



Distance Analysis in Badminton

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ABSTRACT

This study aimed to determine the court area distance traveled by the badminton women's single players. The results of the study can be the basis for further research to improve achievements in badminton. The study was conducted in Jakarta. The research was a descriptive study with survey method. The population of this study were national badminton women's single players. The sampling technique used purposive sampling, which included the top 50 women's single players in the world. The data collection technique used in this study was the observation of match videos taken from Youtube which were analyzed by using the kinovea software application. The data analysis technique used descriptive statistics analysis, namely data descriptions in the form of frequency distributions, graphs, and data distribution (mean, median, mode, standard deviation, and variance). The research results show that the total distance covered in one badminton game for women's singles was 3.9 kilometers. It is expected that the Vo2max value can be standardized for badminton players by adjusting it to the badminton game category.

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INTRODUCTION

Badminton is a game sport widely loved around the world, including in Indonesia. This sport can be played by people of all ages, indoors or outdoors. Badminton is played on a court marked by lines of specific length and width, divided into two equal halves by a net suspended from poles at the court's edges, according to official regulations (BWF, 2022). Achieving victory requires programmatic and continuous preparation through serious and correct training to meet desired goals. In the training program, several components affect sports performance: physical, technical, tactical/strategic, and mental components (Ramli, Juhanis, Silatul Rahmi, Iskandar, 2024). Physical condition is a crucial component for achieving optimal performance. Physical condition is a fundamental determinant of sports achievement (Mulyadi, H., & Nikon, 2019).

Physical condition is the ability of the body's organs to function effectively during physical activity, representing an integrated set of components (Musrifin, A. Y., & Bausad, 2020). Several components of physical condition need consideration and development, including cardiovascular endurance, endurance strength, muscle strength, flexibility, speed, stamina, agility, muscle explosiveness, and strength endurance (Mashuri, et al., 2019). Therefore, preparing athletes for events necessitates developing their physical condition, focusing on the specific demands of competition.

However, physical demands vary across sports due to distinct movement characteristics (Nugroho et al., 2021). Badminton is an intermittent sport characterized by rapid accelerations, decelerations, and frequent changes of direction over short distances, demanding explosive movements and quick reflexes (Phomsoupha & Laffaye, 2015), including rapid acceleration, deceleration, and many explosive movements with changes of direction in short distances (Seth, 2016). Badminton playing patterns have been studied in several previous studies (Phomsoupha & Laffaye, 2015). These patterns demand a combination of aerobic (60–70%) and anaerobic (30–40%) energy systems (Laffaye et al., 2015), with speed, agility, and flexibility serving as dominant physical attributes (Torres-Luque et al., 2019). Phomsoupha & Laffaye (2015) highlight that badminton possesses distinct characteristics, including physiological aspects such as players' heart rate responses during matches, alongside considerations of anthropometry, visual fitness, and biomechanics.

To be able to improve the performance of badminton players on the court, it is necessary to conduct a performance analysis to find out how the player's skills and efficiency perform during the match. Performance measurement significantly influences success in sports. Recent research related to sports performance analysis was conducted by Krizkova et al. (2021). Their study shows that performance analysis is increasingly important in sports performance research, a growth facilitated by cutting-edge technology and smart devices. Kilit et al.'s (2018) study demonstrates that sports performance analysis enables coaches and practitioners to effectively use time-efficient and specific training to improve the desired physical condition of tennis players. A recent study by Merritt and Clauzet (2014) found that scoring dynamics in professional team sports, regardless of the scoring system used, tend to follow consistent patterns—such as scoring tempo aligning with a Poisson process and scoring balance resembling a Bernoulli process.

