Metadata of the article that will be visualized online

Article Title	**Serve profile of male and female professional tennis players at the 2015 Roland Garros Grand Slam tournament**	
Journal Name	German Journal of Exercise and Sport Research	
CopyrightHolder	Springer-Verlag GmbH Deutschland, ein Teil von Springer Nature (This will be the copyright line in the final PDF)	
Author	Family name:	**Torres-Luque**
	Particle:	
	GivenName:	**G.**
	Suffix:	
	Organization:	University of Jaén
	Division:	Faculty of Humanities and Education Science
	Address:	Jaén, Spain
	Email:	gtluque@ujaen.es
Author	Family name:	**Blanca-Torres**
	Particle:	
	GivenName:	**J. C.**
	Suffix:	
	Organization:	University of Jaén
	Division:	Faculty of Humanities and Education Science
	Address:	Jaén, Spain
	Email:	jcblancatorres@gmail.com
Author	Family name:	**Cabello-Manrique**
	Particle:	
	GivenName:	**D.**
	Suffix:	
	Organization:	University of Granada
	Division:	Faculty of Physical Activity and Sport Sciences
	Address:	Granada, Spain
	Email:	dcabello@ugr.es
Corresponding Author	Family name:	**Fernández-García**
	Particle:	
	GivenName:	**A. I.**
	Suffix:	
	Organization:	University of Zaragoza
	Division:	Faculty of Health and Sport Science
	Address:	Calle de Pedro Cerbuna, 12, 50009 Zaragoza, Spain
	Email:	angelivanfg@unizar.es
Schedule	Received:	12 March 2019
	Accepted:	20 July 2019
	Published online:	

Abstract	The aim of this study was to compare the serve statistics profile of male and female high-level tennis players. In all, 111 tennis singles matches of the Roland Garros 2015 tennis tournament were collected and 10 variables related to first and second serve were analyzed according to service box (deuce and advantage sides) and landing location (wide, body and T-areas). The results show: (a) men served faster than women; (b) men served a higher percentage of serves at T-area on deuce side (35.0 vs 27.7%) and at the wide zone on advantage side (44.1 vs 36.7%) with first serves, while women hit more to the body on both sides; (c) men won a higher percentage of points with their first serve compared to women at any zone on both sides, except for the T-area on deuce side; (d) with their second serve, men placed a greater percentage of serves in the T-area on deuce side (28.0 vs 21.8%) and wide on the advantage side, whereas women directed more to the body on the advantage side (41.4 vs 33.5%); (e) men won a higher percentage of points with their second serve when they placed it to the body zone on deuce side (54.1 vs 47.1%) and at the T-area on the advantage side (64.4% vs 44.1%). Our conclusions are that with respect to gender, players showed differing serve patterns. Men served faster, with higher success and placed their serves more frequently to the external areas of the service boxes, while women directed a higher percentage of serves to the body of their opponent.
Zusammenfassung	Das Ziel der Untersuchung bestand im Vergleich der Aufschlagstatistik zwischen männlichen und weiblichen Spitzenspielern. 111 Tenniseinzelspiele auf Sandplätzen (Roland Garros 2015) wurden nach 10 Beobachtungskriterien für den ersten und zweiten Aufschlag von der Einstand- und Vorteilseite und hinsichtlich der Aufschlagrichtung (außen, Körper oder Mitte) analysiert. Die Ergebnisse zeigen: (a) Männer servierten schneller als Frauen; (b) Männer platzierten einen höheren Prozentsatz der ersten Aufschläge in den T-Bereich auf der Einstandseite (35,0 % vs. 27,7 %) und von der Vorteilseite nach außen (44,1 % vs. 36,7 %), während Frauen auf beiden Seiten mehr auf den Körper platzierten; (c) Männer gewannen beim ersten Aufschlag einen höheren Prozentsatz an Punkten als Frauen, mit Ausnahme von Aufschlägen in den T-Bereich auf der Einstandseite; (d) mit dem zweiten Aufschlag von der Einstandseite platzierten die Männer häufiger in die T-Zone (28,0 % vs. 21,8 %), während die Frauen auf der Vorteilseite mehr auf den Körper aufschlugen (41,4 % vs. 33,5 %); (e) Männer gewannen mit ihrem zweiten Aufschlag einen höheren Prozentsatz an Punkten, wenn sie ihn von der Einstandseite auf den Körper (54,1 % vs. 47,1 %) und von der Vorteilseite in die T-Zone platzierten (64,4 % vs. 44,1 %). Daraus lässt sich schließen, dass die Spieler je nach Geschlecht unterschiedliche Aufschlagmuster aufweisen. Männer servierten schneller und mit höherer Erfolgsrate. Sie platzierten ihre Aufschläge häufiger in die Außenbereiche des Aufschlagsfelds, während Frauen zu einem höheren Anteil auf den Körper ihrer Gegnerinnen servierten.

