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Original article

Analysis of phases and medalists to women's singles matches in badminton at the Tokyo 2020 Olympic Games

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection.

Abstract

Purpose: The purpose of this study is to determine the technical and tactical styles of the world's best badminton players at the Tokyo 2020 Olympic Games.

Materials and methods: The research material consisted of the post-event analysis of 58 matches from the Tokyo Olympics. Through AHP analysis (analytic hierarchy process) to 6 temporal variables with a high influence on match/game effectiveness were selected. Match/game statistical analysis, with the one-way measure of the variance (ANOVA), and independent-sample T-test, were conducted by using IBM SPSS for Windows version 22.0 (IBM. Corp. Armonk, NY) in order to compare the statistical differences.

Results: This conducted study showed that frequency of strokes in badminton was 1-1.12 strokes/sec, which is one of the longest rally strokes. The mean and standard deviation of the women's singles players, particularly in the knockout stage, is greater than the mean and standard deviation of the group stage. Results show the differences between Group Phase (35.05±9.77, 47.07±13.12, s, P=0.020) and Eliminatory Phase (11.93±1.58, 13.93±2.30, s, P=0.030) respectively.

Conclusions: The women's singles competition currently mainly revolves around the technical and tactical styles of «fast-oriented», «offensive-oriented» and "self-oriented". This is in line with the current trend of development of the world's women's singles athletes' more «masculine» style of play.

Key words: badminton players, Tokyo 2020 Olympic Games, women's singles, AHP, comparative analysis, ANOVA

Анотація

Сян-Цянь Сюй, Георгій Коробейніков, Вей Хань, Мирослав Дутчак, Димитрій Ніконоров, Мен Чжао, Вікторія Міщенко. Аналіз виступів призерів жіночих одиночних матчів з бадмінтону на Олімпійських іграх 2020 року у Токіо.

Мета: Метою цього дослідження є визначення техніко-тактичного стилю найкращих бадмінтоністів світу на Олімпійських іграх 2020 року в Токіо.

Матеріали та методи: Матеріал дослідження складався з пост-подійного аналізу 58 матчів Олімпійських ігор у Токіо. За допомогою AHP-аналізу (процес аналітичної ієрархії) було обрано 6 тимчасових змінних, які найсильніше впливають на ефективність матчу/гри. Статистичний аналіз матчу/гри з одностороннім виміром дисперсії (ANOVA) та Т-критерієм для незалежної вибірки було проведено з використанням IBM SPSS для Windows версії 22.0 (IBM. Corp. Armonk, NY) для порівняння статистичних відмінностей.

Результати: Проведене дослідження показало, що частота ударів у бадмінтоні становить 1-1,12 ударів/с, що є одним із найдовших розіграшів. Середнє значення та стандартне відхилення гравців жіночого одиночного розряду, особливо на стадії плей-офф, більше, ніж середнє значення та стандартне відхилення на груповому етапі. Результати показують відмінності між груповою фазою (35,05±9,77, 47,07±13,12, с, P=0,020) та елімінаційною фазою (11,93±1,58, 13,93±2,30, с , P =

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0,030) відповідно.

Висновки: Змагання в жіночому одиночному розряді нині переважно обертаються навколо техніко-тактичних стилів: «орієнтований на швидкість», «орієнтований на наступ» та «орієнтований на себе». Це відповідає сучасній тенденції розвитку більш «чоловічого» стилю гри спортсменок-одиночниць у світі.

Ключові слова: бадмінтоністки, Олімпійські ігри 2020 р. у Токіо, жіночий одиночний розряд, AHP, порівняльний аналіз, ANOVA.

Introduction

Badminton became an official Olympic sport at the 1992 Olympic Games held in Barcelona and the study of the performance capabilities of its players became the focus of the researchers [4, 16]. Studies on the characteristics of badminton game focused on the analysis of singles' match. The main direction of its research is the change of game characteristic [13, 20], Temporal and discrete comparison of competition activity [1, 2, 19], technical and timing characteristics of badminton players [7].

In badminton, over the past decades, there have been very large changes in technical equipment and effectiveness of technical and tactical training [22]. Reducing the weight of the racket, improving the quality of the shuttlecock and racket, changing the rules of sports competitions have led to a noticeable increase in the speed of the entire game, a decrease in the processing time of the shuttlecock, and as a result - to an increase in the intensity of the training and load [5]. These changes influenced the structure of physical training, the strategy of competitive struggle, the planning and programming of the training process, which caused a change in the philosophy and conceptual foundations of the game of badminton [6]. Correspondingly, with the rapid improvement of the comprehensive ability of women's badminton singles players and the gradual change in their technical and tactical playing styles, the women's singles' technical and tactical styles have shown a masculine tendency. The previous research on the Olympic badminton women's singles competition is mainly based on statistical differences and comparative analysis. The found that temporal and notational structure of the men's singles and women's singles match at the Beijing Olympics was different when comparing men's singles from women's singles. It was also found differences between the two events: the smash and the drive were commonly used by men and the drop was commonly used by women. The analyse statistical differences in men's and women's singles badminton competitions at the London (2012) and Rio de Janeiro (2016) Olympic Games conclusion points out that the timing factors of badminton singles were dissimilar.

