

Exploring Gender-Based Disparities in Finalist Technical-Tactical Actions: A Study of Amateur and Professional Padel Players

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Abstract

Our aim in this study was to analyze gender differences across amateur and professional padel players related to the last shot of each rally. We analyzed a total of 180 games per category (professional and amateur), with 90 games for each gender. We performed descriptive and inferential analyses, including the Chi-square (χ^2) statistical test, the Cramer's V coefficient (V_c), subsequent Z-tests and corrected standard residuals (CSR). Results revealed that male amateurs produced more winners than female amateurs (CSR = 3.2). Conversely, male professionals exhibited more forced errors (CSR = 3.0) than female professionals, while female professionals committed more unforced errors (CSR = 3.8). In addition, there was a significant relationship between the type of the last shot played and player gender among amateurs, particularly when the last shot resulted in a winner ($p < .001$) or an unforced error ($p = .011$). Similarly, among professionals, there was a significant relationship between gender and last shot play when the last shot was a forced error ($p = .009$). Likewise, there was a relationship between the court zone and gender in amateur padel, when the last shot was an unforced error ($p = .002$) and among professionals,

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when the last shot was a winner ($p = .001$). In conclusion, the type of technical-tactical action, its effectiveness, and the area of the court were influenced by the players' sex in both amateur and professional padel.

Keywords

last shot, performance, game analysis, racquet sports, court zone

Introduction

The number of research studies on padel has increased in recent years (Martín-Miguel et al., 2023; Sánchez-Alcaraz, Cánovas et al., 2022), but research about amateur padel remains scarce (Ramón-Llin et al., 2020, 2021; Sánchez-Alcaraz, Siquier-Coll, et al., 2021), especially when compared with scientific papers on professional padel (Conde-Ripoll et al., 2024; Escudero-Tena et al., 2023; Sánchez-Alcaraz et al., 2022). Existing studies about amateur padel deal with internal loading parameters (Díaz-García et al., 2017), injury epidemiology (Muñoz, Coronado et al., 2022) or racket characteristics (Escudero-Tena, Muñoz, et al., 2023). Regarding external loading parameters in amateur padel matches, play for each point typically lasts about 5 seconds, with an average of three shots played within that time frame (Ramón-Llin et al., 2017). The duration of point play is longer in women's than in men's padel, although the number of shots taken is higher in men's padel (Fernandez-de-Osso et al., 2023). Additionally, over 80% of serves employ a conventional tactic formation (Ramón-Llin et al., 2021), with servers and returners covering the most distance per point (Ramón-Llin et al., 2020). Groundstrokes are the most frequently used shots, followed by volleys (Ramón-Llin et al., 2017; Sánchez-Alcaraz, Siquier-Coll, et al., 2021). In men's amateur padel, the player on the left side of the court typically makes more shots than the player on the right side of the court. Furthermore, in roughly 50% of points, male players cover distances of eight meters or less (Ramón-Llin et al., 2020), and they spend approximately 80% of the match walking (Ramón-Llin et al., 2021).

The many studies that have measured external loading parameters in professional padel have represented various conditions faced by the athletes (Martín-Miguel et al., 2023; Sánchez-Alcaraz et al., 2023). These studies can be categorized into those that address: (a) temporal structure, (b) players' movements on the court, (c). scoreboard results, and (d) technical-tactical actions.

In terms of temporal structure, a professional padel set typically lasts around 30 minutes (Sánchez-Alcaraz, Jiménez, et al., 2021), and gender differences show longer durations for women. Out of the total match duration, only 30% corresponds to the active phase of play (Sánchez-Alcaraz, Jiménez, et al., 2021), with each point averaging between 12.5 and 13.5 seconds (Sánchez-Alcaraz, Jiménez, et al., 2021). Regarding players' movement, high-level players cover an average distance of 1000 meters per set, with 50.8% of this covered during ball play. On a per-point basis, a

player covers an average of 11 meters (Ramón-Llin et al., 2021). The primary movements involve lateral or forward motion, with a significant number of jumps executed (Priego et al., 2013). Regarding scoring, only two sets are played in over 70% of men's matches, while in women's padel, the percentage of two set matches falls below 70% (Sánchez-Alcaraz, Siquier-Coll, et al., 2021). Additionally, the number of games per match tends to increase as rounds of a tournament progress, with this number higher in women's padel (Muñoz, Toro-Román et al., 2022).