Keywords separated by '-'	Notational analysis - Tennis serve - Racquet sports - Performance indicators
Keywords separated by '-'	Notationsanalyse - Tennisaufschlag - Schlägersportarten - Leistungsindikatoren

Ger J Exerc Sport Res
https://doi.org/10.1007/s12662-019-00615-z
Received: 12 March 2019
Accepted: 20 July 2019

G. Torres-Luque[1] · J. C. Blanca-Torres[1] · D. Cabello-Manrique[2] · A. I. Fernández-García[3]

[1] Faculty of Humanities and Education Science, University of Jaén, Jaén, Spain
[2] Faculty of Physical Activity and Sport Sciences, University of Granada, Granada, Spain
[3] Faculty of Health and Sport Science, University of Zaragoza, Zaragoza, Spain

Serve profile of male and female professional tennis players at the 2015 Roland Garros Grand Slam tournament

Introduction

Tennis is a dynamic and complex game where decisions about shot placement, ball speed and effect (flat, slice or topspin) and movement over the court need to be made continuously (Gillet, Leroy, Thouvarecq, & Stein, 2009). Strategy and tactics provide tennis players with game plan and specific purpose (Crespo & Reid, 2008; Over & O'Donoghue, 2010) and are based on three factors: knowledge of one's own and opponent's strengths and weaknesses and contextual and environment factors such as type of surface, weather conditions, tournament round or quality of opposition (O'donoghue, 2001; Varas Caro & Gómez Ruano, 2016; Cui, Gómez, Gonçalves, Liu, & Sampaio, 2017). In the last decade, the professional tennis game (men's and women's) has evolved towards offensive style. Most players use "all court" based on aggressive baseline strokes and offensive serve and serve-return strategies with the aim of putting more pressure on the opponent (Filipčič, Filipčič, & Berendijaš, 2008; Katić, Milat, Zagorac, & Đurović, 2011; Stare, Zibrat, & Filipcic, 2015).

Nowadays it is possible to access of a huge amount of statistical data in high performance sport with a simple manner. Specifically, in tennis, the Association of Tennis Professionals (ATP), Women's Tennis Association (WTA) and the International Tennis Federation (ITF) provide competition statistics of the main events on their websites through their partnerships with Infosys, SAP and Slamtracker. The analysis and the ability to interpret the data help us to understand player behaviors with the goal of enhancing competitive performance and training processes (Hughes & Bartlett, 2002; O'Donoghue, 2012; Sánchez-Pay, Palao, Torres-Luque, & Sanz-Rivas, 2015).

Past researchers in tennis have studied players positioning and movements (Martínez-Gallego et al., 2013; Martínez Gallego et al., 2013), experience and relative quality of the players (Cui et al., 2017), performance indicators (Katić et al., 2011) or time factors (Takahashi, Wada, Maeda, Kodama, & Nishizono, 2009), but service is the most extensively investigated tennis elements because it is the most powerful tool to achieve direct points or can be used to take initiative at the beginning of a point (Cross & Pollard, 2009; Gillet et al., 2009; Hizan, Whipp, & Reid, 2015). Nevertheless, although the serve is the most analyzed stroke in tennis, most studies have analyzed the performance according with the overall statistics without taking into account the spatial distribution of the serve in both serve box sides.

Furthermore, due to physical (Munivrana, Filipčić, & Filipčić, 2015) and technical differences between players of different sexes (Filipčič et al., 2008; Reid, Morgan, & Whiteside, 2016), it is questionable whether there will be differences between groups in serve-specific tactics and performance statistics.

Therefore, the purpose of this study was to investigate the differences between male and female high-level tennis players in serve-specific statistics at the 2015 Roland Garros Grand Slam. This study provides insights into the tactical dimension of high-level tennis players and the information would be of particular interest to coaches looking to optimize an athlete's success.

Method

Sample

Service data from 126 Roland Garros matches were collected (63 from male and 63 from female players) from the official tournament website (www.rolandgarros.com). All players proceeded from the second round of the tournament to the final like others studies have done previously (Sánchez-Pay et al., 2015; Torres-Luque, Fernández-García, Sánchez-Pay, Ramírez, & Nikolaidis, 2017). Matches that ended in retirement or disqualification were not considered for the analysis, which occurred in a total of 15 cases distributed as follows: (a) male category: 6 cases; (b) female category: 9 cases; thus, a total of 111 (57 from male and 54 from female) matches were considered in which a total of 19,752 serves were analyzed. Male matches were played as the best of 5 sets and female as the best

JournalID: 12662 · ArticleID: 615 · DispatchDate: 05.08.2019 · ProofNo: 1, p. 1

Table 1 Categories and variables

Categories	Variables
Serve speed ($km \cdot h^{-1}$)	Maximum first serve speed Maximum second serve speed Average first serve speed Average second serve speed
Serve location	First serve direction (%) Second serve direction (%)
Serve performance	First serve points won (%) Second serve points won (%)
Aces	First serve aces Second serve aces

of three, all of them with tie break in the final set (ITF, 2017).

