

ACTIVITY PATTERNS IN MALE AND FEMALE WHEELCHAIR TENNIS MATCHES

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Abstract:

The aim of this study was to compare activity patterns between male and female wheelchair tennis (WT) matches. Sixteen singles international WT matches (eight male and eight female) were analysed. Each match was recorded and analysed according to the following variables: *total match time* (minutes), *total set time* (minutes), *effective playing time* (%), *total resting time* (%), *working time:resting time ratio* (W:R), *resting time between points* (seconds), *rally duration* (seconds), *points per set*, *shots per set*, *shots per rally*, *bounces per point*, and *time between shots* (seconds). Mann-Whitney U test was used to compare between the genders and Wilcoxon test was used to compare variables with the type of point (non-game point opportunity – NGO, and game point opportunity – GO). Female matches showed higher values ($p < .05$) in *rally duration*, *bounces per point*, and *frequency of shots* than male matches. Both genders spent more time between points in GO than in NGO situation. The findings indicate that male and female players play in a different way, and these differences should be taken into consideration by the WT coaches.

Key words: adapted tennis, gender, match activity

Introduction

Knowledge of the activity patterns during competition is indispensable for improving of training methods since it provides information about the total amount of work, rest periods, and series or repetitions of training exercises, amongst many other aspects (Kovacs, 2007). Activity patterns have been extensively studied in racket sports such as badminton (Abian-Vicen, Castanedo, Abian, & Sampedro, 2013; Cabello-Manrique & Gonzalez-Badillo, 2003), squash (Girard, et al., 2007), paddle tennis (Carrasco, Romero, Sañudo, & De Hoyo, 2011), table tennis (Zagatto, Morel, & Gobatto, 2010), and tennis (Fernandez-Fernandez, Sanz-Rivas, & Mendez-Villanueva, 2009a; Kovacs, 2004; O'Donoghue & Ingram, 2001). Adapted racket sports have also been studied, yet to a lesser extent. Wheelchair tennis (WT) is the adapted racket sport that has gained most ground in recent years (Bullock & Sanz, 2010). Activity patterns have been studied over the last 10 years showing the total match time (TT) of a singles match to be between 50 and 80 minutes (Croft, Dybrus, Lenton, & Goosey-Tolfrey, 2010; Filipčič & Filipčič, 2009; Roy, Menear, Schmid, Hunter, & Malone, 2006; Sánchez-Pay, Torres-Luque, Fernández-García, &

Sanz-Rivas, 2013; Sanz, Cid, Fernández, & Reina, 2009; Sindall, et al., 2013), the effective playing time (EPT) to be around 15-20% of the TT, which is equivalent to a ratio of around 1:4 of working time/resting time (Filipčič & Filipčič, 2009; Roy, et al., 2006), and the rally duration (RD) to be between 6 and 10 seconds, with 3-4 shots per rally (SR) (Bullock & Pluim, 2003; Sánchez-Pay, Sanz-Rivas, Montiel, Zanco, & Torres-Luque, 2015a; Sanchez-Pay, Sanz-Rivas, & Torres-Luque, 2015; Veltmeijer, Pluim, Thijssen, Hopman, & Eijsvogels, 2014). All these studies were performed with male players, so there are no insights into female WT matches.

Differences in activity patterns according to gender have also been studied in racket sports. Principally, conventional tennis (CT) has been studied the most and differences have been found between the genders (Brown & O'Donoghue, 2008; O'Donoghue & Ingram, 2001). Gender differences in activity patterns show specific needs in the game, so the training system should be adapted to gender.

Also, activity patterns have been studied in different adapted sports such as sitting volleyball (Häyrynen & Blomqvist, 2006), sledge ice hockey (Häyrynen, et al., 2011), and wheelchair basketball (Croft, et al., 2010), but no study has compared

possible differences between the genders. There are no previous measurements for adapted sports considering activity patterns by gender, so we do not know how these values would be affected. Therefore, the aim of this study was to determine the activity pattern of WT during a high-level competition and show possible gender differences.

