Original Article

Competition performance variables differences in elite and U-21 international men singles table tennis players

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Abstract:

Physiological indicators say a lot about the preparedness and performance of athletes. We considered the basic Table tennis is one of the most popular and common sports in the world, is considered a very complex sport and is still being developed intensively. With most of the research dedicated to the elite players' skills and fitness, youth and junior players are practically left out of attention. The aim of this study was to compare table tennis game structure among world Top Level Elite (TLE) and under 21 years of age international players' (U-21) categories. Video recordings of a total of 28 matches including semi-finals and finals from the Super Series matches were designated for analysis. The game structure variables selected for this study included match duration, game duration, rallies per game, shots per rally, rally length, rest time between rallies, ball in play in seconds, ball in play in percentage and work to rest ratio. Comparison of all variables between two categories was done using the independent sample *t*-Test. There were statistically significant differences between the categories in game duration, shots per rally, ball in play in seconds, rally length, and rest time between the rallies ($p < .05$). This information can assist coaches in improving technical and tactical skills of the table tennis players and to effectively assist prospective youth in reaching the top International standard.

Key words: table tennis; performance analysis; world's elite; U-21 international players.

Introduction

A growing body of research has emerged from a specific area of performance analysis, which is notational analysis. It is an objective feedback or way of recording performance, so that important events during performance can be quantified and analyzed in a consistent and reliable manner (Hughes & Franks, 2008). Hughes (1998) explained five applications of notational analysis, which are tactical evaluation, technical evaluation, analysis of movement, coach and player education and performance modelling using match analysis databases. Performance wise, this study was concerned in particular with the first three purposes. As for the training outcome, notational analysis links to the physical fitness domain and opens up an option of improving the game essential physical fitness structure and physical fitness variables (Krasilshchikov, 2014).

Notational analysis gained great popularity in such ball games as football (Clemente et al., 2012), volleyball (Patsiaouras et al., 2011) and handball (Leuciuc, 2010). In racket sports however, it is often difficult to classify players' moves into simple locomotive movements such as running because of the restricted court areas used. Therefore, different methods of analyzing rallies and the activity that occurs within rallies were suggested by Hughes & Franks (2008). Rally times and the recovery times in between rallies give indication of the demands of different levels of competition within the different racket sports. Rally times have been analyzed for table tennis (Drianovski & Otcheva, 2002), badminton (Liddle & O'Donoghue, 1998), tennis (Collinson & Hughes, 2002), and squash (Docherty, 1982).

Liddle and O'Donoghue (1998) investigated rally and rest times for each discipline of badminton apart from mixed doubles and found mean rest duration to be longer than mean rally duration for all forms of the game. In men's singles, mean rally duration was found to be 9.15 ± 0.43 s, whilst the mean rest time was 13.84 ± 1.16 s. These figures differ greatly from those found by Docherty (1982) showing rally length to be around five seconds with five to ten seconds of recovery in between, stating however that the rally length would be expected to be longer at the elite level. The analysis was performed live using computer notation during matches (Liddle & O'Donoghue, 1998). Conclusions were drawn from the research that training should be specific to the discipline in which performers participate.

Very limited studies till date were attempted in table tennis with ones particularly related to comparisons of world's elite and junior elite players practically unavailable. Therefore, an assessment of the playing activity through notational analysis of the match structure and temporal structure variables of the world elite men's singles table tennis players may provide some baseline data for further use by coaches, sports

scientists, and future investigators in order to improve the performance of elite and junior table tennis players in the international competitions.

The study objective was to quantify and compare the game structure in World Top Level Elite and U-21 International men singles table tennis players.

Material & methods

Sample

Video recordings of the matches in ITTF International events were collected throughout the years of 2013-2014 from the video library of the Performance Analysis Unit, National Sports Institute of Malaysia. Only semi-finals and finals from the Super Series matches were taken into consideration for further analysis. The matches involving players with defensive playing style were excluded from analysis in this study. Hence, video recordings of 28 matches were collected with 155 games eventually analyzed.

The games included Top Level Elite category (world ranked) and U-21 category. The matches were played at the best of seven sets format, finishing 4-3 ($n = 3+3$), 4-2 ($n = 4+5$), 4-1 ($n = 4+3$), and 4-0 ($n = 5+1$) matches for TLE category and U-21 category respectively. The study was delimited to only male table tennis players.

All matches were recorded on video at the official competitions. 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 table tennis player himself) and an experienced full-time table tennis 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 Universiti Sains Malaysia human ethics research committee.