This study is based on the theory and framework of MÁ's (2020) research on Serving Patterns of Women's Badminton Medalists in the Rio 2016 Olympic Games and Chiminazzo's (2018) research on comparison between groups and play-offs stages in 2016 Rio Olympic Games. Meanwhile, has organized and referenced the literature of prior research reporting on badminton match results [10, 12, 13, 14] and has combined the variables related to match and game data collected during the 2020 Olympics. Within that framework, conducted a one-way measure of the variance (ANOVA) analysis on the women's singles athletes CHEN YUFEI, TAI TZU-YING, PUSARLA V. SINDHU, and Non-medal players. It also conducted an independent-sample T-test for the Group Phase (GP) and Eliminatory Phase (EP) to summarise the practice characteristics of the 11 variables concerning women's singles players during the competition. These can provide references for future targeted training.

This study is based on the framework research on Serving Patterns of Women's Badminton Medalists in the Rio 2016 Olympic Games and Chiminazzo's (2018) research on comparison between groups and play-offs stages in 2016 Rio Olympic Games. Meanwhile the analysis of literature of prior research reporting on badminton match results [11, 13, 14, 20] and has combined the variables related with the 2020 Olympic Game.

Material and Methods

The sample was composed of the 58 matches (116 sets) played by successful players, and Non-medal players, GP, and EP during the 2020 women's singles Olympic Games badminton event (Tokyo, Japan). This study conducted a statistical analysis of the performance of the athletes (https://en.sports.nhk.or.jp/olympic/highlights/content/3e8a1dcf-4d89-4c08-a81e-e75ad5a107a2) through 58 matches (116 sets). 43 women from 37 countries and regions with an average height of 167.95±7.22cm and an average age of 25.9 1±3.46 (Table 1) were observed. All matches were publicly available on TV and the data was used with the approval of the Shandong Sports University Ethics Committee and in accordance with the China Data Protection Law.

The 11 variable data of the sample collected by the study are all from the official statistics of the whole game after the game. 11 temporal structure variables were selected for this study, which consists of duration of the match (m), longest rally (s), longest rally (strokes), average rally (s), average

Table 1. *The physical characteristics of the athletes*

Variables		N	Mean	SD
Age	Woman	43	25.91	3.46
Height	Woman	43	167.95	7.22

Table 2. *Variables analyzed in singles badminton competition*

Group of variables	Game statistics
Variables related to match	Duration of the match, longest rally(s), longest rally (strokes), average rally (s), average rally (strokes)
Variables related to set	Match points, game points, points scored without service, points scored with service, biggest lead, biggest comeback to win (game leader)

rally (strokes), match points, game points, points scored without service, points scored with service, biggest lead, biggest come back win (game leader) (Table 2). Using a specifically designed spreadsheet (Microsoft Excel) the data of the CHEN, TAI, PUSARLA, Non-medal players, GP, and EP from the 2020 Olympics was collected NHK (Exclude abstaining athletes). It was then exported to the software.

Experts from among the qualified coaches of the Chinese National Team were invited for an objective analysis of the data obtained.

Statistical Analysis

Through the AHP (analytic hierarchy process), the weights of 11 variable indicators were evaluated, as well as the variable indicators that had a greater impact on the performance of women's sports in the Tokyo Olympics were selected and analyzed. According to the results of the AHP, the weight evaluation of 8 experts, for each evaluation index, could be obtained. Among them, the evaluation of expert 3 and expert 4 failed to pass the consistency test, and these results were eliminated. The indicators were finally evaluated and ranked and their analysis found that a limited number of factors, mainly round factors, determined the athletic performance of badminton players. The most critical indicators were: average rally (strokes), average rally (s), longest rally (strokes), duration of the match, longest rally (s), and game points.