Methods

Participants

Sixteen international WT matches (eight male and eight female matches) were video recorded and analysed during an international WT tournament. All matches were played on the outdoor hard courts under the International Tennis Federation (ITF) rules (ITF, 2012). The best international ranking players competed in this tournament, qualified through a competition system in the Open Division. The sample data of each variable was obtained from a total of 1926 points throughout 16 matches.

Procedure

Each match was filmed using a Panasonic HC-V700 (Panasonic, Japan) camera with a super wide angle. A total of eight cameras was used because the first round of the male competition was played on eight courts at the same time. The cameras were located in a corner of the court, outside the fence, so that it did not interfere with the game, but could record the entire tennis court. Each camera recorded 30 frames per second. The videotapes were later replayed on a monitor for computerized viewing of the activity patterns.

The analysis was carried out using Lince software (Gabin, Camerino, Anguera, & Castañer, 2012). This software enables one to code every action (e.g. shots per rally) and also shows the duration of the action (e.g. rally duration) in milliseconds. Furthermore, the changes between changeovers were excluded from the resting time and total set time.

Data were collected by means of systematic observation performed by two tennis coaches experienced in research and certified by the Royal Spanish Tennis Federation. Intra-rater reliability was calculated in a way that each observer registered the same period of play (one set) on two occasions separated by a four-week period. Cohen's Kappa was used and values of 0.95 and 0.91 were obtained for each observer. After that, each observer analysed two matches to calculate an inter-rater reliability. Cohen's Kappa was used and values obtained were considered as very good (>.80) (Landis & Koch, 1977).

Variables

Each point was analysed following the same procedure: a) gender of the match; b) set number; c) game number; d) score in the game; e) start of a

rally; f) finish of a rally; g) total shots in a rally; h) total bounce number; and i) point winner player. This process generated the following variables according to other WT and CT studies (Kovacs, 2004; O'Donoghue & Ingram, 2001; Sanchez-Pay, et al., 2015a; Torres-Luque, Cabello-Manrique, Hernández-García, & Garatachea, 2011):

- Total match time (minutes): from the beginning of the first point until the last point and the match end.
- Total set time (minutes): from the beginning of the first point in a set until the last point and the set end.
- Effective playing time (%): summation of the duration of each point during a given match is divided by total match time.
- Resting time (%): summation of the resting time from the end of a point until the next point begins and divided by total match time.
- Working Time/Rest Time: a determination of the playing to rest time within a given match, stated as a ratio.
- Resting time between points (seconds): from the end of a point until the next point begins.
- Rally duration (seconds): from the start of each point until the end of the point, as the rules dictate (ITF, 2012).
- Points per set: total number of points recorded in a set.
- Shots per set: summation of the total number of shots per set.
- Shots per rally: the number of valid strokes made by the two players during a point.
- Bounces per point: the number of total bounces in a point.
- Frequency of shots (seconds): time between consecutive shots (seconds), dividing rally duration by shots per rally.

The point began when the player started to separate his/her hands in a serve movement. Moreover, in a double fault situation the point was finished when the ball bounced out or touched the net.

Each point was encoded as either a non-game point opportunity (NGO) or a game point opportunity (GO) in order to score tennis rules (ITF, 2012). In this way 0-0, 15-0, 15-15...were encoded as NGO, and 0-40, 40-15, 30-40, 40-30, 40-A... were encoded as GO. Also, each point was categorized by gender (either male or female).