Procedure

The 10 variables considered were sorted into four categories: variables related to serve speed, variables related to serve direction; variables related to serve performance and variables related to aces (**Table 1**). All of them were classified according to the serve landing location. The service box on both the deuce and the advantage sides of the court were each divided into three zones of equal width: "wide" is the area from the lateral line of service box up to 1.37 meters towards the central service line; "T" is the area from the central service line up to 1.37 meters towards lateral lines of service boxes; and "body" is the area between "wide" and "T" area. This classification is based on the information from the statistical link (www.rolandgarros.com).

Statistical analysis

A specific record sheet was designed for this study (Microsoft Excel) and the data were subsequently exported into the statistical program SPSS 22.0 for further analysis. Firstly, a descriptive analysis of the data (means and standard deviation) was done. Secondly a univariate (Mann–Whitney U) test (non-parametric) was carried out with the aim of analyzing the differences between sexes (male vs. female) because the assumptions of normality and homogeneity of variances were not satisfied. Significance was set at $p < 0.05$.

Results

The results related with serve speed are shown in **Table 2**.

The results obtained shown that males had higher maximum and average first and second serve speeds ($p < 0.001$) compared to females independent of serve side and location.

Table 3 shows the differences between sexes regarding serve direction (%).

With first and second serves, males placed a higher percentage at the T area on the deuce side and the wide area when they did it on the advantage side ($p < 0.01$), whereas females more frequently hit the first and second serve towards the body area on both sides ($p < 0.005$), except the second serve on the deuce side.

In **Table 4** it can be observed that with the first serve, males had better performance on both sides independent of the location ($p < 0.05$), except when they served to the T area on the deuce side. Nevertheless, with the second serve, males only obtained better performance when they placed the serve at the body and at the T area on the deuce and advantage side respectively ($p < 0.05$).

Furthermore, both genders obtained their best first serve performance when they placed at the T area on the deuce side and at the wide area on advantage. Nonetheless, with the second serve, males had better performance at the wide area on the deuce side and at the T in advantage, while females performed better at the wide area on both sides.

The results related with the location of the aces are shown in **Table 5**.

On the deuce side there are no differences, although on the advantage side males obtained a greater percentage of the aces when they served to the T area and females had a greater percentage when they placed the serve at the wide area ($p < 0.05$).

Discussion

The aim of this study was to compare the serve statistics profile between male and female high-level tennis players on a clay court. Also, the first and the second service are analyzed—an aspect that is very novel. The main finding is that the males have different serve patterns than females. The beginning of the point in tennis seems decisive for increasing the chances of winning (Gillet et al., 2009). As many studies report, serve is the most relevant stroke in tennis and its importance is greater on fast surfaces (O'Donoghue & Ballantyne, 2004; Brown & O'Donoghue, 2008) and greater in men's than in women's professional tennis (Gillet et al., 2009; Reid et al., 2016). There are many studies that concluded that males serve faster, get more aces, make fewer double faults and win a greater percentage of serve points than females (Filipčič et al., 2008; Hizan, Whipp, & Reid, 2011; Cross, 2014; Reid et al., 2016). However, there is a lack of information about how the landing location of the stroke affects the serve performance in both sexes.

Prior studies show an average speed in males' tennis between 182 and 185 $km \cdot h^{-1}$ for the first serve and between 146 and 150 $km \cdot h^{-1}$, for the second serve in matches played on clay (Cross & Pollard, 2009; Fernández-García, Torres-Luque, Sánchez-Pay, & Fradua, 2012; Tudor, Zečić, & Matković, 2014), whereas, for females, Reid et al. (2016) show average speeds of 152 and 131 $km \cdot h^{-1}$, respectively, for the first and second serves in matches played on hard court. However, none of the previous studies have considered the direction of the serve and the clay surfaces.

As for the distribution of the first serves, Hizan et al. (2015) concluded, as does this study, that females use a higher percentage of serves toward the body than males, on both sides. They obtain percentages of 26.4 vs. 6.8 at the deuce and 24.2 vs 8.5 on the advantage side, respectively. As for the males, they tend to direct more of their serves to the exterior areas, at the deuce (44.5% open and 48.7% to the T) and to the open, when on advantage (47.1%) than females; this slightly differs from the results of this study in which there were no difference on the first open serve, at the deuce and on the T, at advantage time. The said difference might be due to the fact that the matches analyzed by Hizan et al. (2015)

JournalID: 12662 · ArticleID: 615 · DispatchDate: 05.08.2019 · ProofNo: 1, p. 2

were played on a quick court where the direct serve is most played (O'Donogue & Ballantyne, 2004) because of the characteristics of the surface (Brody, 2003). It is true that this study only analyzes clay surface, but our results show that on clay courts both males and females open their first serves, on both sides, more than on any other direction. This fact could be explained by the added difficulty of winning direct points with the serves on clay courts both for males and females: they try to displace their rivals with the serves, thus making their returns more difficult, so as to gain a wider striking angle at the following shot and dominate the point from the beginning (Dent, 1994; Gillet et al., 2009).