A descriptive analysis of the data, for each variable respectively, with means and standard deviation, was reported. With the use of the one-way measure of the variance (ANOVA) and independent-sample T-test analysis, differences in 6 variables at the competition level were analyzed. In particular, ANOVA was conducted to analyze the comparison of variables to determine if there were any significant differences ($p<0.05$) between the observed players. Six variables and independent sample T-tests were used for comparison to determine if there were any significant differences ($p<0.05$) between GP and EP levels

Results

The descriptive statistics along with the ANOVA comparisons of the variables for CHEN YUFEI, TAI TZU-YING, PUSARLA V. SINDHU, and the non-medal players are presented (Table 3). The results presented in depicted in the table show the mean and standard deviations for the 6 tested variables for each athlete respectively. Their differences in match duration, longest rally (strokes), average rally (s), and average rally (strokes) are significant ($p<0.05$). Their differences in longest rally (s) and game points are not as significant ($P>0.05$). In summary, the average value of CHEN (Gold) in notational and temporal variables is higher than other medal athletes. It can

Table 3. *Players difference test results on 6 variables*

Variables	Medalists	Mean	Std. Deviation	R-value
Duration of the match (m)	CHEN (Gold)	56.00	27.15	0.019
	TAI (Silver)	46.17	22.95	
	PUSARLA (Bronze)	42.17	10.65	
	Non-medal players	35.65	11.67	
Longest rally (s)	CHEN (Gold)	49.40	14.26	0.163
	TAI (Silver)	37.83	9.04	
	PUSARLA (Bronze)	38.33	12.40	
	Non-medal players	36.88	11.35	
Longest rally (strokes)	CHEN (Gold)	41.40	14.40	0.030
	TAI (Silver)	28.17	9.54	
	PUSARLA (Bronze)	31.67	11.89	
	Non-medal players	27.77	8.58	
Average rally (s)	CHEN (Gold)	14.40	2.70	0.030
	TAI (Silver)	11.17	1.17	
	PUSARLA (Bronze)	13.00	2.10	
	Non-medal players	12.26	1.76	
Average rally (strokes)	CHEN (Gold)	8.80	2.78	0.005
	TAI (Silver)	5.83	1.60	
	PUSARLA (Bronze)	8.00	2.37	
	Non-medal players	6.53	1.32	
Game points	CHEN (Gold)	1.40	0.89	0.208
	TAI (Silver)	1.50	0.55	
	PUSARLA (Bronze)	1.00	0.63	
	Non-medal players	0.80	1.01	

Table 4. *GP and EP difference test results on 6 variables*

Variables	Phase	Mean	Std. Deviation	R-value	Z
Duration of the match (m)	GP	33.34	9.85	0.003	-4.155
	EP	53.93	16.86		
Longest rally (s)	GP	35.05	9.77	0.020	-3.112
	EP	47.07	13.12		
Longest rally (strokes)	GP	26.34	7.41	0.000	-3.205
	EP	37.57	12.41		
Average rally (s)	GP	11.93	1.58	0.030	-2.861
	EP	13.93	2.30		
Average rally (strokes)	GP	6.20	1.23	0.001	-3.908
	EP	8.57	2.07		
Game points	GP	0.80	0.96	0.555	-1.587
	EP	1.11	1.03		

be inferred from Table 3 that CHEN technical and tactical style category belongs to the "defensive counterattack" type of pull-and-attack defensive tactics; TAI in 4 average values of these variables are all lower than other medal athletes. It also reflects from Table 3 that the technical and tactical style category of TAI belongs to the speed-based offensive tactics of "pressing the net", and has become the main representative of the "masculine" style of play. It can be seen from Table 3 that the technical and tactical style of PUSARLA (Bronze) is between the CHEN (Gold) and the DAI (Silver), and the technical and tactical style performance is not obvious.

The analyses of technical and timing variables provide important information for understanding the match. The descriptive statistics in conjunction with the T-test comparisons of the game, and the match structure variables between GP and EP, are presented in Table 4. The results presented in this table show the mean and standard deviations for tested variables respectively. The comparison between phases showed that duration of the match (m), longest rally (s), longest rally (strokes), average rally (s), and average rally (strokes) were significantly higher ($p<0.05$) in the EP. Only game points presented higher frequency in the GP. To sum up the above, we can conclude that play-offs were more intense than the group stage. Research in this area is relevant for understanding the match and providing information for training planning. The results of this study are important to set the appropriate targeting of workloads in view of the requirements of a match.

Discussion

Thus, modern badminton is characterized by the use of new technologies and the development of playing skills [15, 17]. At the same time, women's badminton is distinguished by its technical and tactical style [11, 23]. Our research has shown that women's competition is characterized by fast and aggressive play. This trend is related to the male style of playing badminton.