Statistical analysis

The data were obtained via the visual analysis of matches. These data were entered into spreadsheets (Microsoft Excel) for processing purposes. From the spreadsheets, the data was exported to IBM SPSS, version 19.0 (IBM Corp., Armonk, NY, USA) for analysis. From the raw data, the mean, minimum, maximum, and standard deviation were calculated. All variables were tested for distribution normality. For this proposes, the

Kolmogorov-Smirnov test was used. The results showed $p < .05$, so non-parametric tests were used. The Mann-Whitney U test was used to compare between the genders (male and female), and the Wilcoxon test was used to compare variables with the type of point (NGO and GO). The variables: resting time between points, rally duration, shots per rally, bounces per point, and frequency of shots were normalized, with the aim of comparing NGO variables between the genders as well as GO variables. Thereafter, a Mann-Whitney U test was used.

Subsequently, shots per rally and rally duration were categorized. Six or more shots in a point were grouped as 5+ shots, and rally duration was categorized by range: 0 to 5 seconds, more than 5 to 10 seconds, more than 10 to 15 seconds, and more than 15 seconds. Shots per rally and rally duration were expressed as percentages, so Z-test was used to compare proportions between the genders. Significance level was set at $p < .05$.

Results

Table 1 shows match activity in male and female WT matches and statistically significant differences between them.

Female matches showed higher values in almost all variables. Specifically, female players had longer rally duration ($p < .001$) than male players. In contrast, during male points the ball bounces fewer times than during female points (2.46 ± 1.85 vs 2.97 ± 2.53 , respectively). Moreover, male players hit the ball every 1.90 ± 0.38 seconds, whereas female players did the same every 2.15 ± 0.41 seconds, which was a statistically significant gender difference.

Table 2 shows statistically significant differences in match activity between NGO and GO situations in male and female matches as well as statistically significant differences between the genders in NGO and GO.

Male and female players play their GO and NGO in the same way. There were significant differences only in resting time ($p < .001$); both genders spent more time resting in GO. Between the genders, the shots per rally showed significant differences in NGO ($p < .001$) and GO ($p < .05$) and female points had more bounces in NGO than male points ($p < .001$).

Figure 1 shows the distribution of shots per rally in male and female matches. No significant

Table 1. Mean (M), standard deviation (SD), and statistical differences in match activity between male and female matches

	Male	Female	Gender differences	
	M±SD	M±SD	p value	Z value
Total match time (min)	64.65±13.36	77.62±31.67	.833	-.0211
Total set time (min)	30.43±8.04	34.50±9.06	.165	-1.387
Effective playing time (%)	20.77±3.42	22.32±5.22	.373	-0.892
Resting time (%)	79.23±3.42	77.68±5.22	.373	-0.892
W:R ratio	3.95±0.86	3.72±1.11	.373	-0.892
Resting time between points (s)	23.98±9.69	25.91±17.96	.065	-1.848
Rally duration (s)	5.58±3.65	6.82±4.83	.000	-5.839
Points per set	53.53±11.34	58.11±14.83	.467	-0.728
Shots per set	157.24±31.07	180.50±77.82	.766	-0.297
Shots per rally	2.90±1.71	3.10±2.01	.095	-1.669
Bounces per point	2.46±1.85	2.97±2.53	.000	-3.518
Frequency of shots	1.90±0.38	2.15±0.41	.000	-12.930

Note. Bolded numbers are statistically significant differences. Gender differences: statistical differences between male and female players.

Table 2. Statistical differences in match activity between point type and gender

	Male			Female			Dif. Gender	
	NGO	GO	p value	NGO	GO	p value	NGO p value	GO p value
Resting time between points (s)	22.72	28.76	.000	23.88	33.01	.000	.067	.429
Rally duration (s)	5.51	5.75	.264	6.79	6.86	.236	.808	.723
Shots per rally	2.87	2.96	.324	3.08	3.17	.116	.000	.008
Bounces per point	2.47	2.44	.718	2.95	3.04	.100	.000	.268
Frequency of shots	1.89	1.91	.399	2.16	2.13	.225	.236	.297

Note. Bolded numbers are statistically significant differences.

