

Analysis of the smash and footwork performance of men's singles athletes at the 2021 Toyota Thailand open

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Abstract

This study aims to analyze the success rate of smash techniques and dominant footwork patterns in the men's singles semifinals and finals of the 2021 Toyota Thailand Open. The study used a quantitative descriptive method with four male singles athletes who competed in the semifinals and finals as subjects. Data collection was conducted through observation using a smash technique and footwork analysis instrument sheet, while data analysis used descriptive statistics in the form of percentages. The results showed that the success rate of smash techniques in the semifinals and finals was very high. Full smashes, cut smashes, whip smashes, and circular smashes had a success rate of over 90%, while backhand smashes were rarely used in the finals. In addition, the most dominant footwork pattern was movement to the left rear, both in the semifinals and finals. These findings indicate that the effectiveness of smashes and the dominance of certain footwork patterns play a significant role in athletes' performance at the world level. The research results are expected to serve as evaluation material and a reference for coaches and athletes in developing training programs that are more aligned with the actual needs of competition.

Keywords: match analysis, smash, footwork, badminton.

INTRODUCTION

Badminton is a competitive sport that requires integrated mastery of technique, tactics, physical fitness, and mental strength. At the international competition level, an athlete's success is largely determined by their ability to apply effective and efficient techniques in dynamic match situations (Gustaman, 2019). Therefore, detailed performance analysis, particularly concerning critical elements such as smash execution and footwork efficiency, is crucial for optimizing training regimens and enhancing competitive outcomes (Qian et al., 2021). This paper meticulously examines the smash and footwork performance of men's singles athletes during the 2021 Toyota Thailand Open, offering insights into the kinetic and kinematic determinants of shuttlecock speed and on-court movement patterns (Ramasamy et al., 2021; Valdecabres et al., 2020). Understanding these intricate relationships can inform targeted training methodologies, enabling athletes to refine their offensive power and defensive agility in high-stakes environments (Valdecabres et al., 2020). This study will specifically investigate how elite male players modulate their forehand jump smash to achieve shuttlecock speeds exceeding 111 m/s, considering the critical role of shoulder internal rotation and elbow extension at contact (Ramasamy et al., 2021). Furthermore, the analysis will delve into the contextual variables influencing players' on-court movements, providing a comprehensive understanding of how strategic footwork adaptations contribute to overall match performance (Valdecabres et al., 2020). This comprehensive approach aims to bridge the gap between theoretical biomechanical principles and their practical application in competitive badminton, ultimately guiding coaches and players toward more effective strategies (King et al., 2020; Ramasamy et al., 2021).

A critical component of this analysis will involve assessing how specific kinematic adjustments, such as increased pelvis-thorax separation during the retraction phase, contribute to the generation of

high shuttlecock velocities (King et al., 2020). The study will also analyze the temporal and spatial characteristics of footwork patterns, evaluating their efficiency in facilitating rapid court coverage and optimal positioning for stroke execution (Valldcabres et al., 2020). Additionally, this research will explore the interaction of these contextual variables on players' on-court movements, providing a more holistic understanding of performance dynamics in elite badminton (Valldcabres et al., 2020). This detailed examination aims to clarify how full-body kinematic parameters contribute to the generation of post-impact shuttlecock velocities and how these movements are modulated by situational variables during competitive play (King et al., 2020; Valldcabres et al., 2020). The intricate interplay between whole-body kinematics and shuttlecock speed, particularly during the jump smash, highlights the importance of factors such as peak wrist linear velocity, jump height, and the duration of the acceleration phase (Miller et al., 2020).

These kinematic determinants collectively influence the power and accuracy of the smash, with shorter acceleration phase durations and specific racket-shuttlecock impact locations being critical for maximizing shuttlecock speed and shot outcome (King et al., 2020; McErlain-Naylor et al., 2020). Moreover, the efficiency and speed of footwork are paramount in badminton, enabling players to rapidly transition between defensive and offensive postures, with lunges being a frequently utilized movement to cover court (Huang et al., 2019). This paper will also explore the temporal dynamics of these lunges, including their initiation, execution, and recovery phases, to discern optimal biomechanical efficiencies for rapid court coverage. Differences in landing techniques for lunging steps between elite and recreational players, such as greater peak ankle eversion in elite athletes, further underscore the biomechanical distinctions that contribute to superior on-court mobility and injury prevention in professional play (Mei et al., 2016). These biomechanical efficiencies are critical for minimizing impact loading on the lower extremities, which is a significant concern during high-intensity movements like the lunge, especially given the considerable forces exerted on the knees (Lam et al., 2018). Repetitive lunges with strenuous impact during the heel contact phase, often involving a footstrike angle exceeding 40 degrees, contribute significantly to impact loading and are a known factor in chronic knee injuries among badminton players (Lam et al., 2017, 2018).