With the second serve, we conclude that males use the T zone more than females, at deuce, (27.9 vs 21.8%) and the wide area (41.4 vs 33.5%) during advantage. These results coincide with those of Hizan et al. (2015) and it may be due to the fact that male tennis aims more at the opponent's backhand as it is normally the weakest shot (Gillet et al., 2009; Hizan et al., 2015), whereas females aim their serves more than males to the central area, this being the safest and enabling them to avoid their opponent's backhand, which is often the best shot in female tennis (Reid et al., 2016).

As for the percentage of points won with the first serve, previous studies have shown values between 69 and 71% for males on clay (Cross & Pollard, 2009; Fernández-García et al., 2012; Tudor et al., 2014) and between 60 and 65% for females (Hizan et al., 2011; Reid et al., 2016), which are very similar to those obtained in our study. Males obtain a higher performance than females with their first serves in both sides and in all areas, except when they aim at the T zone, on the deuce side, in which both achieve their highest performance, whereas, at advantage time, both males and females coincide and win the most points when they open their serve. Differences remain however very small.

Previous studies show percentages of points won with the second serve ranging from 51 to 53 for males on clay (Cross & Pollard, 2009; Tudor et al., 2014) and of 41 for females (Reid et al., 2016), this

Abstract · Zusammenfassung

Ger J Exerc Sport Res https://doi.org/10.1007/s12662-019-00615-z

G. Torres-Luque · J. C. Blanca-Torres · D. Cabello-Manrique · A. I. Fernández-García

Serve profile of male and female professional tennis players at the 2015 Roland Garros Grand Slam tournament

Abstract

The aim of this study was to compare the serve statistics profile of male and female high-level tennis players. In all, 111 tennis singles matches of the Roland Garros 2015 tennis tournament were collected and 10 variables related to first and second serve were analyzed according to service box (deuce and advantage sides) and landing location (wide, body and T-areas). The results show: (a) men served faster than women; (b) men served a higher percentage of serves at T-area on deuce side (35.0 vs 27.7%) and at the wide zone on advantage side (44.1 vs 36.7%) with first serves, while women hit more to the body on both sides; (c) men won a higher percentage of points with their first serve compared to women at any zone on both sides, except for the T-area on deuce side; (d) with their second serve, men placed a greater percentage of serves in the T-area on deuce side (28.0 vs 21.8%) and wide on the advantage side, whereas women directed more to the body on the advantage side (41.4 vs 33.5%); (e) men won a higher percentage of points with their second serve when they placed it to the body zone on deuce side (54.1 vs 47.1%) and at the T-area on the advantage side (64.4% vs 44.1%). Our conclusions are that with respect to gender, players showed differing serve patterns. Men served faster, with higher success and placed their serves more frequently to the external areas of the service boxes, while women directed a higher percentage of serves to the body of their opponent.

Keywords

Notational analysis · Tennis serve · Racquet sports · Performance indicators

Aufschlagsprofile von männlichen und weiblichen Tennisprofis beim Grand-Slam-Turnier Roland Garros 2015

Zusammenfassung

Das Ziel der Untersuchung bestand im Vergleich der Aufschlagstatistik zwischen männlichen und weiblichen Spitzenspielern. 111 Tenniseinzelspiele auf Sandplätzen (Roland Garros 2015) wurden nach 10 Beobachtungskriterien für den ersten und zweiten Aufschlag von der Einstand- und Vorteilseite und hinsichtlich der Aufschlagrichtung (außen, Körper oder Mitte) analysiert. Die Ergebnisse zeigen: (a) Männer servierten schneller als Frauen; (b) Männer platzierten einen höheren Prozentsatz der ersten Aufschläge in den T-Bereich auf der Einstandseite (35,0 % vs. 27,7 %) und von der Vorteilseite nach außen (44,1 % vs. 36,7 %), während Frauen auf beiden Seiten mehr auf den Körper platzierten; (c) Männer gewannen beim ersten Aufschlag einen höheren Prozentsatz an Punkten als Frauen, mit Ausnahme von Aufschlägen in den T-Bereich auf der Einstandseite; (d) mit dem zweiten Aufschlag von der Einstandseite platzierten die Männer häufiger in die T-Zone (28,0 % vs. 21,8 %), während die Frauen auf der Vorteilseite mehr auf den Körper aufschlugen (41,4 % vs. 33,5 %); (e) Männer gewannen mit ihrem zweiten Aufschlag einen höheren Prozentsatz an Punkten, wenn sie ihn von der Einstandseite auf den Körper (54,1 % vs. 47,1 %) und von der Vorteilseite in die T-Zone platzierten (64,4 % vs. 44,1 %). Daraus lässt sich schließen, dass die Spieler je nach Geschlecht unterschiedliche Aufschlagmuster aufweisen. Männer servierten schneller und mit höherer Erfolgsrate. Sie platzierten ihre Aufschläge häufiger in die Außenbereiche des Aufschlagsfelds, während Frauen zu einem höheren Anteil auf den Körper ihrer Gegnerinnen servierten.