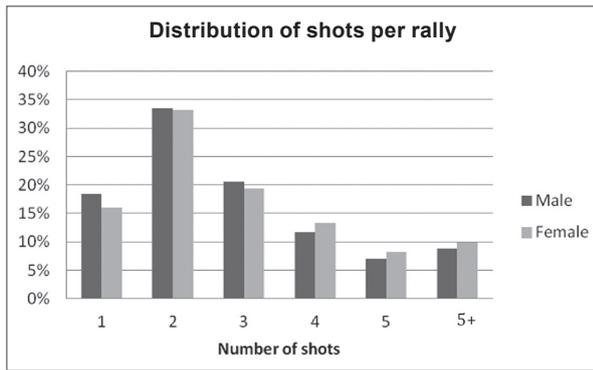


Figure 1. Distribution of shots per rally.

differences were found between the genders with each group of shots. Both male and female players finished most points by the second shot. The first two shots (serve and return) represented 51.92% of total shots in male and 49.21% in female players.

Figure 2 shows the distribution of rally duration in male and female matches. Statistically significant differences were found ($p < .05$) between the genders in all ranges of time. The greatest differences between the groups were in the 0-5 seconds range (57.04% in male and 42.90% in female matches). In male matches, 31.35% of the total points finished between more than 5 to 10 seconds; in female matches this was 38.89%.

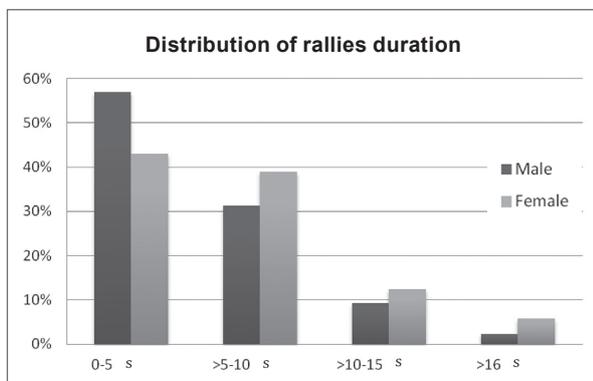


Figure 2. Distribution of rallies' duration.

Discussion and conclusions

The aim of this study was to approach to the playing characteristics of WT in high-level competitions and show probable differences between the genders (male and female matches). To our knowledge, no studies have been done that analyse WT match played by women, so in the discussion the authors will compare the results regarding female WT matches with female CT matches.

Data show that TT in male matches (64.65 ± 13.36 minutes) is lower than in female matches (77.62 ± 31.67 minutes), although the difference is not significant (Table 1). Male matches in our study have a similar total match time as recorded in other

studies on the top ten ITF ranking on hard court (Sánchez-Pay, et al., 2013). The differences between the genders in the total match time variable could be due to more matches being played to three sets, as shown in a higher standard deviation in the female matches (Table 1).

The percentage of effective playing time (EPT), percentage of total resting time (TRT), and W:R ratio are directly related among themselves, so they have the same statistical differences ($p = .373$). Specifically, female players have higher values than male players in all of them. The percentage of EPT and TRT shows a W:R ratio of 1:3.95 in the male matches and 1:3.72 in the female matches, so female WT matches could be considered more continuous than male WT matches, although significant differences were not found. From a general point of view, EPT is between 20-22% of total time (Table 1) similar to CT (male and female) matches (Fernandez-Fernandez, Mendez-Villanueva, Fernandez-Garcia, & Terrados, 2007; Fernandez-Fernandez, et al., 2009b; Mendez-Villanueva, Fernandez-Fernandez, Bishop, Fernandez-Garcia, & Terrados, 2007), so it seems that WT has a similar activity pattern as CT.

