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Original Article

Match and Game Performance Structure Variables in Elite and Youth International Badminton Players

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Abstract:
The aim of this study was to investigate the differences in the game structure between the Elite Level (EL) and Youth International under 19 years of age (U-19) International badminton players. A total of 14 matches including semi-finals and finals of International tournaments were selected for the analysis. The game structure variables in this study included match duration, game duration, rallies per game, shots per rally, rally duration, rest time between rallies, ball in play (s), ball in play (%) and work to rest ratio. Independent Sample t-test was used for the comparison of all variables between the Elite Level and Youth International Level categories. Statistically significant differences were observed between the categories in match duration, game duration, shots per rally, ball in play (s), rally duration and rest time between the rallies ($p<0.05$).
The research outcome and obtained information can help improving technical and tactical skills as well as the match outcome in badminton players of both Junior International and Elite levels. It may as well effectively assist prospective youth in reaching the top International standards.
Keywords: badminton; elite players; youth internationals; match analysis.

Introduction

Research and scientific analysis of the performance outcome in racket sports have been increased in the latest decades. This is largely due to racket sports becoming more commercialized with many more people starting to play and watch the racket sports competitions. Hence among the purposes of the performance analysis related research, one is to help improving the players' skills and performance efficiency during the match. Eventually, the game becomes more interesting and attracts more people to watch it.

Notational analysis is an objective way of feedback in which performance is recorded so that the key elements of it can be analyzed in a valid and consistent manner (Hughes and Franks, 2008). Hughes (1998) had defined the application of notation analysis into 5 different areas which are tactical evaluation, technical evaluation, study of movement, development of a database and modelling and for the educational use with both coaches and players.

Tactical evaluation, technical evaluation and analysis of movement were within the main focus of this study. Apart from the aforesaid areas, notational analysis links to the physical fitness domain opening up an option of improving the game essential physical fitness structure and variables in order to improve the performance outcome (Krasilshchikov, 2014).

Analysis of the research available on the matter however reveals that performance analysis is typically targeting more of the elite players (Leuciuc, 2010), whereas research involving their upcoming junior counterparts is very limited (Loh & Krasilshchikov, 2015; Clemente et al., 2012).

Interestingly though, in the history of BWF World Junior Championship men singles event, only 3 out of 15 players eventually managed to win the BWF World Championship men singles. Lin Dan, one of the best badminton players in the men singles event has never won the World Junior Championship but had managed to win 5 times in BWF World Championship men singles. This shows that the game structure in elite level and junior level might have some important differences.

Therefore, notational analysis is important to apply to the sport of badminton at various levels of performance. With the results from the notational analysis, and notational analysis related research, coaches can help the players to progress smoothly from junior category to the open category of the game.

The main objective of the study was to determine and quantify the game structure of men's single badminton players in Elite Level (EL) and Youth under 19 years of age (U-19) International categories.

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Materials and methods

Participants

Video recordings of the matches in BWF International events were collected throughout the year 2014 from the video library of the Performance Analysis Unit, National Sports Institute of Malaysia. Only the matches from semi-finals and finals were chosen for further analysis because the level of playing in the closing stage was assumed similar. Video recordings of the total of 14 matches were collected with total 34 games eventually analysed. The games were inclusive of Elite Level and Youth International level players. The study was delimited to only male badminton players.

The matches were analyzed post-event using video recordings. This was due to the speed of live match play being too fast to gather all relevant details. The analyses were performed in slow motion, at half speed by the researcher (a badminton player himself) and an experienced full-time badminton coach of a National standard.

All the subjects were aware of being video recorded and familiar to being observed; hence no written consent from the subjects was necessary. The research protocol was approved by the Universiti Sains Malaysia Human Research Ethics Committee (JEPeM).

Procedure

Analyses of all the games were done using Elite Sport Analysis-FOCUS-X2 PRO software in the post-match mode. The software allows the users to view the video and also record the "events"(actions) that they are interested in by using the 'Category Set' facility in the software. The researcher viewed video of a game performance and then recorded the actions using the 'Category Set' that the researcher himself had created.
After that, the data of events (actions) was extracted from the matrix and exported to spreadsheet in Microsoft Excel. It was then followed by the calculation of the game structure variables for each game and match.
The assistance of a full time state level badminton coach was utilised during performance analysis to ensure the validity and accuracy of the analysis.

Game structure variables

Nine game structure variables were selected for this study including match duration, game duration, rallies per game, shots per rally, rally duration, rest time between rallies, ball in play (s), ball in play (%) and work to rest ratio. Since one game represents the enclosed unit of the play and is not related to other games in the match neither by duration nor by results (Vuckovic, Dezman, Pers, & Kovacic, 2005), all variables were studied on the game level except match duration.
Hence, game duration, rallies per game, shots per rally, rally duration, rest time between rallies, ball in play (s), ball in play (%), and work to rest ratio were game derived variables (per game data/collected from each game), whereas match duration was match related variable (per match data/collected from each match).