In relation to technical-tactical actions, male professionals typically execute around 9.6 shots per point, while females execute approximately 12 shots per point (Lupo et al., 2018), with the volley the most frequently employed shot in women's play (Sánchez-Alcaraz et al., 2020). Regarding shot distributions on the court, there are disparities across studies. According to Mellado Arbelo et al. (2019), most shots in men's padel are executed from the back of the court, but Courel-Ibáñez et al. (2019) found most shots in men's padel to have been hit from the baseline corners. Sánchez-Alcaraz, Muñoz et al. (2022) found that, in both men's and women's padel, most shots were executed from the central area of the net.

The last shot of the point has been widely analyzed in both men's and women's professional padel (Conde-Ripoll, Muñoz, Sánchez-Alcaraz et al., 2024; Courel-Ibáñez et al., 2017; Sánchez-Alcaraz, Siquier-Coll, et al., 2021). These investigators noted that the point can end with a winner, a forced error or an unforced error. A winner occurs when a player wins the point with a direct shot, a forced error occurs when the player loses the point due to an error when taking a highly difficult shot, with a poor position for its execution due to the opponent's prior shot (Lupo et al., 2018). An unforced error occurs when the player loses the point due to a bad play or an error in a situation that should have been fully controlled by the player (Sánchez-Alcaraz, Siquier-Coll, et al., 2021). Prior research suggests that men make more winners than women, while women commit more errors (forced and unforced) than men (Escudero-Tena et al., 2024; Escudero-Tena, Mancha-Triguero, et al., 2022). In addition, on the last shot type, male players perform more winners with the smash, and make more errors with the backhand volley, when compared to female players. For their part, female players make more winners and errors than male players with the bandeja. Only one research team analyzed the hitting zone for final technical-tactical actions; Escudero-Tena, Parraca, et al. (2023) found that the smash loses efficiency as players hit further away from the net zone.

Despite growing performance analyses in padel, there is a noticeable gap of studies focusing on amateur players, particularly in relation to hitting zones. Understanding performance in padel is essential for coaches to effectively plan training sessions and develop tailored training tasks, and for players to make informed decisions in live game situations. We aimed to address this gap by examining gender disparities in both professional and amateur padel, with a specific focus on the effectiveness and court positioning of the final shot. We made the following hypothesis based on prior, mostly professional, padel research: (a) In both amateur and professional levels, male players will produce more winners than female players, whereas the latter will commit more

errors, regardless of error type; (b) in both amateur and professional level play, males will produce more winners with no-bounce shots, compared to females, whereas female players will commit more errors (both forced and unforced) with any kind of shot; and (c) male players will produce more winners from areas close to the net, compared to female players, whereas males and females will produce errors in similar areas of the court.

Method

Research Design

This was an observational study that followed a descriptive empirical strategy in which data was nomothetic, punctual, and multidimensional (Thomas et al., 2023).

Participant Sample and Ethical Considerations

The observed matches of the professional category are openly available on the official World Padel Tour (WPT) YouTube channel, making it unnecessary to procure informed consent from participants, though our research protocol did receive advance approval from our university ethics committee. These matches were semi-final and final rounds. Consequently, the level of the four players of each match was guaranteed to be maximum high level WPT circuit play (i.e., the top 20 male players whose M age = 33.8 years old; two were left-handed and 18 were right-handed; and the top 20 female players whose M age = 30.6; one was left-handed; and 19 were right-handed).

We selected amateur matches randomly from competitions hosted by amateur territorial federations. Since these data were not obtained from open access source available to all members of the public, we obtained the written informed consent from both the federations and the players in these matches. All procedures were conducted according to the ethical standards in sport and exercise science research (Harriss et al., 2019) and with approval from our local ethics committee. We considered amateur players to be those who had not participated in any international category competition, were not below position 50 in the regional ranking and did not meet any requirements to play professional tournaments. We enrolled a total of 20 male amateur players (M age = 35.2; three left-handed and 17 right-handed) and 20 female amateur players (M age = 33.4; two left-handed and 18 right-handed).

In total, we analyzed 180 games per amateur and professional category, with 90 games for each gender, resulting in our examination of 2278 match points. Of these, we analyzed 1182 points in the professional matches, and 1096 in the amateur matches.