Procedure

Analyses of all games were done using Elite Sport Analysis-FOCUS-X2 PRO software in the post-match mode. The software allows the user to view video of a performance and then enter the 'events' (actions) that they are interested in using the Category Set facility in the Focus software.

After that the data of the actions were extracted from the matrix and exported to spreadsheet in Microsoft Excel. Eventually it was followed by the calculation of the game structure variables for each game and match.

Game Structure Variables

There were nine game structure variables selected for this study including match duration (s), game duration (s), rallies per game, shots per rally, rally length (s), rest time between rallies (s), 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 length, rest time between rallies, ball in play in seconds, ball in play in percentage and work to rest ratio are game-related variables (per game data / collected from each game), whereas match duration is 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 table tennis 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 0.95 on intra-operator reliability, and 0.84 on inter-operator reliability. Variables with reliabilities above $\alpha = .80$ can be trusted on (Krippendorff, 2004).

Statistical Analysis

Statistical Package for the Social Sciences (SPSS) version 21.0 statistical program was used to analyze the data collected in this study. The results of variables for each match and game were exported from the spreadsheet in Microsoft Excel to SPSS for further analysis.

Descriptive statistics were reported in mean and standard deviation for each variable for TLE (world ranked) and U-21 international players respectively. Comparison of variables between different groups was done using Independent Sample *t*-Test to determine if there were any significant differences between TLE and U-21 players. Relationships were determined using Pearson Product Moment correlation coefficient. A level of significance of $p < .05$ was used for all of the statistical analyses.

Results

Regarding the normality of the variables distribution, most z-score of skewness and kurtosis were within 1.96 for match variables and 3.29 for game variables. These conclude that the null hypothesis of normality failed to be rejected (Kim, 2013). There was homogeneity of variance as assessed by Levene's Test for Equality of Variances.

Descriptive statistics along with the *t*-Test comparisons from an analysis of a total of 85 games out of 16 matches in Top Level Elite category and of a total of 70 games out of 12 matches for the U-21 table tennis players in this study are presented in Table 1.

Table 1. Comparison of table tennis game structure variables between the categories

Variables	Top Level Elite		U-21		Mean Difference [95% CI]	<i>t</i> (<i>df</i>)	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
<i>Game</i>							
Game duration (s)	388.78	121.92	342.72	99.36	46.07 [10.95, 81.18]	2.59 (152.99)	.010*
Rallies per game	19.52	4.05	19.19	3.49	0.33 [- 0.88, 1.55]	0.54 (153)	.590
Shots per rally	4.75	0.79	4.23	0.69	0.52 [0.28, 0.76]	4.29 (153)	< .001***
Ball in play (s)	70.58	15.37	63.61	12.67	6.97 [2.52, 11.42]	3.10 (153)	.002**
Ball in play (%)	19.01	3.62	19.41	4.24	- 0.40 [- 1.65, 0.84]	- 0.64 (153)	.525
Rally length (s)	3.64	0.53	3.34	0.48	0.31 [0.15, 0.48]	3.55 (153)	.001**
Rest between rallies (s)	318.09	110.70	278.05	91.93	40.03 [7.88, 72.19]	2.46 (152.99)	.015*
Work to rest ratio	0.24	0.06	0.24	0.07	- 0.01 [- 0.03, 0.01]	- 0.81 (153)	.421
<i>Match</i>							
Match duration (s)	2405.83	775.24	2414.99	494.97	- 9.16 [- 535.96, 517.63]	- 0.04 (26)	.972

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

The results presented in Table 1 show the means and standard deviations for tested variables in TLE and U-21 categories respectively.

There was a statistically significant difference in game duration between TLE and U-21 categories, $t(152.99) = 2.59$, $p = .010$ with TLE players typically playing longer games as compared to U-21 players.

There was a significant difference in mean of number of shots per rally, ball in play in minutes, and rally length between TLE and U-21 players ($p < .05$). The means for these variables were significantly higher in TLE category than in U-21 category. The mean difference in shots per rally between Top Level Elite and U-21 was statistically significant, $t(153) = 4.29$, $p < .001$, 95% CI [0.28, 0.76] with mean shots per rally in TLE players being higher than in U-21. The mean difference in ball in play in seconds between TLE and U-21 was statistically significant, $t(153) = 3.10$, $p = .002$, 95% CI [2.52, 11.42] with mean ball in play of Top Level Elite category being longer than in U-21 category players. The mean difference in rally length between Top Level Elite and U-21 was statistically significant, $t(153) = 3.55$, $p = .001$, 95% CI [0.15, 0.48] with mean rally length in Top Level Elite players being slightly higher than in U-21. The mean difference in rest time between rallies between Top Level Elite and U-21 categories was statistically significant, $t(152.99) = 2.46$, $p = .015$, 95% CI [7.88, 72.19] in favor of Top Level Elite players who had rested longer than U-21 players.