Reliability

A match was randomly selected from among matches available for analysis by a full-time badminton coach. The video was viewed twice throughout a two month period by the coach and the researcher who collected the whole data of the matches. Krippendorff's alpha (α) was calculated to assess inter- and intra-operator reliability (α can range between - 1 and 1, where 1 indicates perfect agreement). Alpha was 0.93 on intra-operator reliability, and 0.85 on inter-operator reliability. Variables with reliabilities above $\alpha = .80$ can be trusted for further analysis (Krippendorff, 2004).

Statistical Analysis

Statistical Package for the Social Sciences (SPSS) version 21.0 software was used to analyse the data collected in this study. The results on the variables for each match and game were exported from spreadsheets in Microsoft Excel to SPSS for further analysis.
Descriptive statistics were reported in the mean and standard deviation for each variable for Elite Level and U-19 Level respectively. Independent Sample *t*-test was used for the comparison of variables between two categories to determine if there were any significant differences between EL and U-19 Level. The level of significance at $p<0.05$ was used for all statistical analyses.

Results

A total of 20 games out of 8 matches in EL category were analysed, whereas in the U-19 level, a total of 14 games out of 6 matches were analysed. According to Kim (2013), the z- scores of skewness or kurtosis larger than 1.96 in relatively small sample sizes ($n<50$), the null hypothesis of normality is rejected. Since the z-score of skewness or kurtosis for most game and match variables in current research were within 1.96, therefore null hypothesis of normality has failed to be rejected. There was the required homogeneity of variance as assessed by Levene's Test for equality of variances.

Descriptive statistics along with the *t*-Test comparisons of the game and match structure variables for both groups are presented in Table 1.

Table 1 Comparative statistics of the variables in EL and U-19 International badminton players

Variables	EL		U-19		Mean difference [95% CI]	*t*	*p*
	M	SD	M	SD			
Game							
Game duration (s)	1449.2	434.6	1066.3	152.0	382.9 [166.01,599.82]	3.63	.001***
Rallies per game	35.1	5.1	37.7	3.6	2.56 [5.82,0.69]	1.60	.119
Shots per rally	12.3	8.6	8.2	5.9	4.09 [3.28,4.90]	9.87	.001***
Ball in play (s)	419.9	101.9	306.7	62.72	113.16 [55.52,170.85]	4.00	.001***
Ball in play (%)	29.5	3.2	29.1	6.29	0.44 [-3.40,4.29]	0.24	.811
Rally duration (s)	11.9	8.04	8.1	5.3	3.79 [3.04,4.54]	9.91	.001***
Rest between rallies (s)	1029.4	343.2	759.6	144.6	269.88 [93.67,446.09]	3.14	.004**
Work to rest ratio	0.4	0.07	0.4	0.13	0.02 [-0.08,0.08]	0.04	.97
Match							
Match duration	3263.0	943.6	2488.0	705.7	1135.00 [131.78,2138.22]	2.46	.03*

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

The results presented in Table 1 show the mean and standard deviations for tested variables in EL and U-19 categories respectively. There were significant differences between the means of game duration (s), number of shots per rally, ball in play (s), rally duration, and the rest time between rallies between EL and U-19 ($p<.05$). Match duration was significantly different between the two categories of players as well.

There was a statistically significant difference in game duration between EL and U-19 categories ($t(25.10)=3.63$, $p=0.001$) with mean difference between the categories at 382.91s, meaning eventually that Elite players displayed longer game duration as compared to U-19 category.

A statistically significant difference was discovered in number of shots per rally between EL and U-19 categories ($t(1217.14)=9.87$, $p<0.001$) with the mean difference between the categories equalling 4.09 and being higher with Elite category.

There was a statistically significant difference in ball in play (s) between EL and U-19 categories ($t(31.60)=4.00$, $p<0.001$) with the mean difference between the categories equalling 113.16s in favour of Elite category.

There was a statistically significant difference between rally duration (s) between EL and U-19 categories ($t(1212.38)=9.91$, $p<0.001$) with the mean difference between the categories at 3.79s and an Elite Level category having played longer rallies as compared to Youth International players.

A statistically significant difference was observed in the rest time between the rallies between EL and U-19 categories ($t(27.296)=3.14$, $p=0.004$) with the mean difference between the categories at 269.88s and Elite players obviously taking longer rest as compared to Youth Internationals.

Match duration has been significantly different between EL and U-19 categories ($t(12)=2.46$, $p=0.03$) with the mean difference between the categories equalling 1135.00s and Elite players obviously being able to play longer competition matches as compared to Youth Internationals.

Discussion

According to Lees (2003), duration of 20 to 90 minutes is common across all competitive matches of racket sports and is dependent on the scoring system of the game. Due to the changes in the scoring system in 2006, many researches have been assessing the differences between the old and new scoring system. Apparently, the new scoring system had shortened the duration of the badminton match with the average match in 21 point system being played in 17.27±2.67 min, whereas with the old 15 point system it was 24.06±2.38 min (Chee, Chen & Asok, 2008).