This study was conducted to compare the performance of these particular athletes in this event in order to determine their differences in each match, 36-83min (35.65±11.6756.00±27.15). This was done by examining the longest rally (strokes), average rally (s), and average rally (strokes) ($p<0.05$). Slight differences from previously studied results were observed [2, 8]. The specific causes correlate with the observed players or the level of the competition. The frequency of high-demanding, longest rally sec/strokes, and average rally sec/strokes were 1.20, 1.36, 1.19, 1.32, and 1.56, 1.83, 1.63, 1.71 for CHEN, TAI, PUSARLA, and the non-medal players respectively. Following previous relevant case studies, the stroke by time ratio has a propensity of 1-1.12 strokes/sec, which is one of the longest rally strokes/sec. Hitherto researchers in this field have determined a frequency of from 0.56 to 1.08 strokes/sec [2, 3, 8]. Examining the above variables, it was concluded that the intensity of the singles matches, and the level of the athletes' energy reserves, depend on the combination of high-intensity short rallies (anaerobic system) and longer, moderate high-intensity rallies (aerobic system) [18], the result of which is a longer rally duration with a greater number of shots. The results simultaneously confirmed the current trends of intermittent and high-intensity demands required from players during elite badminton matches, as well as the increasing number of long rallies played during women's singles matches [9]. Despite these findings, coaches and teachers rarely pay attention to the practical effects of the above variables in training.

Current research on the kinematic characteristics of badminton matches is mainly based on video analysis to characterise the duration of matches, technology, and movement distance [21]. This study paralleled the significant differences ($p<0.05$) between GP and EP at the duration of the match (m), longest rally(s), longest rally (strokes), average rally (s), and average rally (strokes), while the differences in game points held no significance ($p>0.05$). The mean and standard deviation of the women's singles players, particularly in the knockout stage, is greater than the mean and standard deviation of the group stage. This means the players performed better at the knockout stage and were more stable. The frequency of these high-demanding longest rally sec/strokes and average rally sec/strokes were 1.35, 1.24, and 2.00, 1.56 for GP and EP respectively throughout the 2021 Tokyo Olympic Games. In relation to the duration of the match, EP is longer between GP (33.34±9.85 m) and EP (53.93±16.86 m). This portrays an important difference between players, as one must be more effectively prepared to participate in the EP (Torres-Luque et al, 2019). Gomez et al. (2020) reported the total match duration (two-step cluster analysis) between regular matches (ranged between 21.2 and 55.8 minutes for women's matches) and long matches (ranged between 70.4 and 110.6 minutes for women's matches). To the author's knowledge, this is the first study to show that EP exhausts the most time in a match, as seen by the

figure in table 4, spanning 54-71 minutes. This should be a fundamental consideration when developing a training regiment. Even though these results are important for athlete preparation, the data in the game structure is more revealing. Results show the differences between GP and EP respectively in the longest rally (s) (35.05±9.77, 47.07±13.12, P=0.020) and average rally (s) (11.93±1.58, 13.93±2.30, P=0.030). This data raises some questions about the structure of the strokes. In conclusion, the longest rally (strokes) (37.57±12.41, P=0.000) and average rally (strokes) (8.57±2.07, P=0.001) are significantly higher in EP.

Thus, our research shows that in women the technical and tactical properties of playing badminton are associated with the possibilities of training situation and the impact on the effectiveness of competitive activity. A truly competitive situation provokes an increase in match time and strength requirements for female athletes.

Conclusions

Badminton is an intermittent high-intensity sport. Women's singles matches at the 2021 Tokyo Olympic Games averaged between 19 to 81 minutes (average time per match was 39.05±15.49 minutes, average time per set was 18.24±5.61 minutes). 17 to 56 shots of rallies were realized (average rally (strokes) 29.33±10.05 strokes). The duration of a single rally was 9-18 strokes, and the number of shots in a single rally was 4-12 strokes. The duration of rallies accounted for 26-31% of the total match time. The main contributions of the results of this study are as follows:

1. Through the discussion and analysis of the results of the differences between CHEN, TAI, PUSARLA, and the Non-medal players, GP, EP in 58 matches, and the games related variables, it is evident that the women's singles competition currently mainly revolves around the technical and tactical styles of "fast-oriented", "offensive-oriented" and "self-oriented". This is in line with the current trend of development of the world's women's singles athletes' more "masculine" style of play.
2. The duration of the match confirmed that the longest rally sec/strokes and average rally sec/strokes can be used as models and reference indicators for coaches and athletes to simulate different training (multi-shuttle training, rally training et al.). This helps to continuously improve the pertinence and effectiveness of elite female badminton athletes in their Olympic preparations, enhancing the training effect and athletic performance of these first-class athletes.
3. The extension of the match time, the increase of the longest rally, the average rally multi-shot ratio, the rally interval, and the offence ratio place higher demands on the physical strength of female athletes.
4. The women's singles competition currently mainly revolves around the technical and tactical styles of "fast-oriented", "offensive-oriented" and "self-oriented". This is in line with the current trend of development of the world's women's singles athletes' more "masculine" style of play.

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Declaration of conflicting interests

The authors declare that there were no conflict of interests.

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