ISSN 1750-9823 (print)
International Journal of Sports Science and Engineering
Vol. 02 (2008) No. 04, pp. 216-222

Time Motion and Notational Analysis of 21 Point and 15 Point Badminton Match Play

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(*Received July 15, 2008, accepted October 02, 2008*)

Abstract. The purpose of this study was to investigate and compare the time motion and notational variables of 21 point singles' badminton play and of the old scoring system (15 points for males and 11 for females). Sixteen (8 males and 8 females) state-level badminton players with a mean age of 15.7 ± 1.2 years participated in this study. They were initially tested using incremental treadmill test following Bruce protocol to obtain individual maximum oxygen consumption (VO2max) value. VO2max of the male and female participants were 47.1 ± 5.2 ml·kg-1·min-1 and 39.8 ± 6.2 ml·kg-1·min-1 respectively. On a separate day, they played a simulated badminton match using 21 points (Trial 1) and 15 / 11 points (Trial 2) scoring system. During the trials, a video camera was used for time-motion and notational analysis throughout the match. The statistical analysis showed that total number of shots and rallies in a match were the only variables which were significantly higher in the 15 points compared to 21 points in men's singles match play [331.2 ± 51.6 vs 463.5 ± 24.7 (total shots) and 70.2 ± 1.2 vs 97 ± 6.6 (total rallies) respectively]. Even though female players had a greater point difference (10 points) in the new scoring system compared to the male counterparts, there were no significant differences in all parameters measured. The patterns of play which were analyzed on the basis of notational variables were also similar in both scoring systems. However, some differences in the time motion and notational analysis were found between genders suggesting that there should be different training regimens for men and women in their respective disciplines due to greater intensity, speed of play and the longer rally lengths in men's singles. Therefore, it is recommended that players should impart more emphasis in the development and improvement of the skills/techniques rather than making any drastic changes to the training programme to develop their physical fitness to meet the demands of the match with the 21 point scoring system.

Keywords: Time motion analysis, notational analysis, badminton.

1. Introduction

The game of badminton started back in 2000 years ago and it is known as "battledore and shuttlecock" in Ancient Greece and later "Poona" in India during the 18th Century. A series of changes in the scoring system was also observed since the Badminton Association of England published the first set of rules in September 13, 1893 (Bischof, 2006). In December 2005, the Badminton World Federation –BWF (formally known as International Badminton Federation – IBF) experimented with the 3 x 21 point scoring system and made its first debut at the Saiqi Invitational World Cup 2005 in Yunan Province, Yiyang, China (Badminton Asia, 2006).

The change from the traditional 3 x 15 point system to the rally point system was proposed to regulate the playing time and to simplify the system for television viewers. The changes in the scoring system affect how players score points and to win the game as the number of points per game is increased for all matches (Percy, 2007). The differences in the physiological demands could be expected between the new (21 points) and the old (15 points for doubles and men's singles while 11 points for women's singles) scoring system. However, it could be quantitatively explained and supported by gathering information relating to the technical and tactical aspects of performance (Carlson et al., 1985; Hughes, 1988). Time motion analysis has proven to be particularly important in directing coaches to look into a player's game requiring attention and in the development of training techniques (Liddle et al., 1996).

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To promote an understanding of specific game demands and thus assist the creation of game-specific training schedules, the nature, extent and intensity of movement has to be assessed (Green et al., 1976; Reilly, 1976; Withers et al., 1982; Mayhew, 1985; Docherty et al., 1988; Allen, 1989; Salmoni et al., 1991; Lothian, 1994; Liddle et al., 1996). Hence, the present study was undertaken with a view to analyse and compare the time motion variables and notational variables of singles' badminton play following 21 point scoring system and 15 point scoring system.

2. Methods

This study has been approved by the Research and Ethics Committee, School of Medical Sciences, Universiti Sains Malaysia, Health Campus, Kelantan. Each subject gave written informed consent before the start of the study.