Schlüsselwörter

Notationsanalyse · Tennisaufschlag · Schlägersportarten · Leistungsindikatoren

JournalID: 12662 · ArticleID: 615 · DispatchDate: 05.08.2019 · ProofNo: 1, p. 3

Table 2 Differences in variables related to serve speed between genders (units: km · h^{-1})

	Wide area			Body area			T area		
	Male	Female	*p*	Male	Female	*p*	Male	Female	*p*
1st Serve Maximum Serve Speed (Deuce Side)	192.6 ± 9.9	162.3 ± 19.8	0.000	200.2 ± 21.7	168.8 ± 20.7	0.000	203.9 ± 9.2	167.1 ± 31.6	0.000
1st Serve Maximum Serve Speed (Advantage Side)	198.8 ± 10.2	163.7 ± 26.8	0.000	193.1 ± 27.9	162.8 ± 30.5	0.000	199.0 ± 13.8	165.0 ± 30.4	0.000
2nd Serve Maximum Serve Speed (Deuce Side)	151.4 ± 45.8	111.1 ± 60.7	0.000	164.4 ± 10.6	141.9 ± 12.2	0.000	153.7 ± 31.4	108.7 ± 57.8	0.000
2nd Serve Maximum Serve Speed (Advantage Side)	154.4 ± 15.1	113.5 ± 50.1	0.000	155.9 ± 20.7	133.1 ± 32.2	0.000	125.0 ± 70.8	85.1 ± 73.0	0.000
Average 1st Serve Speed (Deuce Side)	180.2 ± 8.6	154.2 ± 18.4	0.000	187.2 ± 20.6	158.5 ± 20.2	0.000	193.9 ± 1.0	158.9 ± 30.6	0.000
Average 1st Serve Speed (Advantage Side)	179.0 ± 13.2	152.1 ± 26.0	0.000	179.4 ± 26.4	153.1 ± 30.1	0.000	187.9 ± 9.0	157.7 ± 29.0	0.000
Average 2nd Serve Speed (Deuce Side)	146.5 ± 44.3	108.6 ± 59.3	0.000	153.0 ± 9.1	144.0 ± 94.5	0.000	146.9 ± 29.9	105.2 ± 55.9	0.000
Average 2nd Serve Speed (Advantage Side)	143.1 ± 11.5	108.4 ± 47.9	0.000	141.9 ± 17.1	124.3 ± 29.8	0.000	121.1 ± 68.7	82.9 ± 71.0	0.000

1st First, *2nd* Second

Table 3 Differences in variables related to serve direction between sexes

	Wide area			Body area			T area		
	Male	Female	*p*	Male	Female	*p*	Male	Female	*p*
1st Serve Direction (%) (Deuce Side)	39.1 ± 13.3	38.2 ± 17.5	0.450	26.0 ± 12.0	34.1 ± 18.6	**0.001**	35.0 ± 11.2	27.7 ± 13.9	**0.000**
1st Serve Direction (%) (Advantage Side)	44.1 ± 14.9	36.7 ± 16.1	**0.000**	22.6 ± 14.2	29.9 ± 17.5	**0.001**	33.3 ± 13.8	33.4 ± 18.5	0.725
2nd Serve Direction (%) (Deuce Side)	17.9 ± 16.0	21.0 ± 19.1	0.348	54.2 ± 20.1	57.2 ± 21.5	0.348	28.0 ± 17.6	21.8 ± 20.0	**0.003**
2nd Serve Direction (%) (Advantage Side)	41.4 ± 22.5	33.5 ± 24.2	**0.009**	46.6 ± 21.1	53.4 ± 24.8	**0.040**	12.0 ± 14.0	13.2 ± 15.4	0.993