Study Variables

We defined and analyzed the following variables, based on their categorical core and degree of openness (Anguera & Hernández-Mendo, 2016):

- Gender: men's and women's categories were established to record the possible differences between them.
- Category: professional and amateur categories were established to record the possible differences between them.
- Effectiveness of the last shot: winner, forced error or unforced error. These categories were defined on the basis of previous studies ([Sánchez-Alcaraz, Siquier-Coll, et al., 2021](#)).
- Last shot type: we distinguished a difference between forehand, backhand, side wall, back wall forehand, back wall backhand, double wall, fence, contrapared, forehand bajada, backhand bajada, forehand volley, backhand volley, dropshot, slow smash, bandeja, vibora, smash x3, smash x4, powerful smash, fake smash, recovery smash and other (cadete, willy...). The definition of each of these categories was based on those used in previous research ([Escudero-Tena et al., 2024](#); [Escudero-Tena, Muñoz, et al., 2022](#)).
- Zone: area of the court where the last shot of each point was made based on the proposal of [Fernandez-de-Osso \(2019\)](#) ([Figure 1](#)).

Process

A specialist padel observer with more than 10 years experience playing on the professional circuit and more than five years teaching federation courses and holding a

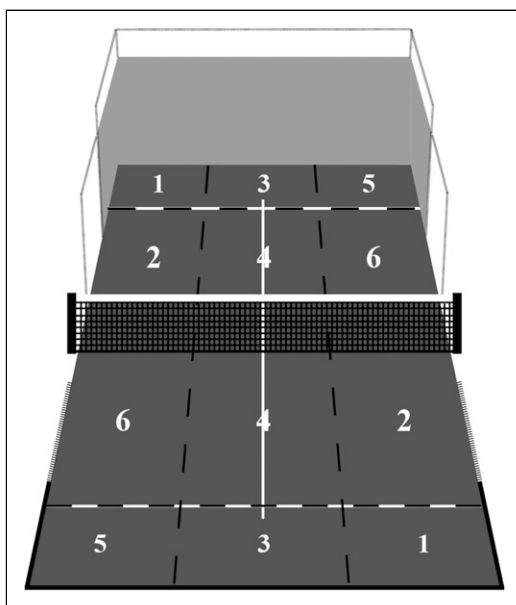


Figure 1. Court zones.

doctoral degree in Sports Sciences collected all observational data. We performed an intra-observer reliability analysis to ensure the accuracy of the data ratings. In this method, the observer reanalyzed a random sample of 30 games to make sure we had enough relevant data representing 10%–20% of the study sample (Igartua, 2006). The mean intra-observer reliability was 0.96, considered almost perfect (Landis & Koch, 1977). Likewise, another observer with a doctor degree in Sports Sciences and also a specialist in padel, with a large number of published scientific investigations related to the subject of this study who had trained padel players for more than five years also analyzed a random sample of 30 games, allowing us to calculate the mean inter-observer reliability (0.94) for these games (Landis & Koch, 1977). Table 1 shows the value of Cohen's Kappa coefficient (K) for each of the study variables.

To avoid possible errors when interpreting the data and given that the weather conditions or the type of court could have affected the player's style of play and performance in different games, those amateur game sequences that occurred in the same conditions as the professional sample were selected for analysis. For this, the same type of court (glass), its location (heated indoor court), and the brand of the ball (Head® Padel Pro) were also considered.

Statistical Analysis

We performed a descriptive data analysis to obtain information on the number of times the categories of each study variable occurred (frequency and percentage). We continued with an inferential analysis to develop contingency tables, including the Chi-square (χ^2) statistical test to obtain estimates of the association between variables. We calculated the strength of association between variables with Cramer's V coefficient (Vc) (Field, 2018). Crewson (2006) differentiated the strength of association according to the value, considering a small (<0.100), low (0.100–0.299), moderate (0.300–0.499) or high (>0.500) association. In addition, subsequent Z-tests were performed to compare column proportions, adjusting for p values <0.05 according to Bonferroni corrections. Contingency tables allowed the identification of associations between

Table 1. Inter-Observer and Intra-Observer Reliability.

Study variables	Inter-observer	Intra-observer
	K	K
Gender	1.00	1.00
Category	1.00	1.00
Effectiveness of the last shot	0.98	1.00
Last shot type	0.85	0.87
Zone	0.89	0.91

Note. K: Cohen's kappa coefficient.

variable categories through corrected standard residuals (CSR). Residuals > |1.96| betrayed cells with more or fewer cases than there should be (Field, 2018). The significance level was set at $p < .05$ and all statistical analyses were performed using the SPSS 27.0 software package for Windows.

Results

There was a relationship between the effectiveness of the last shot and the player’s gender in amateur padel ($X^2 = 10.293$; $df = 2$; $p = .006$; $V = 0.106$) and professional padel ($X^2 = 16.765$; $df = 2$; $p < .001$; $V = 0.127$).