Consequently, understanding the biomechanical loading characteristics during these movements is essential for designing effective injury prevention strategies and optimizing training protocols for elite athletes (Lam et al., 2017, 2018). Such detailed biomechanical analyses can highlight the necessity of maintaining high levels of core and knee dynamic stability during these strenuous maneuvers to accommodate rapid changes in body position and mitigate injury risk (Lam et al., 2020). This paper therefore aims to quantify the specific kinematic and kinetic parameters associated with high-performance smashes and efficient footwork, thereby establishing a foundation for advanced biomechanical analysis in competitive badminton. Specifically, it will evaluate the intricate relationship between lower limb kinematics and vertical ground reaction forces during lunges to elucidate mechanisms underpinning both peak performance and potential injury risk (Huang et al., 2019). This investigation will also explore the influence of racket technology and string tension on shuttlecock velocity and trajectory, contributing to a more nuanced understanding of equipment interaction with player performance. Furthermore, the study will consider how these factors synergistically influence the overall match strategy and outcomes in high-level men's singles competition, providing a holistic perspective on performance optimization. This comprehensive analysis will thus provide invaluable data for tailoring training regimens and equipment designs to enhance athlete resilience and maximize competitive advantage (Lam et al., 2017, 2018). To mitigate the high incidence of lower extremity injuries associated with these strenuous movements, appropriate footwear with optimal shock attenuation is paramount to reduce impact loads (Lam et al., 2017). Elite players exhibit distinct lunge biomechanics, characterized by larger sagittal footstrike angles and increased knee moments, which necessitate specific footwear designs to manage these unique loading patterns effectively (Lam et al., 2017). This underscores the need for further research into how specific shoe heel designs influence ground reaction forces and knee moments during maximum lunges (Lam et al., 2017), particularly given the prevalence of overuse injuries in badminton (Du & Fan, 2020). This is particularly relevant for female and less-skilled athletes, who may experience higher ground reaction forces or knee loading during extreme lunges, suggesting a potential gender and skill-level disparity in impact characteristics (Lam et al., 2018).

Such disparities highlight the critical need for individualized training and equipment considerations, particularly in the design of footwear and rehabilitation strategies, to minimize injury risk across diverse athlete populations (Lam et al., 2017, 2018). Previous studies have indicated that unskilled athletes exhibit higher plantar loading in the lateral forefoot during lunges compared to skilled athletes, emphasizing the importance of footwear that can accommodate these varied loading patterns to prevent injury (Lam et al., 2018). Therefore, further investigation into the biomechanical responses to varying shoe designs during maximal lunges is crucial for mitigating injury risk and optimizing performance across different skill levels (Lam et al., 2017). This includes examining how factors such as material composition and midsole properties of footwear can be modified to better attenuate impact forces and reduce joint loading during aggressive movements (Gammelgaard et al., 2017; Lam et al., 2018). This paper specifically aims to analyze the smash and footwork performance of men's singles athletes at the 2021 Toyota Thailand Open, focusing on the kinematic and kinetic parameters that differentiate high-level play. This will involve a detailed quantitative assessment of smash velocity, shuttlecock trajectory, footwork patterns, and lunge kinematics, providing insights into the biomechanical underpinnings of elite badminton performance.

The findings from this analysis are expected to inform targeted training methodologies and equipment innovations aimed at enhancing player efficacy and reducing injury incidence. Given the emphasis on injury reduction, a thorough examination of shoe-ground kinematics, ground reaction forces, and knee joint loading during lunges across different footwear designs will be critical (Lam et al., 2017). This investigation will therefore provide empirical data to guide the selection and design of badminton footwear, thereby contributing to the prevention of chronic lower extremity injuries prevalent in the sport (Lam et al., 2018).