1st First, *2nd* Second

Table 4 Differences in variables related to serve performance between sexes

	Wide area			Body area			T area		
	Male	Female	*p*	Male	Female	*p*	Male	Female	*p*
1st Serve Points won (%) (Deuce Side)	69.4 ± 16.4	65.6 ± 31.8	**0.041**	63.0 ± 19.8	57.0 ± 26.7	**0.048**	73.3 ± 15.0	66.3 ± 26.3	0.118
1st Serve Points won (%) (Advantage Side)	71.9 ± 15.6	62.9 ± 21.8	**0.000**	62.4 ± 23.2	56.4 ± 24.9	0.050	71.6 ± 17.5	61.3 ± 21.3	**0.001**
2nd Serve Points won (%) (Deuce Side)	57.8 ± 34.8	52.3 ± 37.1	0.337	54.1 ± 19.2	47.1 ± 26.4	**0.007**	54.4 ± 28.6	47.8 ± 36.9	0.161
2nd Serve Points won (%) (Advantage Side)	56.2 ± 26.3	57.1 ± 30.6	0.600	52.9 ± 20.0	51.7 ± 24.8	0.773	64.6 ± 35.7	44.1 ± 37.3	**0.001**

1st First, *2nd* Second

data being on quick court. These values are lower than in this study, both in their absolute values and differences, for males (52 and 64%) and for females (44 and 57%). Furthermore, significant differences are only found for males when they aim at the body on the deuce side (54.1 vs 47.1%) and when they aim at the T on the ad side (64.6 vs 44.1%). The fact that males reach their best performances when they aim at the T on the advantage side may be due to the uncertainty generated in the rival by the fact that they only aim at this area at a rate of 12%. However, it is necessary to continue investigating this type of conclusion, in general, and concretely on a clay surface[18].

Lastly, while males have a higher percentage of aces, compared with females, when they aim at T zone on the advantage side, women achieve the same result

JournalID: 12662 · ArticleID: 615 · DispatchDate: 05.08.2019 · ProofNo: 1, p. 4

Table 5 Differences in variables related to aces between sexes

	Wide area			Body area			T area		
	Male	Female	*p*	Male	Female	*p*	Male	Female	*p*
1st Aces (%) (Deuce Side)	35.3 ± 35.4	47.8 ± 42.7	0.086	6.9 ± 18.3	3.6 ± 11.5	0.135	57.8 ± 37.5	48.6 ± 41.9	0.173
1st Aces (%) (Advantage Side)	35.7 ± 38.4	49.3 ± 41.0	**0.035**	2.8 ± 12.3	7.8 ± 23.6	0.201	61.5 ± 39.3	43.0 ± 40.2	**0.004**
2nd Aces (%) (Deuce Side)	63.3 ± 44.2	75.0 ± 50.0	0.665	16.7 ± 30.9	0.0 ± 0.0	0.469	20.0 ± 41.4	25.0 ± 50.0	0.885
2nd Aces (%) (Advantage Side)	0.0 ± 0.0	0.0 ± 0.0	1.000	0.0 ± 0.0	0.0 ± 0.0	1.000	100.0 ± 0.0	100.0 ± 0.0	1.000

1st First, *2nd* Second

when they open their serve on the same side. Further studies will be needed that will consider not only the variables analyzed but also the players' laterality (serving and returning) and also the comparison of results on the different types of surfaces. However, this study allows an approximation to a specific training in relation to the sex, in high-level players on the clay surface.

Conclusions

According to the sex, players had different serve patterns. Males served faster, had better performance and located their serves more frequently to the external areas of the service boxes, while females directed a higher percentage of serves to the body of their opponent.

Corresponding address

A. I. Fernández-García
Faculty of Health and Sport Science, University of Zaragoza
Calle de Pedro Cerbuna, 12, 50009 Zaragoza, Spain
angelivanfg@unizar.es

Compliance with ethical guidelines

Conflict of interest G. Torres-Luque, J.C. Blanca-Torres, D. Cabello-Manrique and A.I. Fernández-García declare that they have no competing interests.[19]

For this article no studies with human participants or animals were performed by any of the authors. All studies performed were in accordance with the ethical standards indicated in each case.[20]

References

Barnett, T., Meyer, D., & Pollard, G. (2008). Applying match statistics to increase serving performance. *Medicine and Science in Tennis*, *13*(2), 24–27.

Brody, H. (2003). Bounce of a tennis ball. *Journal of Science and Medicine in Sport*, *6*(1), 113–119.

Brown, E., & O'Donoghue, P. (2008). Gender and surface effect on elite tennis strategy. *Coaching and Sport Science Review*, *15*(46), 11–13.

Crespo, M., & Reid, M. (2008). *Coaching beginner and intermediate tennis players: a manual of the ITF coaching programme*. London: International Tennis Federation.[21]

Cross, R. (2014). Men's tennis vs Women's tennis. *ITF Coaching and Sport Science Review*, *62*, 3–5.

Cross, R., & Pollard, G. (2009). Grand Slam men's singles tennis 1991–2009. Serve speeds and other related data. *Coaching and Sport Science Review*, *16*(49), 8–10.