Rally duration (RD) is statistically higher ($p < .001$) in female matches than in male matches (6.82 ± 4.83 seconds and 5.58 ± 3.65 seconds, respectively). The higher values in RD could explain the need of female players to use more time between points for rest and preparation for the next point. The differences in rally duration between male and female matches (Table 1) follow the line of CT, where rallies on hard courts are longer in female than in male matches (Brown & O'Donoghue, 2008; O'Donoghue & Ingram, 2001). The shorter rally duration in male matches could be a consequence of fewer shots per rally (SR) in male (2.90 ± 1.71) than in female matches (3.10 ± 2.01), although no significant differences were found. From a general point of view, the number of shots per rally is similar to other studies on male high-level WT matches (Bullock & Pluim, 2003; Sanchez-Pay, et al., 2015a; Veltmeijer, et al., 2014) and higher than in recreational level matches (Filipčič & Filipčič, 2009), so SR could be influenced by the quality level of players. Male and female players have a similar distribution of shots per rally (Figure 1), but RD shows a different distribution between the genders (Figure 2). This reaffirms the idea that in female matches rallies last longer than in male matches.

The main difference between WT and CT is that the ball can bounce twice before one returns it (ITF, 2012). In this study, the ball bounced about 2.5 times in a point in male matches and 3 times in female matches. It is important to note that the service shot involves hitting without a bounce, so the first shot after the first bounce is the return shot. Therefore, in the shots per rally variable we have to subtract one shot (1.9 in male and 2.1 in female

matches). Thus, male players allowed a mean of 1.29 bounces per shot and female players 1.41. This suggests that female players use the second bounce rule more than male players. No studies have been found on the reason for using the first or second bounce. Its use could be due to different reasons: on the one hand, women hit the ball with less power than men, and the ball should bounce twice to arrive in the baseline region where players spend most of their time (Filipčič & Filipčič, 2009); on the other hand, the second bounce is usually used to play a defensive shot, further away from the baseline (Sanz, 2003). These could be some reasons for the differences and could help in understanding the differences between the genders in the frequency of shots variable ($p < .001$). In this way, male players hit the ball every 1.90 second and female player every 2.15 seconds. This shows that men's matches have more speed in the game (timing) than women's matches. Previous studies showed the rate as one shot every 2.05 seconds in a male national WT competition (Sanchez-Pay, et al., 2015b). No studies have been found on female WT matches treating this variable, although the differences between the genders in the speed of the game follow the line of CT where also women's matches are slower than men's matches (O'Donoghue & Ingram, 2001).

Previous studies analysed the activity pattern in non-game point opportunity (NGO) and game point opportunity (GO) (Sanchez-Pay, et al., 2015b) with the aim of understanding how these situations affect the way players play. No significant differences were found in rally duration and shots per rally in a male national competition. No other variables have been analysed neither is there any information on female matches. In this study male and female matches showed significant differences only in

resting time between points (Table 2). Resting time between points was higher in GO than in NGO in male (28.76 and 22.72 seconds) and female matches (33.01 and 23.88 seconds). This could indicate that players spend more time resting and preparing for the next point which is of greater importance for the score. In NGO situations, female players played more shots and used more bounces per point than male players, although only shots per rally showed differences between the genders in the GO situation. This indicates that male and female players play points in a different way, and this should be taken into consideration by WT coaches.

Our study has some limitations. Although the analysed matches were part of an international competition, they were not among the top ten international ranking. Also, it is important to consider that the values obtained refer to a hard court; it would be interesting to compare between court surfaces and players' level of injury (amputees, spine bifida, spinal cord, etc.).

The results of this study show the differences in activity patterns between male and female players in high-level WT matches on hard courts. In conclusion, it has been observed that duration of female points is longer and that female players hit the ball more times per point than male players. In contrast, male points are faster and male players use less bounces to finish the point than women. Both spend more time between points in game point opportunity than non-game point opportunity. Moreover, male and female players play NGO and GO in a different way in relation to shots per rally. Coaches and fitness trainers can use these values to improve tennis-specific training programs and tactics for each gender.

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