One performance analysis that can be conducted is measuring mileage. Measuring mileage aims to determine the necessary endurance (Vo2max) for players, particularly in badminton, because badminton matches are characterized by alternating high-intensity, short-duration efforts interspersed with rest periods. Therefore, badminton players must possess a Vo2max

appropriate for the demands of the game. Vo2max is the ability of the heart, lungs, and blood vessels to function optimally at rest or during exercise, particularly in taking oxygen and channeling it to tissues active for the body's metabolism (Nugraha, 2017). Maximum oxygen volume (Vo2max) is the level of body capacity expressed in liters per minute or milliliters/minute/kg of body weight.

However, currently, there is no Vo2max standard specifically used for badminton. The standards used are still general, even though badminton has different characteristics from game sports such as volleyball, basketball, and football. The aforementioned studies indicate that research on sports performance analysis remains limited. This is evident from the time span of the research conducted. In addition, there is still no research on the distance covered on the court during a badminton game. The results of this research will be valuable for establishing standards related to energy systems, speed training, and other aspects. Therefore, the researcher is interested in conducting research on the distance covered on the court in badminton games for women's singles athletes, as understanding this distance will provide a benchmark for energy system demands and Vo2 max in the sport. Understanding the total distance covered during matches can inform VO₂max standardization and training model development. Thus, this study aims to analyze the distance traveled on the court during badminton matches by elite women's singles players, which could serve as a foundation for sport-specific endurance training standards. Therefore, the title of this study is Distance of Field Area in the Game of Badminton in Women's Singles.

METHODS

The specific purpose of this study was to address the aforementioned limitations by determining the distance covered in a badminton game. The urgency of this study lies in quantifying the distance covered (the field area) in a single badminton game. The findings could serve as a benchmark for understanding energy system utilization in badminton, particularly given the shift to a rally scoring system. Furthermore, the results could provide a foundation for researchers to develop training models aimed at improving crucial physical components in badminton, such as endurance, agility, and speed. Therefore, the key finding of this study was the distance covered, which could be the basis to develop training models for improving physical components and serve as a standard for physical tests, especially for women's singles players.

Participants and Sampling Procedures

The population for this study comprised Indonesian women's singles badminton athletes. A purposive sampling technique was used to select participants based on the inclusion criterion of being ranked within the top 50 of the BWF world rankings. Consequently, only one athlete, namely Gregoria Mariska Tunjung, met the inclusion criteria and was selected for this study.

Data Collection Procedures

The research was conducted from early March to October 2024. Data collection involved video analysis of Gregoria Mariska Tunjung's performances in two international tournaments: the Kumamoto Masters (Japan) and the Madrid Spain Masters. These matches were chosen because the player reached the final round in both events. Match recordings were processed using Kinovea software to calculate the distance traveled per game. Data were analyzed from each round and set played throughout both tournaments.

Research Design and Data Analysis

The research method used in this study is a descriptive method using surveys. Descriptive statistical analysis was used, including frequency distribution, graphical representation, and

measures of central tendency and dispersion (mean, median, mode, standard deviation, and variance). Calculations were performed using Excel and SPSS 25. The data analyzed comprised the results of each match round, from round 32 to the final round.

RESULTS

The following presents the research results, including average values, median, mode, standard deviation, and the highest and lowest values obtained from data processing. The research data was taken from the overall results of the two championships: Kumamoto Master Japan and Madrid Spain Master. Table 1 presents a summary of the mileage research results in one game across the two championships:

Table 1. Descriptive Statistics of Distance Covered (in meters)

	Data Description	Value
1	Minimum	243,94
2	Maximum	582,32
3	Mean	357,82
4	Median	357,49
5	Mode	-
6	Variance	6591,06
7	Standard Deviation	81,19

Here are the detailed results of the two matches: the Kumamoto Master Japan and the Madrid Spain Master. The results of the research on the Kumamoto Master Japan championship consisted of 5 rounds, starting from round 32 to the final round. In each round, Indonesian women's badminton player, Gregoria Mariska, played 2 straight sets. So, the total number of sets in the Kumamoto Master Japan championship is 10 sets. The results of the study showed that the distance score ranged from 297.41 to 582.32 meters per badminton game, with an average score of 393.06 meters, a standard deviation of 75.87, a median of 379.84 meters, and no mode value. The following shows the trend of data from the research results obtained for each set in each round:

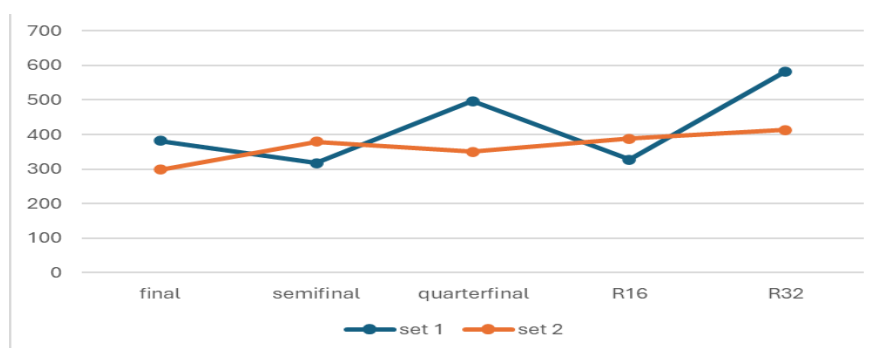


Figure 1. The Distance Score at the Kumamoto Masters Japan Championship

The results of the research on the Madrid Spain Master championship consisted of 5 rounds, starting from round 32 to the final round. In this championship, Indonesian women's badminton player, Gregoria Mariska, played two straight sets in the round of 32, the quarterfinals, and the final, while playing three sets (a rubber game) in the round of 16 and the semifinals. So, the total number of sets in the Madrid Spain Master championship is 12

sets. The results of the study showed that the distance score ranged from 243.94 to 460.66 meters per badminton game, with an average score of 344.79 meters, a standard deviation of 63.29, a median of 344.79 meters, and no mode value. The following shows the trend of data from the research results obtained for each set in each round:

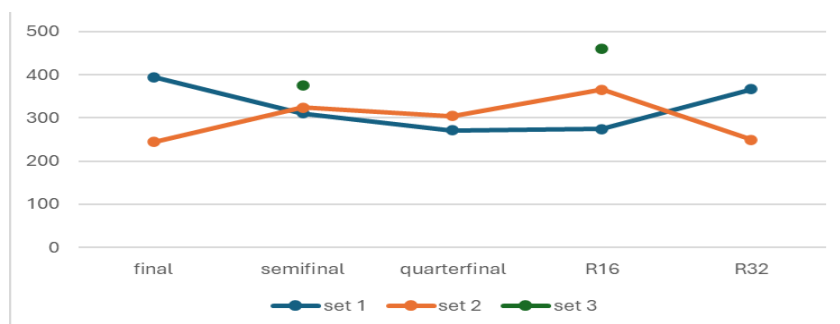


Figure 2. The Distance Score at Madrid Spain Masters Championship

The following are the results of the study, comparing each round of the two matches:

Table 2. Research Results of Each Round of Two Matches

Championship	Set 1				
	R32	R16	Quarterfinal	semifinal	Final
Kumamoto Japan	582,32	327,4	496,3	317,64	381,19
Madrid Spain Master	366,85	274,27	271,4	310,81	394,6
Championship	Set 2				
	R32	R16	Quarterfinal	semifinal	Final
Kumamoto Japan	412,64	387,72	349,34	378,5	297,51
Madrid Spain Master	249,67	365,64	304,21	324,1	243,94

The table above illustrates the comparison of the results of each round of two matches: Kumamoto Japan and Madrid Spain Master. From the table, it can be seen that there is a significant difference in mileage in both sets 1 and 2, especially in round 32, with a difference of 215.47 meters in set 1 and 162.97 meters in set 2. For the other rounds, the difference in mileage in each set is not as substantial. The distance difference in round 16 for set 1 was 53.13 meters, while for set 2 it was 22.08 meters. For the Quarterfinal round, set 1 is 224.9 meters and set 2 is 45.13 meters. In the semifinal round, set 1 is 6.83 meters. And for the final round, set 1 is 53.57 meters and set 2 is 13.41 meters. Here is a graph of the result lines for each round of the two matches compared:

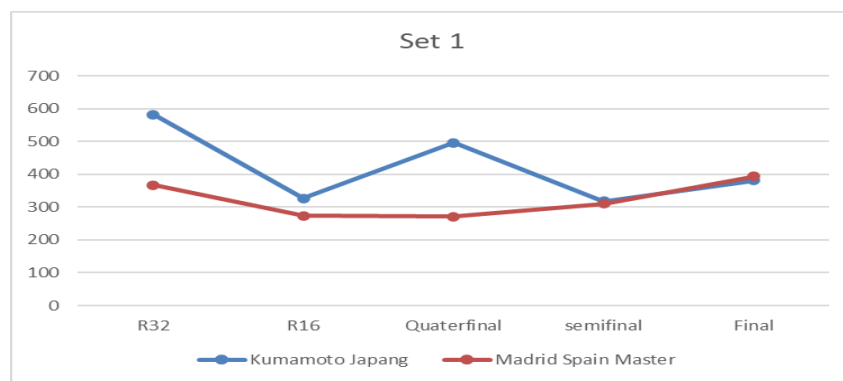


Figure 3. Set 1 Results by Round for Both Matches

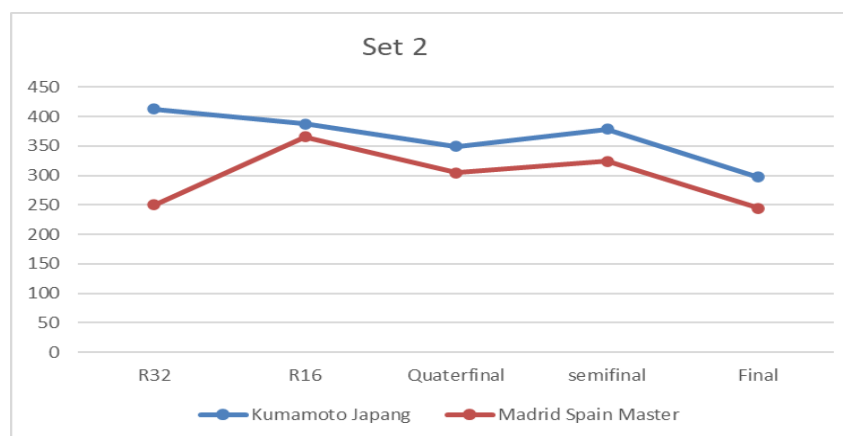


Figure 4. Set 2 Results by Round for Both Matches

DISCUSSION

Based on the results of the research described above, the data obtained from two championships involved women's singles players who reached the final round of each tournament. This resulted in a total of 10 rounds across the two championships: round of 32, round of 16, quarterfinals (last 8), semifinals, and the final. The total number of sets played in these two championships was 22, with 10 sets played in the Kumamoto Japan Masters and 12 sets in the Madrid Spain Masters. The higher number of sets in the Madrid Spain Masters was due to two matches extending to three sets (rubber sets) in the round of 16 and the semifinals. The study results indicate that the total distance covered across the two championships was 7872.04 meters, equivalent to 7.9 kilometers. The distance covered in each championship was 3930.56 meters (3.9 kilometers) in the Kumamoto Japan Masters and 3941.48 meters (3.9 kilometers) in the Madrid Spain Masters.