In amateur padel, male players produced more winners than female players, whereas in professional padel, male players tended to commit more forced errors compared to female players. Female players demonstrated more unforced errors relative to male players (Table 2). In amateur padel, there was a relationship between the type of the last shot and the player’s gender when the last shot was a winner ($X^2 = 59.276$; $df = 18$; $p < .001$; $V = 0.457$) or an unforced error. ($X^2 = 34.569$; $df = 18$; $p = .011$; $V = 0.274$). However, there was no significant relationship between the type of the last shot and the player’s gender when the last shot was a forced error ($X^2 = 17.012$; $df = 13$; $p = .199$; $V = 0.311$).

In Table 3 it can be observed that, in amateur padel, male players produced more winners with the smash x3 and powerful smash than female players, while female players produced more winners with the backhand, back wall forehand and slow smash. Additionally, male players committed more unforced errors with the powerful smash than female players, while female players committed more unforced errors with the slow smash.

Table 2. Winners, Forced Errors and Unforced Errors by Gender in Amateur and Professional Padel.

Effectiveness of the last shot	Men’s			Women’s		
	<i>n</i>	%	CSR	<i>n</i>	%	CSR
Amateur						
Winner	175	35.4a	3.2	109	25.6b	−3.2
Forced error	87	17.6a	−1.3	89	21.0a	1.3
Unforced error	232	47.0a	−1.9	227	53.4a	1.9
Professional						
Winner	217	41.5a	1.2	198	37.8a	−1.2
Forced error	136	26.0a	3.0	96	18.3b	−3.0
Unforced error	170	32.5a	−3.8	230	43.9b	3.8

Note. *n*: number; %: percentage; CSR: corrected standard residuals; CSR > 1.96: Bold; a, b: indicate significant differences in the Z tests for comparison of column proportions from $p < .05$ adjusted according to Bonferroni.

Table 3. Differences Between Men's and Women's Amateur Padel by Last Shot Type and Its Effectiveness.

Last shot type	Winner						Forced error						Unforced error					
	Men's			Women's			Men's			Women's			Men's			Women's		
	n	%	CSR	n	%	CSR	n	%	CSR	n	%	CSR	n	%	CSR	n	%	CSR
Forehand	11	6.3a	-1.4	12	11.0a	1.4	8	9.2a	-1.3	14	15.7a	1.3	28	12.1a	0.1	27	11.9a	-0.1
Backhand	5	2.9a	-2.3	10	9.2a	2.3	13	14.9a	0.1	13	14.6a	-0.1	34	14.7a	0.9	27	11.9a	-0.9
Side wall							4	4.6a	0.9	2	2.2a	-0.9	3	1.3a	-0.7	5	2.2a	0.7
Back wall forehand	2	1.1a	-2.2	6	5.5b	2.2	4	4.6a	-1.6	10	11.2a	1.6	16	6.9a	0.5	13	5.7a	-0.5
Back wall backhand	3	1.7a	-0.1	2	1.8a	0.1	6	6.9a	-0.8	9	10.1a	0.8	10	4.3a	1.0	6	2.6a	-1.0
Double wall	1	0.6a	0.8	0	0.0a	-0.8	10	11.5a	-0.4	12	13.5a	0.4	5	2.2a	0.3	4	1.8a	-0.3
Fence							0	0.0a	-1.7	3	3.4a	1.7	1	0.4a	-1.0	3	1.3a	1.0
Contrapared							10	11.5a	1.4	5	5.6a	-1.4	2	0.9a	0.0	2	0.9a	0.0
Forehand bajada	8	4.6a	-0.7	7	6.4a	0.7	1	1.1a	-0.6	2	2.2a	0.6	12	5.2a	-0.5	14	6.2a	0.5
Backhand bajada	1	0.6a	-0.3	1	0.9a	0.3							7	3.0a	1.2	3	1.3a	-1.2
Forehand volley	30	17.1a	1.6	11	10.1a	-1.6	15	17.2a	1.9	7	7.9a	-1.9	32	13.8a	-0.1	32	14.1a	0.1
Backhand volley	8	4.6a	-1.8	11	10.1a	1.8	7	8.0a	-0.2	8	9.0a	0.2	32	13.8a	0.6	27	11.9a	-0.6
Dropshot	5	2.9a	-0.4	4	3.7a	0.4							2	0.9a	0.0	2	0.9a	0.0
Slow smash	2	1.1a	-4.7	17	15.6b	4.7							4	1.7a	-4.2	26	11.5b	4.2
Bandeja	13	7.4a	0.0	8	7.3a	0.0							12	5.2a	-1.7	21	9.3a	1.7
Vibora	2	1.1a	1.1	0	0.0a	-1.1												
Smash X3	8	4.6a	2.3	0	0.0b	-2.3							0	0.0a	-1.0	1	0.4a	1.0
Smash X4	9	5.1a	1.9	1	0.9a	-1.9							26	11.2a	2.7	10	4.4b	-2.7
Powerful smash	56	32.0a	3.1	17	15.6b	-3.1	1	1.1a	1.0	0	0.0a	-1.0	0					
Fake smash	2	1.1a	1.1	0	0.0a	-1.1												
Recovery smash	7	4.0a	1.0	2	1.8a	-1.0	6	6.9a	0.7	4	4.5a	-0.7	4	1.7a	0.0	4	1.8a	0.0
Other	2	1.1a	1.1	0	0.0a	-1.1	2	2.3a	1.4	0	0.0a	-1.4	2	0.9a	1.4	0	0.0a	-1.4