Cui, Y., Gómez, M.-Á., Gonçalves, B., Liu, H., & Sampaio, J. (2017). Effects of experience and relative quality in tennis match performance during four Grand Slams. *International Journal of Performance Analysis in Sport*, *17*(5), 783–801.

Dent, P. (1994). Reading the game. *ITF Coaching & Sports Science Review*, *3*, 4–5.

Fernández-García, A., Torres-Luque, G., Sánchez-Pay, A., & Fradua, L. (2012). Influence of the type of surface in the statistics of competition of high performance tennis. In *Proceedings of VII Congreso Internacional de la Asociación Española de Ciencias del Deporte* (pp. 412–413).

Filipčič, T., Filipčič, A., & Berendijaš, T. (2008). Comparison of game characteristics of male and female players at Roland Garros 2005. *Acta Universitatis Palackianae Olomucensis. Gymnica*, *38*(3), 21–28.[22]

Gillet, E., Leroy, D., Thouvarecq, R., & Stein, J.-F. (2009). A notational analysis of elite tennis serve and serve-return strategies on slow surface. *The Journal of Strength & Conditioning Research*, *23*(2), 532–539.

Gómez-Ruano, M. A. (2017). The importance of notational analysis as an emergent research topic in sport sciences. *Ricyde. Revista Internacional De Ciencias Del Deporte*, *13*(47), 1–4. https://doi.org/10.5232/ricyde2017.047ed. La importancia del análisis notacional como tópico emergente en Ciencias del deporte.[23]

Hizan, H., Whipp, P., & Reid, M. (2011). Comparison of serve and serve return statistics of high performance male and female tennis players from different age-groups. *International Journal of Performance Analysis in Sport*, *11*(2), 365–375.

Hizan, H., Whipp, P., & Reid, M. (2015). Gender differences in the spatial distributions of the tennis serve. *International Journal of Sports Science & Coaching*, *10*(1), 87–96.

Hughes, M. D., & Bartlett, R. M. (2002). The use of performance indicators in performance analysis. *Journal of Sports Sciences*, *20*(10), 739–754.

Katić, R., Milat, S., Zagorac, N., & Đurović, N. (2011). Impact of game elements on tennis match outcome in Wimbledon and Roland Garros 2009. *Collegium Antropologicum*, *35*(2), 341–346.

Kovacs, M. S. (2007). Tennis physiology. *Sports Medicine*, *37*(3), 189–198.

Martínez Gallego, R., Luján, G., Francisco, J., James, N., Ramón Llin, J., Crespo, M., et al. (2013). The relationship between the incidence of winners/errors and the time spent in different areas of the court in elite tennis. *Journal of Human Sport and Exercise*, *8*(3), 601–607.

Martínez-Gallego, R., Guzmán, J. F., James, N., Pers, J., Ramón-Llin, J., & Vuckovic, G. (2013). Movement characteristics of elite tennis players on hard courts with respect to the direction of ground strokes. *Journal of Sports Science & Medicine*, *12*(2), 275.

Munivrana, G., Filipčić, A., & Filipčić, T. (2015). Relationship of speed, agility, neuromuscular power, and selected anthropometrical variables and performance results of male and female junior tennis players. *Collegium Antropologicum*, *39*(Supplement 1), 109–116.

O'Donoghue, P. (2012). Break points in Grand Slam men's singles tennis. *International Journal of Performance Analysis in Sport*, *12*(1), 156–165.

O'Donoghue, P. G. (2001). The most important points in grand slam singles tennis. *Research Quarterly for Exercise and Sport*, *72*(2), 125–131.

O'Donoghue, P., & Ballantyne, A. (2004). The impact of speed of service in Grand Slam singles tennis. In *Science and racket sports III: the proceedings of the eighth international table tennis federation sports science congress and the third world congress of science and racket sports*.

O'Donoghue, P., & Ingram, B. (2001). A notational analysis of elite tennis strategy. *Journal of Sports Sciences*, *19*(2), 107–115.

Over, S., & O'Donoghue, P. (2010). Analysis of strategy and tactics in tennis. *International Tennis Federation Coaching and Sport Science Review*, *50*(18), 15–16.

Reid, M., McMurtrie, D., & Crespo, M. (2010). The relationship between match statistics and top 100 ranking in professional men's tennis. *International Journal of Performance Analysis in Sport*, *10*(2), 131–138.

Reid, M., Morgan, S., & Whiteside, D. (2016). Matchplay characteristics of Grand Slam tennis: implications for training and conditioning. *Journal of Sports Sciences*, *34*(19), 1791–1798.

JournalID: 12662 · ArticleID: 615 · DispatchDate: 05.08.2019 · ProofNo: 1, p. 5

Reilly, T., Morris, T., & Whyte, G. (2009). The specificity of training prescription and physiological assessment: A review. *Journal of Sports Sciences*, *27*(6), 575–589.