Subjects and general design

Eight male and eight female badminton players' between 14 to 17 years were recruited for this study. They are physically fit, competitive and being in regular training under the badminton project (Projek Gemilang) and badminton core sports programme (Sukan Teras). Each subject who participated in this study has at least two years of competitive experience in badminton at state level and they are familiar with both 15 or 11 points and 21 points scoring system. All the subjects were free from any serious injury or health problems. Anthropometric measurements of all subjects such as height, weight and percentage of body fat were presented in Table 1. The present study was carried out in the following phases:

- Phase 1: Laboratory test to determine the individual VO2max
- Phase 2: Experimental Trial 1 – 21 points simulated match
- Phase 3: Experimental Trial 2 – 15 points (men) and 11 points (women) simulated match

Laboratory test

Before the test began, subjects were equipped with a heart rate monitor (T61, Polar Electro Oy, Finland) and a mouth piece fixed to a headgear with breathing hose connected to a gas analyzer (V-Max Spectra, USA). This metabolic measurement system was selected to measure oxygen uptake (VO_2), carbon dioxide production (VCO_2) and respiratory exchange ratio (RER) of the subjects during the exercise test. Once the metabolic measurement system was calibrated, the test began with recording the resting heart rate and followed by the incremental treadmill test.

Subjects performed a graded exercise test on a motor-driven treadmill (Quinton^{TM}, Model 18-60, USA) using the Bruce protocol where the work load was increased by changing both the speed and percent grade. During the first stage (minutes 1 to 3) of the test, subjects ran at a 1.7 mph at a 10% grade. At the start of second stage (minutes 4 to 6), the grade was increased by 2%, and the speed was increased to 2.5 mph. In each subsequent stage of the test, the grade increased 2%, and the speed was increased either 0.8 or 0.9 mph until subjects was exhausted. The subjects ran on the treadmill until volitional exhaustion despite verbal encouragement towards the end of the test. Blood samples of 1 ml were withdrawn from antecubital vein immediately after the test to determine the blood lactate concentrations. Subjects were advised to perform active cool down for 5 minutes on the treadmill. The results were recorded and then analysed to determine the fitness level of each individual.

Experimental trials

In Trial 1, subjects are paired up to play against each other using the 21 point rally system. In Trial 2, the same pair played against each other using the old scoring system whereby the men's singles used the 15 point scoring system and the women's singles used the 11 point scoring system. The matches were played in best of 3 games. These two trials were separated by a 1 week. All the subjects were requested to maintain the same type of training or physical activity 7 days prior to each experimental trial and were told to refrain from strenuous training 24 hour prior to each experimental trial.

All the matches during the experimental trials were conducted as an official tournament, which means that there were umpires, line judges and were in accordance with rules as set by the Badminton World Federation – BWF. According to Cabello and Gonzalez-Badillo (2003), it was necessary to take account of a factor that may affect the results obtained, such as the intensity with which the match was contested. To consider the results obtained as representative of maximum effort, the match had to be hard fought with the players performing to their full capacity. This was controlled by choosing for analysis the matches that a priori were likely to be the most hotly contested – that is, between players of the same level by using

information obtained from results in other competitions and from their respective coaches – as well as the importance of the result within the competition. Thus, in the present study, the subjects were matched according to their playing level as determined by the coach.

Time motion and notational analysis

A digital video camera was placed at one of the side lines to record each match played for time motion analysis purposes. All the video were analysed through Utilius® fairPLAY Lite version 4.0.3 (CCC GmbH, Germany). From the recoded tapes, the duration of each match and game, the duration of rally and rest, and number shots and rally were recorded. From these data, the following variables were calculated for each game:

- Work density = rally time divided by rest time
- Average shots per rally = total number of shots divided by total number of rallies in a game
- Shots per rally time (shots·sec-1) = number of shots performed in the rally divided by duration of the rally
- Effective playing time (EPT, expressed in percent of the total time of playing in a game) = rally time divided by rally + rest time expressed in percent

Besides time motion analysis, a hand notational analysis was done whereby frequency of all shot types and unforced errors were measured from the recoded match. Each stroke-move was noted and categorised into service, clear, drop shot, smash, net, lob, hit, block and whip. In addition, the unforced errors were also analysed and divided into 3 types namely: in the net, out of court and misjudged. The purpose was to compare the patterns of play between the two different scoring systems.

Calculations and statistics

All the analysis were analysed using Statistical Package for Social Science (SPSS) version 14.0. Paired T-tests (2-tailed) analysis was used to compare mean difference in each variable (rally time, rest time, work density, set duration, game duration, average shots per rally, shots per rally time, effective playing time) between the 21 point and 11 point / 15 point match play. Independent T-tests was used to compare the variables between genders in the 21 points match play. Level of significance was accepted when p value was less than 0.05 ($p<0.05$). Results were reported as mean ± standard deviation.

