehand smash in badminton material for students of the Hashemite University (Al-Haliq, 2020)	Students	Strength and speed training
A novel mathematical model of the badminton smash: simulation and modeling in biomechanics (Putra & Mohamad, 2024)	Badminton players	Muscle strength biomechanical
Biomechanical Analysis of Smash Stroke in Badminton: A Comparative Study of Elite and Recreational Players: a systematic review (Edmizal, Barlian, Komaini, et al., 2024)	Badminton players	Improving smash performance
Kinetic and kinematic determinants of shuttlecock speed in the forehand jump	Badminton players	Improving smash speed

smash performed by elite male Malaysian badminton players (Ramasamy et al., 2024)		
Glutamine Accelerates Post-Exercise Recovery of Arms Power, Leg Power, and Smash Velocity at 48 Hours for Non-Elite Badminton Athletes (Wismanadi et al., 2024)	Non-elite badminton athletes	Glutamine accelerates athlete recovery
Badminton overhead backhand and forehand smashes: A biomechanical analysis approach (Rusdiana et al., 2021b)	Badminton players	Improving smash speed
Effect of Fatigue on Biomechanical Variable Changes in Overhead Badminton Jump Smash (Rusdiana et al., 2020)	Male badminton players	Fatigue reduces jumping smash performance
Characteristics of surface electromyography of forehand smash of badminton players (Zhang, 2021)	Badminton players	Improving smash speed and power
Impact of cardiovascular fatigue on kinematic changes in badminton overhead jump smash: A descriptive analysis (Rusdiana et al., 2023)	Male badminton players	Fatigue reduces jumping smash performance
Biomechanics analysis of badminton forehand smash in standing classification disability players (Purnama & Doewes, 2022)	A para-badminton players	Generates smash speed

#### 4. DISCUSSIONS

Smash is a complicated movement that requires many things, such as technique, proper kinetic chain, lower body strength, and leg strength. Core stability training, which includes a wide range of movements, allows players to perform exercises at a faster pace than weight training or other machine-based exercises, but with greater strength than athletic training. The highly repetitive nature of badminton has also shown that highly coordinated core stability training helps in producing reliable shots with speed and accuracy (Solanki & Gill, 2021). The “Shuttle Time” program effectively improved this coordination ability. The use of different training modules (speed, power and jumping ability) is adapted to the applied method. The combination of speed, power and jump training greatly improves the speed and power ability of young badminton players, which is very effective in improving badminton performance (Niyazov et al., 2024). Arm strength training properly can make the muscles in the arm stronger and able to produce greater power when doing a smash. Flexibility training also increases the

range of motion and coordination when doing a smash. So that the muscles become strong so that they can produce good accuracy and speed (Kuswanti et al., 2024). Having strong arm muscles and flexibility can make for an effective shot to produce speed and power in a smash in badminton.

Strength biomechanics in badminton aims to understand how activity and muscle strength affect performance and injury prevention in this dynamic sport. This involves analyzing various movements, such as lunges and pulses, and their impact on muscle function and joint mechanics. It is very important for badminton to lunge and return to the starting position before hitting the next shot, as this can affect the overall outcome of the match. Previous studies have shown that fatigue reduces movement quality, and lunge landings increase the risk of lower extremity injuries (Tong et al., 2023). The biomechanical movements used for each sport may differ, as may the factors that cause injury, and the amount of information needed to develop injury prevention strategies. Knowing the biomechanical characteristics of the movements required for each sport can be critical to athlete management (Hu et al., 2022). Badminton prioritizes motor skills, so it requires good physical strength in terms of flexibility and speed of athletes. To effectively improve the overall capacity of the phosphate functional system, whole-body explosive endurance training is performed during high-load training. So, after improving the coordination of the body, it can promote energy recovery and can also be used as a measure to delay fatigue during competition (Biao & Lu, 2023).

Research has explored many different aspects that improve smash effectiveness, from body position to muscle conditioning. In order to perform an effective smash, the positioning phase aims to adjust the body position and posture to respond to the shuttlecock. Experimental and biomechanical studies have emphasized the importance of smash quality with respect to angle of departure and distance height in attacking strokes. However, positioning in badminton shots is still a relatively unstudied component. Novice players have inconsistent positioning, in contrast to experienced players who use consistent positioning. This shows how important positioning mastery is to improving smash ability (Li et al., 2023). In physical fitness, "core strength" is a term that refers to the ability of muscles to generate force through contraction and compression of the abdominals. To help badminton players become more stable. To perform a badminton smash effectively, badminton players must be flexible, the level of coordination is also important. Players must be flexible in order to smash effectively and the level of coordination of badminton players greatly affects their performance (Ma et al., 2024). Good arm elastic strength is necessary. Elastic strength is a kind of strength in which muscles can move quickly against a resistance, which has a combination of contraction speed & mobility speed is considered power. Exercises that can create elastic strength are resistance exercises, where we are required to push, pull, lift, & hold weights (Widiastuti et al., 2019).

Anaerobic training allows players to improve their timing, ability and quality of execution when attacking the ball. It also helps athletes regulate muscle cell contractions and other physiological reactions to support fast and effective movements during matches. The results of this study support the research proposition that applying new high-intensity training will help improve and increase smash speed (Mukhlif et al., 2025). This suggests that short-duration, high-intensity activities increase enzyme activity and muscle strength, which are important for increasing smash speed. The group that received pull over training was

significantly affected in their ability to increase smash speed, and the group that received jump squad training was also significantly affected in their ability to increase smash speed (S et al., 2023). Athletes should create a targeted training program that focuses on kinematics, kinetics, and neuromuscular determinants. So that athletes can have faster and more targeted smashes (Kumar & Das, 2024). By doing this exercise athletes can make smash shots faster and have greater power.

Overall, the results of the study suggest that glutamine supplementation appears to aid recovery after eccentric exercise, as indicated by a decrease in circulating levels of CK and Mb during periods of extremely difficult training and competition (Córdova-Martínez et al., 2021). Glutamine buffering and its effect on lactic acid can prevent fatigue caused by product inhibition and increase activity duration (Sadeghi & Ghiyami, 2019). Glutamine supplementation did not affect energy production or physical performance because muscle concentrations of Krebs cycle intermediates did not limit phosphocreatine depletion, lactate accumulation, and endurance time (Fister et al., 2019).

Fatigue can reduce jumping smash performance by reducing shuttlecock speed and shot accuracy. When the upper limb muscles are fatigued, forehand smashes become less accurate as the level of muscle activation changes while the ball remains in motion (Le Mansec et al., 2020). This shows that the muscle is not contracting enough to produce the required power. In addition, this shows that due to fatigue, the power that extends from the feet to the shoulders through the elbow joints is cut off so that the jump smash becomes less effective due to fatigue (Alkhawaldeh, 2022). To reduce the negative effects of fatigue, exercise programs should incorporate techniques to manage fatigue, such as reducing the amount of time spent resting and incorporating exercises that improve muscular endurance and muscle coordination (Kumar & Das, 2024). In badminton, shuttlecock speed and accuracy compromise jump smash performance due to fatigue, which alters biomechanical and neuromuscular function. Managing fatigue well and performing targeted training can reduce this impact and improve performance.

## 5. CONCLUSIONS

Based on the results of research on the analysis of badminton smash techniques using a biomechanical approach by searching the literature, the effect of smash techniques with a biomechanical approach based on relevant results includes improving smash performance, strength and speed training, muscle strength biomechanical, improving smash speed, glutamine accelerates athlete recovery, and fatigue reduces jumping smash performance. There are limitations in previous research, so further research is expected to develop effective and efficient training programs.

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