The rest of the variables have not shown any significant differences between the two groups in the study.

Discussion

Top Level Elite players had significantly longer game duration as compared to U-21 players. This may be due to the fact that higher standard players while playing against each other can prolong the duration of the game, as supported by Katsikadelis et al. (2007). Therefore, it is suggested that matches among players with high quality or skill level will cause longer game duration. However, longer game duration can also result from the longer rest time between rallies, and not merely because of longer ball in play.

The higher quality players had usually more number of shots involved in the game. So it makes sense to propose that Elite players having higher level of skills could produce higher number of shots per rally as

compared to U-21 players. In squash, Vuckovic et al. (2005) stated that the point was won gradually by performing high number of shots to gather the advantage at highest international quality level, which can be exploited in the attack to win the rally. This resulted in longer rally length and greater number of shots.

The study by Pradas et al. (2011) which included a match of round of 16 and 4 matches of quarter finals, discovered that duration of ball in play and rest time increased in the semi-finals and final rounds when compared to the previous rounds, but no significant differences were recorded. The mean duration of the ball in play was 73.75s ($SD = 24.74$) reported by them. In this current study, Top Level Elite played for 70.58s ($SD = 15.37$) and U-21 for 63.61s ($SD = 12.67$) on the ball in play variable.

Katsikadelis et al. (2007) corroborated on the assumption that longer duration of rallies time can increase the total real play time. The rule modifications introduced by the ITTF in the technical regulation of table tennis may explain this difference resulting in a higher number of shots per rally and ball in play time.

According to Lees (2003) the duration of rally of 3 to 10s is more common across all racket sports. The present study found that the rally length was within the common range, i.e. between 3 and 4s. In badminton, Faude et al. (2007) reported 5.5s ($SD = 4.0$) of rally length.

Lees (2003) supported the fact that the rally length is important to the utilization of energy systems since the intensity of effort is greatest during the rally. In squash, Sharp (1998) had classified the rallies into three main groups, including those that last up to 5s, those that last between 6 to 20s and those that last for more than 20s. This time classification is apparently related to the utilization of anaerobic and aerobic energy sources. Players rely on the energy sources to be delivered at higher rates as they progress in competition or compete in higher level of competition.

A past study was performed by Yoshida, Imoto, and Ushiyama (1992) using the 9th Asian table tennis championship final at Niigata, Japan as match sample. They stated that the mean duration of rally in male category was 3.18 ± 0.93 s. Hughes (1995) suggested that elite players were expected to play considerably longer rallies at their level. Consequently, TLE players are constantly pushing their limits to sustain longer in playing.

In table tennis, players are allowed to towel off every 6 points from the start of each match. Also, each player is allowed to use one 1 min time out period between rallies during a match. These rules have allowed the players and coaches to play tactically if situation was desirable. Consequently, the total rest time of the game could be extended. Also, Pradas et al. (2011) suggested that the rise in the ball in play actions can heighten the game intensity. Therefore due to the increase in the number of shots, more recovery time was required.

A Pearson product-moment correlation coefficient was computed in this study to assess the relationship between number of shots and rest time between rallies. There was a positive correlation between the two variables, $r = 0.625$, $n = 155$, $p < 0.001$. Overall, there was a strong, positive correlation between number of shots and rest time between rallies. Increases in rest time between rallies were correlated with increases in number of shots. As the result, the Top Level Elite players may need longer rest time between rallies compared to U-21 players due to higher playing intensity and having produced more shots in the game.

Conclusions

There were statistically significant differences between world Top Level Elite and U-21 men singles players in terms of the game structure. Findings of the current study can help improving technical and tactical aspects of playing table tennis at different levels of performance in both Top Elite and Youth Elite players.

This study confirms that table tennis should be classified as a mixed anaerobic-aerobic sport: anaerobic – based on the game aspects and the game-related temporal structure; and yet aerobic – based on match duration. This information can highlight the importance of studying and analyzing the demand of the sport. In return, obtained information on performance variables can assist in planning and fitness applications whereby training programs can be created based on the knowledge of performance structure, and in order to ensure that match and game intensity and duration demands are properly addressed.

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