3. Results

Laboratory test

Peak values for blood lactate concentrations and heart rate obtained at exhaustion during VO_2max test in male players were 10.9 ± 2.5 mmol·L^{-1} and 190.5 ± 6.2 beats·min^{-1} respectively. Meanwhile in female players, peak values for blood lactate concentrations and heart rate were 10.8 ± 1.6 mmol·L^{-1} and 195.7 ± 7.2 beats·min^{-1} respectively. Maximal oxygen uptake is presented in Table 1.

Table 1**:** Physical characteristics and physiological profiles of the subjects

	Age (years)	Height (cm)	Weight (kg)	BMI ($kg·m^{-2}$)	Percentage Body Fat (%)	VO_{2max} ($ml·kg^{-1}·min^{-1}$)
Males (n = 8)	16.1 ± 0.8	167.1 ± 3.3	62.1 ± 9.2	22.2 ± 3.2	20.6 ± 3.9	47.1 ± 5.2
Females (n = 8)	15.2 ± 1.3	157.4 ± 6.8	53.2 ± 7.5	21.5 ± 3.2	27.9 ± 4.8	39.8 ± 6.2

Data as means ± SD VO_{2max} Maximal Oxygen Uptake

Experimental trials

Sixteen simulated matches were conducted in the Experimental Trial 1 and 2 whereby the players were paired accordingly to their standard of play based on the recommendation of their coach. Eight matches (4 men's singles and 4 women's singles) were played in Trial 1 (21 points for both male and female players) and the other eight matches were played in Trial 2 (15 points for the males and 11 points for the females). During the trials, players were advised to play at their best, regardless 2 or 3 games. In Trial 1, only 1 male and 3 female pairs played the 3rd game. However in Trial 2, only 1 male and 1 female pair played the 3rd game. Therefore, for statistical analysis, only the first 2 games were taken into consideration. The time motion analysis of 16 badminton matches with 2 games each are tabulated in Table 2.

Table 2: Time motion analysis of 21 points and 15 points (11 points in female) between the paired badminton players in the respective simulated match plays.

	Male		Female	
	Trial 1 (21 points)	Trial 2 (15 points)	Trial 1 (21 points)	Trial 2 (11 points)
Match duration (minutes)	17.27 ± 2.67	24.06 ± 2.38	17.14 ± 0.97	18.30 ± 6.09
Average game duration (minutes)	8.64 ± 1.33	12.03 ± 1.19	8.57 ± 0.49	9.15 ± 3.04
Rally time (seconds)	4.62 ± 0.86	4.63 ± 0.49	4.16 ± 0.24	4.03 ± 0.59
Rest time (seconds)	9.71± 1.32	10.29 ± 1.42	10.53 ± 0.35	10.18 ± 1.51
Work density	0.48 ± 0.07	0.46 ± 0.07	0.40 ± 0.02	0.40 ± 0.01
Number of shots per match	331.25 ± 44.74 *	463.5 ± 21.41 †	242.5 ± 8.96	275 ± 84.91
Number of rallies per match	70.25 ± 1.26	97 ± 6.68 ††	70 ± 2.16	77.25 ± 23.92
Average shots per rally	4.74 ± 0.78 **	4.77 ± 0.47	3.48 ± 0.10	3.58 ± 0.42
Shots per rally time (s^{-1})	1.03 ± 0.22 ***	1.03 ± 0.47	0.84 ± 0.31	0.89 ± 0.60
Effective playing time - EPT (%)	32.22 ± 3.34	31.19 ± 3.32	28.30 ± 0.77	28.37 ± 0.31

Data are presented as means ± S.D.

† denotes a significant difference from male's 21 points scoring system ($p<0.05$).

†† denotes a significant difference from male's 21 points scoring system ($p<0.01$).

* denotes a significant difference from the females in the 21 points scoring system at $p<0.05$.

** denotes a significant difference from the females in the 21 points scoring system at $p<0.01$

*** denotes a significant difference from the females in the 21 points scoring system at $p<0.001$.

Meanwhile, for notational analysis; distributions of the various types of strokes and unforced errors of the male and female players during the two experimental trials are shown Figure 1 and 2 respectively.