Compared with other racket sport, badminton (Alcock & Cable, 2009) was considered having longer game duration (12 min) compared to squash (Girard, Vhevalier, Habrard, Sciberrsas, Hot & Millet, 2007) with approximately 8 min of reported mean game timing. Girard et al. (2007) stated that game duration within a squash match was from 5 to 15 min according to the official results from PSA World Championship 2004 in Doha, Qatar. Chee and co-researchers (2008) found out that game duration of current 21 point scoring system was lower than the old 15 point system for badminton due to the scoring system change from service-score system to rally-score system.

Elite players had significantly longer game duration compared with Youth International level players. This may be due to the fact that when higher quality of players played against each other, the duration of the game could be prolonged (Katsikadelis, Plilianidis & Vasilogambrou, 2007). Therefore, it can be suggested that game duration is longer when high quality and skilled players play against each other. However, longer game duration might be caused by other factors, not merely by the prolonged playing time.

Faude et al. (2007) reported the figure of 5.1±3.9 shots per rally among international ranked badminton players while Chee et al. (2008) reported 4.74±0.78 shots per rally in their studies in new scoring system matches. Cabello and Gonzalez (2003) in their study under the old scoring system reported 6.06±1.08 shots per rally. Number of shots per rally does not seem significantly different if compared between other racket sports: tennis was reported as having 2.5 to 3 shots per rally (Fernández-Fernández et al., 2009) while table tennis was reported as having 5.11±0.57 shots per rally (Malagoli-Lanzoni, Di Michelle & Merni, 2013).

There was a significant difference in number shots per rally when comparing the result within the present study (12.3±8.6 and 8.2±5.9 for EL and U-19 respectively), which is supporting the results from the past studies. Elite players obviously had more shots per rally compared to U-19 players. It can be suggested that it is difficult to win a point within a few shots in high standard level competition. Higher quality players play more shots per rally and play less rallies per game (not statistically significant though) compared with lower level players. At highest international level, the point is won gradually by achieving high number of shots to gather the advantage, which can be exploited in the attack to win the rally (Vuckovic et al., 2005). This resulted in longer rally duration and greater number of shots per rally.

In the present study, the mean real playing time was 6.98min (±1.71) for EL and 5.11min (±1.04) for U-19 level. There is a sizeable difference between the present study and the past studies and it may be due to the change in the scoring system. Katsikadelis and co-researchers (2007) stated that longer duration of rallies increase the total real playing time. This can explain the real playing time decreasing after the introduction of the new scoring system.

Chee and co-researchers (2008) found out that the effective playing time for badminton was 32.22% (±3.34). In this study, the ball in play (%) for EL was 29.51% (±3.24), while for the U-19 Level it was 29.08% (±6.29) which is similar if compared to the past studies results. In regard to squash, Girard et al. (2007) reported that 69.7% (±4.7) of the game duration was playing time. This figure confirms that squash players need to have higher aerobic endurance level as compared to other racket sports players.

According to Lees (2003), duration of the rally of 3 to 10s is more common for all racket sports. Faude and co-researchers (2007) stated 5.5s (±4.0) as rally duration in their study using internationally ranked badminton players. The present study has shown that the rally duration for the Elite players was 11.92s (±8.04) which does not line-up with the commonly reported range; while the U-19 players' rally length of 8.13s (±5.35) lines up within the common range previously reported.

Lees (2003) stated that due to the intensity of effort being the greatest during the rally, the length of the rally is important in the sense of the utilization of the energy system. Sharp (1998) had classified the of rallies length in squash into three categories: less than 5s, the ones lasting 6-20s and those lasting more than 20s. This suggested time classification relates to anaerobic and aerobic energy sources in which the player relies on the energy to be delivered and converted at higher rates when competing in the higher standard competitions.

Hughes (1995) stated that elite players were able to play longer rallies at their level with points won through performing high number of shots at highest international level match plays (Vuckovic et al.,2005). Thus, elite players are demonstrating longer rally durations. Pradas and co-researchers (2011) stated that game intensity could be elevated by the increase in the ball in play actions.

Consequently, due to the increase of the shots number, more time is needed for recovery. Elite players play more shots as compared with Youth International players, hence Elite players may need longer resting time as compared to Youth International players.

Conclusions

As a summary for this study, there were differences in the game structure between World Elite level and Youth International badminton players. EL players had longer match duration, game duration, more shots per rally, rally duration, ball in play in seconds and rest time between rallies as compared to U-19 Internationals. The study confirms that badminton is a mixed anaerobic-aerobic sport. It requires the players to use their maximum power during the rally (smashing the shuttlecock) meanwhile it also requires the player to have a good aerobic capacity as the match duration averages at more than an hour. Results of the study can help coaches and sport scientists to plan training programs to meet the demands of the match play in top level badminton. Hence,

training plans and workouts can be modified in order to help the players to fulfil the demand of the sport and improve the performance outcome in every match played.

On the other hand, the results of the study reiterate that progression of youth badminton players to the top level in their career depends greatly on improving the game structure variables which play critical role in effective competing. In this present study, the match duration, game duration and number of shots per rally for Elite and Youth Internationals proved significantly different. This induces Elite Level players to have higher aerobic capacity during the game in order to play at their best skill. Training plans might need to be modified to improve the fitness level of U-19 players in order to meet the Elite level games' requirements and eventually assist them to progress to the Elite Level.

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