Stare, M., Zibrat, U., & Filipcic, A. (2015). Stroke efectivness in professional and junior tennis. *Kinesiologia Slovenica*, *21*(2), 39.

Sánchez-Pay, A., Palao, M. J., Torres-Luque, G., & Sanz-Rivas, D. (2015). Differences in set statistics between wheelchair and conventional tennis on different types of surfaces and by gender. *International Journal of Performance Analysis in Sport*, *15*(3), 1177–1188.

Takahashi, H., Wada, T., Maeda, A., Kodama, M., & Nishizono, H. (2009). An analysis of time factors in elite male tennis players using the computerised scorebook for tennis. *International Journal of Performance Analysis in Sport*, *9*(3), 314–319.

Torres-Luque, G., Fernández-García, A., Sánchez-Pay, A., Ramírez, A., & Nikolaidis, P. (2017). Differences in the statistics of competition in idividual tennis according to the playing surface in male junior players of high-level. *SPORT Tk-Revista Euroamericana De Ciencias Del Deporte*, *6*(1), 75–80.

Tudor, P. B., Zečić, M., & Matković, B. (2014). Differences between 2010 and 2011 performance indicators of tennis play at the Gran Slam tournaments. *Kinesiology*, *46*(1), 101–106.

Varas Caro, I., & Gómez-Ruano, M. Á. (2016). Notational analysis of elite tennis players in contextual variables. *Kronos*, *15*(1), 1–12. Análisis Notacional en Jugadores de Tenis de Élite En Función de las Variables Contextuales.

Author queries

1 page 3, column B-C (abstract-2)

Please confirm the changes made to the German abstract to match the English text.

2 page 3, column B-C (abstract-2)

To enhance searchability, each article should list 5 relevant keywords/Schlüsselwörter (English/German) that are not already mentioned in the main title of the article. Please modify accordingly.

3 page 1, column A

This article will be published with a photograph of the corresponding author. Please upload a suitable picture as an attachment and provide a copyright information if necessary. In the case of multiple corresponding authors, a photograph of each one will be needed.

4 page 1, column A

The tables have been renumbered in order of their appearance in the text. Please verify these corrections.

5 page 1, column A

Please verify the affiliations (address and institutional information).

6 page 1, column A

Please insert a citation for reference 'Barnett, Meyer, Pollard (2008)' into the main text. Alternatively you can delete the entry from the list of references or ask for it to be added as 'Further Reading'.

7 page 1, column A

Please insert a citation for reference 'Gómez-Ruano (2017)' into the main text. Alternatively you can delete the entry from the list of references or ask for it to be added as 'Further Reading'.

8 page 1, column A

Please insert a citation for reference 'Kovacs (2007)' into the main text. Alternatively you can delete the entry from the list of references or ask for it to be added as 'Further Reading'.

9 page 1, column A

Please insert a citation for reference 'O'Donoghue, Ingram (2001)' into the main text. Alternatively you can delete the entry from the list of references or ask for it to be added as 'Further Reading'.

10 page 1, column A

Please insert a citation for reference 'Reid, McMurtrie, Crespo (2010)' into the main text. Alternatively you can delete the entry from the list of references or ask for it to be added as 'Further Reading'.

11 page 1, column A

Please insert a citation for reference 'Reilly, Morris, Whyte (2009)' into the main text. Alternatively you can delete the entry from the list of references or ask for it to be added as 'Further Reading'.

12 page 1, column C

Please verify/correct the change of '19,752 service ' to '19,752 serves'.

13 page 2, column A

Please include reference 'ITF, 2017' in the bibliography or remove the respective reference/references from the text.

14 page 2, column A

Please verify/correct the changes made to the following sentence: This classification is based on the information from the statistical link…

15 page 4, column A-C (table 2)

Please verify the addition of 'km · h–1' to the legend of table 2.

16 page 2, column B

Please verify/correct the changes made to the results section so that it is easier for the readers to understand the content.

17 page 2, column C

Please verify the change of the units for the following (km to km·h –1): 182 and 185 km ·h –1 for the first serve and between 146 and 150 km·h –1

18 page 4, column C

Please verify/correct the changes made to the following sentence: However, it is necessary to continue investigating this type of conclusion, in general, and concretely on a clay surface.

19 page 5, column A

Please confirm or correct the statement for conflict of interest.

20 page 5, column A

Please confirm or correct the statement for ethical guidelines.

21 page 5, column B

The following data has been added: publisher location. Please confirm the added information.

22 page 5, column B

The following data has been added: page range. Please confirm the added information.

23 page 5, column B

The following data has been added: journal name, volume- issue number; page range; DOI). Please confirm the added information.

24 page 6, column A

The following data has been added: number; page range. Please confirm the added information.

25 page 6, column A

The following data has been added: page range. Please confirm the added information.