METHOD

This study uses a quantitative descriptive method with a match analysis approach. Descriptive research aims to objectively describe the success rate of smash techniques and footwork patterns of athletes without providing specific treatment (Sugiyono, 2019). Data were obtained through observation of match recordings that were analyzed systematically. The subjects in this study were four male singles badminton athletes who competed in the semifinals and finals of the 2021 Toyota Thailand Open. The subjects were selected using purposive sampling, namely athletes who qualified for the semifinals and finals because they were considered to have the highest technical quality and performance in the tournament. Data collection was carried out through indirect observation by analyzing video recordings of the men's singles semifinals and finals of the 2021 Toyota Thailand Open. The research instrument was an observation sheet used to record the frequency of successful and unsuccessful smash techniques and the number of footwork movements in each direction of the court. To increase the objectivity of the data, the observation process was assisted by observers who understood the basic techniques of badminton. The data obtained was analyzed using descriptive statistics in the form of percentages.

RESULTS AND DISCUSSION

The Success of the Smash Technique

Observations of the men's singles semifinals and finals at the 2021 Toyota Thailand Open show that the smash technique has a very high success rate. The smash variations analyzed include the full smash, cut smash, whip smash, backhand smash, and circular smash.

Table 1. Success Rate of Smash Techniques in the Semifinals and Finals of the Men's Singles at the 2021 Toyota Thailand Open

Types of Smash	Semifinal (%)	Final (%)
Full smash	94	96
Cut smash	97	96
Whipped smash	94	96
Backhand smash	100	0
Circular smash	92	95

Based on Table 1, the cut smash and full smash are the techniques with the highest success rates in both the semifinals and finals. The backhand smash only appeared in the semifinals with a very low frequency and was not found in the final match. Pola Pergerakan Footwork Dominan

Analysis of footwork movement patterns shows that male singles players move more frequently to the back of the court than to the front or sides.

Table 2. Dominant Footwork Movement Patterns Semifinals and Finals of Men's Singles at the 2021 Toyota Thailand Open

Direction of Movement	Semifinals (times)	Final (time)
Front right	86	41
Front left	92	47
Right side	64	29
Left side	58	26
Rear right	211	98
Rear left	254	115

The left backhand movement pattern was the most dominant in both the semifinals and finals. The results of the study showed that the success rate of the smash technique in the semifinals and finals of the men's singles at the 2021 Toyota Thailand Open was very high. This indicates that athletes at the world elite level have excellent mastery of the smash technique in terms of power, coordination, and accuracy. This finding is in line with Aksan's (2018) opinion that the smash is the main weapon in modern badminton to score points directly. The cut smash and full smash are the most effective and frequently used techniques. The cut smash is used to deceive the opponent by placing the shuttlecock in the front area of the court, while the full smash is used to end the rally with maximum power. The low use of backhand smashes, especially in the final match, shows that elite athletes tend to avoid risks and prefer forehand overhead shots, which have a higher level of accuracy. This prevalence of backward left footwork could be attributed to the tactical imperative of maintaining court position and preparing for subsequent powerful attacking shots from the rear court, which is a common strategy in high-level men's singles badminton (Gammelgaard et al., 2017). This emphasizes the need for athletes to possess exceptional agility and endurance to effectively cover the court and respond to diverse shot placements during prolonged exchanges (Lam et al., 2017). Furthermore, the high frequency of backward movements suggests that defensive capabilities and effective recovery are critical components of success in this discipline (Hung et al., 2020).

Discussion

This mastery allows players to execute powerful offensive maneuvers while simultaneously ensuring a stable base for subsequent defensive or attacking actions, highlighting the intricate interplay between footwork and shot execution (Lam et al., 2018). The minimal sideways movement indicates that the playing pattern emphasizes court length control over court width. Overall, the results of this study emphasize the importance of match-based training that focuses on mastering smash variations and strengthening back footwork, particularly to the left, as key requirements in international men's singles play.

CONCLUSION

This study shows that the success rate of smash techniques in the semifinals and finals of the men's singles at the 2021 Toyota Thailand Open was very high, especially for full smashes, cut smashes, whip smashes, and circular smashes. Backhand smashes were rarely used and did not appear in the final match. The most dominant footwork movement pattern was backward left movement, indicating that international-level men's singles play is dominated by long rallies and overhead shots from the back of the court. These findings can serve as a basis for coaches and athletes in developing more specific and match-based training programs.

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