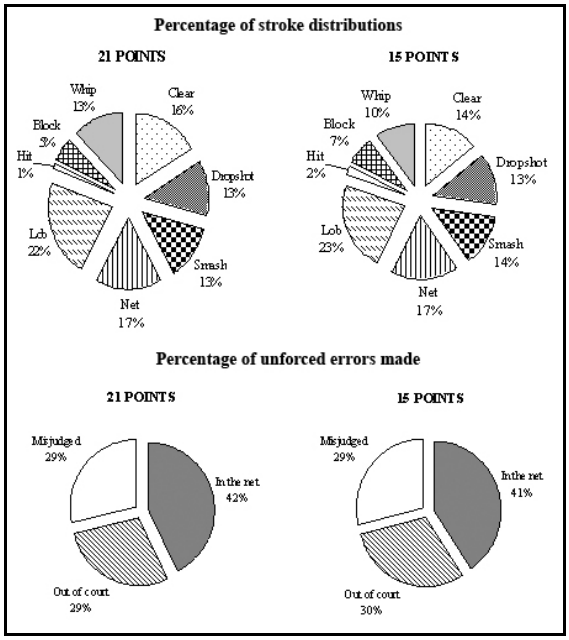

Figure 1: Distributions of various types of strokes and unforced errors of the male players during the two experimental trials

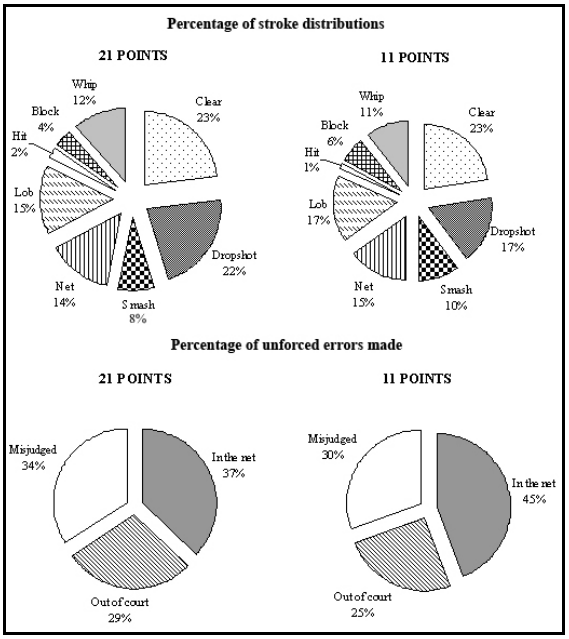

Figure 2: Distributions of various types of strokes and unforced errors of the female players during the two experimental trials

4. Discussion

Time motion analysis

Findings from the present study showed that there were no significant differences in time motion between the two scoring systems except for number of shots and rallies in males' match play. Even though female players had a greater point difference (10 points) in the new scoring system compared to the male counterparts, the time motion between the 2 scoring systems was not affected by this difference. Although there were variations in the game duration in racket sports, a badminton match normally lasts between 20 to 90 minutes depending on the level between the players and number of sets played. In the present study, the average of 2 games match duration was 17.2 ± 2.6 minutes and 24.0 ± 2.3 minutes in the 21 points and 15 points respectively. Therefore, the average match and game duration in the 15 points were slightly longer than the 21 points in men's singles match play. Female players, however, did not show any difference in the 21 and 11 point game and match duration.

Hughes (1995) suggested that elite players were expected to play considerably longer rallies at their level. From the rally and rest times; work density or work:rest ratio was calculated. The present study found that the work density in both scoring systems was approximately 0.5 (1:2) which appeared to be similar to the values reported by Cabello and Gonzalez-Badillo (2003) and Faude et al. (2007). Although no statistical significance was found, results from this research showed that match duration in 15 points (male) and 11 points (female) was longer than playing in the 21 points. However rally time, rest time and work density were not affected in both trials.