This suggests that the distance covered in a single women's singles badminton game is approximately 3.9 kilometers. The findings of this study are expected to provide data for formulating a specific VO_{2max} value tailored for women's singles badminton players, as current VO_{2max} values used are often generalized. Comparing these results with other studies is challenging due to the limited research on distance covered during badminton matches. Existing research predominantly focuses on game characteristics, heart rate, and other physiological parameters. However, recent studies have shed light on the physiological demands of badminton, particularly concerning distance covered and VO_{2max} values in

singles matches. For example, a systematic review by Winata et al. (2025) analyzed match-play data across different badminton categories. While specific distances were not detailed, the study highlighted significant differences in activity profiles between singles and doubles matches, emphasizing the unique demands of each. Additionally, a study by Ye et al. (2024) focused on developing a physical fitness evaluation index for elite male singles badminton players, underscoring the importance of tailored training programs to meet the specific physiological requirements of singles players, including $VO_2\text{max}$ considerations.

Research by Nilesh et al. (2023) found that the average rally duration is 10–12 seconds, supporting the notion that badminton has distinct characteristics compared to other sports. Badminton is a sport with a temporal structure characterized by short-duration, high-intensity actions (Phomsoupha & Laffaye, 2015). It is a highly explosive sport involving unique movements and power techniques within a relatively small court. Success in badminton relies on a combination of physical condition, mental attitude, courage, intelligence, technical skills, and tactical efficiency. Badminton is a fast-paced and explosive sport that requires a combination of unique movements, power techniques, and tactical efficiency within a compact playing area. Success in matches depends on the perfect balance of physical fitness, mental toughness, technical skills, and strategic intelligence, which all require coordinated bodily functions and quick reflexes (Thomas & Pritchard, 2017).

To determine the distance covered, steps taken, and movement patterns during a game, computerized notation analysis is employed. Recent advancements in racket sports analysis, particularly in badminton, have utilized computer-based notation and artificial intelligence to automatically capture detailed performance metrics. For instance, Chien and Yu (2023) developed an automated hit-frame detection system using deep learning to identify key moments in a match, reducing manual analysis. Similarly, Lin et al. (2023) introduced a virtual reality-based match video analysis system, allowing coaches to analyze 3D reconstructions of player movements and shuttle trajectories for enhanced tactical feedback. Furthermore, Nilesh et al. (2023) proposed a framework for real-time analysis of broadcast badminton videos to measure player movement, distance covered, and in-game speed without wearable sensors. This significantly contributes to understanding physiological demands, including $VO_2\text{max}$ estimations, which have traditionally relied on generalized values. Feng and Liu (2025) also emphasized the role of big data and predictive analytics in optimizing game strategies and tailoring performance indicators to individual athletes. Earlier contributions by Weeratunga et al. (2015) demonstrated the feasibility of using computer vision for automated tactical notation, achieving over 85% accuracy compared to manual analysis. Despite this progress, specific studies quantifying the total distance covered and its relationship to $VO_2\text{max}$ in women's singles badminton remain limited. Therefore, integrating these emerging technologies with physiological assessments could offer a more personalized and accurate understanding of player demands. Research by Valldecabres et al. (2020) indicated that the most frequently used footwork patterns were the longitudinal large backward (LLB) in the round of 32 (R1/32) and round of 16 (R1/16), the diagonal short forward left (DSFL) in the quarterfinals (R1/4), and the transverse short right (TSR) in the final round.

This research aimed to serve as a reference for standardizing endurance development ($VO_2\text{max}$) by considering the specific characteristics of badminton. Current standardization often applies general values across all sports. Therefore, it is highly hoped that the results of this study can form the basis for future research on calculating $VO_2\text{max}$ values specific to badminton and its different categories. Additionally, it is also hoped that this research can contribute to developing varied exercises to enhance $VO_2\text{max}$ based on game patterns and adjusted for different categories (singles, doubles, and mixed).

CONCLUSION

Based on the research findings, it can be concluded that the distance covered in a single women's singles badminton game is 3.9 kilometers. This suggests that changes in score acquisition during a badminton game can influence the distance covered, and this research can be used to analyze how changes in distance may relate to game patterns in badminton. Further research could compare distance covered data between rally point scoring and service-over scoring systems. Alternatively, this study could contribute to standardizing VO₂max values specifically for badminton players, particularly in women's singles.

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AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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