The average number of shots in male's 21 points and 15 points, and female's 21 points and 11 points match play were 331.25 ± 44.74, 463.5 ± 21.41, 242.5 ± 8.96, and 275 ± 84.91 respectively. At the same time, number of rallies also varies between scoring systems and genders. Male players showed a significantly higher number of rallies in the 15 points compared to 21 points match play ($p<0.01$). No differences were found in the female counterparts. Average number of shots per rally in males' match play was approximately 4.74 compared to 3.48 in female players. Male players showed significantly higher values in average shots per rally and shots per rally time than female in the 21 points scoring system. This means that males played more shots and at a faster pace than female players. However, Cabello and Gonzalez-Badillo (2003) and Faude et al. (2007) observed higher average shots per rally with 6.06 ± 1.08 and 5.1 ± 3.9 respectively. The discrepancies of the results might be influenced by the players' style of play (Smekal et al., 2001). Interestingly, in this study, it was seen that both shots per match and rallies per match were higher in 15 points (11 points in female) than in 21 points scoring system. These results also affects the game and match duration, suggesting an increased metabolic demand in the 15 and 11 points system. In addition, the different resting intervals between the 2 scoring systems (in 21 points, 60 seconds interval when one side reaches 11 points and 2 minute break between game; while in 15 points, 90 seconds interval between 1st and 2nd game and 5 minutes interval between 2nd and 3rd set) would propose changes to the physiological response.

There was little variation in the shots per rally time between scoring systems in both genders. There were 1.03 ± 0.22 shots·s^{-1} in men's 21 points, 1.03 ± 0.47 shots·s^{-1} in men's 15 points, 0.84 ± 0.31 shots·s^{-1} in women's 21 points and 0.89 ± 0.60 shots·s^{-1} in women's 11 points match play. The results were significantly higher in men's 21 points badminton match compared to the females. These data showed that males were playing at a faster pace than females. The values obtained were similar to studies done by Liddle and O'Donoghue (1998) whereby average shots per rally time in men and women's singles match was 1.00 ± 0.04 shots·s^{-1} and 0.86 ± 0.03 shots·s^{-1} respectively.

Notational analysis

The play patterns were similar in the 21 points and 15 points (11 points in female) in both genders. In the 21 and 15 points men's singles match play, lob was the most frequently used stroke followed by net, clear, smash, drop shot, whip, block and lastly hit. In the females, however, clear was the most highly used stroke followed by drop shot, lob, net, whip, smash and block in both scoring systems. Similar to the male players, hit was the least stroke used in match play.

The male's playing patterns were similar to studies done by Hong and Tong (2000) who performed a notational analysis investigation into playing patterns of the world's top singles badminton players in competition and found that lob was the most popular shot followed by the smash, net and clear. They added that majority of the shots were returned to the forecourt and it is also where the most "effective" shots were returned, with the rear court producing the majority of "ineffective" shots. Liddle et al. (1996) observed that 54% of shots in the singles match play were overhead. Ghosh et al. (2002) reported that three most popular

strokes played in badminton were the over head smash, over head toss and over head drop. In the present study, we found that clear, lob, drop shot and net were among the mostly used strokes in single's match play.

The distributions in types of unforced errors in both genders were also found to be similar in the 21 points and 15 points (11 points in female) in the present study. The unforced error made most by the players was the 'in the net'. Male players made more errors by hitting the shuttle out of court compared to 'misjudged' errors. Female players, however, produced more 'misjudged' errors and followed by 'out of court' errors.

Findings by Har (2007) showed that they were no significant differences between the number of unforced error and types of strokes of winners and losers, and both players produced more unforced errors in 'out of court' followed by 'in the net' and 'misjudged'. Evans (1998) reported that players showed an increased number of errors when playing the clear compared to other shots while smash have a high winner-to-error ratio. However, the probability of making mistakes differed by standard of play in players. Dobson (2001) found that sub-elite players were shown to make a significantly higher percentage of errors than elite players although patterns of play appear to be the same among them. A well planned game strategy could lead to victory. Hong and Tong (2000) suggested that the most important strategy for producing a winning performance was a pressure and attack game.

5. Conclusion

There was a significant difference in the time motion analysis between the 21 and 15 points men's singles badminton match play on the basis of total number of shots and number of rallies in a match. The patterns of play which were analysed through notational analysis also remained unchanged in both scoring systems. The male players played lesser shots and shorter rallies in the 21 points compared to 15 points match. Due to intermittent nature of the game, players need to develop both the aerobic and anaerobic fitness. The above information can help coaches to plan sports specific training programmes to improve aerobic and anaerobic capacity. By understanding the play patterns, a coach should know what the most favoured shots are and avoid the most commonly made mistakes, thus arrange strategy to obtain more points during game.

6. Acknowledgements

The authors would like to express their gratitude to the Malaysian state level badminton players who spent time to participate in this research with commitment, patience, and contribution throughout the data collection process. The study was sponsored by Universiti Sains Malaysia (Grant No.: 304/PPSP/6131576)

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