Note. n: number; %: percentage; CSR: corrected standard residuals; CSR > 1.96: Bold; a, b: indicate significant differences in the Z tests for comparison of column proportions from $p < .05$ adjusted according to Bonferroni.

There was a significant relationship between the type of last shot and the player's gender when the last shot was a forced error ($X^2 = 31.052$; $df = 15$; $p = .009$; $V = 0.366$) in professional padel. However, there was no significant relationship between the type of last shot and the player's gender when the last shot was a winner ($X^2 = 16.609$; $df = 19$; $I = 0.616$; $V = 0.200$) and an unforced error ($X^2 = 21.553$; $df = 18$; $p = .252$; $V = 0.232$) in professional padel.

In [Table 4](#) it can be observed that, in professional padel, female players committed more forced errors with the forehand and double wall than male players. Additionally, male players committed more unforced errors with the contrapared and dropshot than female players. There was a relationship between the court zone and the player's gender when the last shot was an unforced error ($X^2 = 21.029$; $df = 6$; $p = .002$; $V = 0.214$) in amateur padel. However, there was no significant relationship between the court zone and the player's gender when the last shot was a winner ($X^2 = 5.201$; $df = 6$; $p = .518$; $V = 0.135$) and a forced error ($X^2 = 9.123$; $df = 6$; $p = .167$; $V = 0.228$) in amateur padel.

In amateur padel, women committed more forced errors in zone 1 and more unforced errors in zone 5 than men, while men committed more unforced errors in zones 2 and 3 than women ([Table 5](#)). There was a relationship between the court zone and the player's gender when the last shot was a winner ($X^2 = 22.374$; $df = 6$; $p = .001$; $V = 0.232$) in professional padel. However, there was no significant relationship between the zone and gender when the last shot was a forced error ($X^2 = 6.797$; $df = 6$; $p = .171$; $V = 0.340$) or an unforced error ($X^2 = 5.824$; $df = 6$; $p = .121$; $V = 0.443$) in professional padel.

In professional padel, male players performed more winners in zone 3 than female players, while female players performed more winners in zone 5 than male players ([Table 6](#)).

Discussion

Our aim in the present study was to analyze gender disparities in professional and amateur padel, specifically delving into the features of the last shot of each rally, examining its shot type, effectiveness, and the court region where it unfolded.

Last Shot Effectiveness

We initially hypothesized that in both amateur and professional level padel play, male players would produce more winners than female players, whereas the latter would commit more errors, regardless of error type. This hypothesis was partially accepted. Our findings suggested that, in amateur padel, male players produced more winners than female players. Likewise, in professional padel, male players committed more forced errors than female players, whereas the latter produced more unforced errors. Our findings partially align with previous research, since male professional padel players produced more winners and committed fewer errors (both forced and unforced), compared to female players ([Escudero-Tena et al., 2024](#); [Escudero-Tena, Muñoz, et al.,](#)

Table 4. Differences Between Professional Males and Females by Last Shot Type and Its Effectiveness.

Last shot type	Winners						Forced errors						Unforced errors					
	Men's			Women's			Men's			Women's			Men's			Women's		
	n	%	CSR	n	%	CSR	n	%	CSR	n	%	CSR	n	%	CSR	n	%	CSR
Forehand	5	2.3a	-1.0	8	4.0b	1.0	16	11.8a	-3.8	31	32.3b	3.8	15	8.8a	-0.4	23	10.0a	0.4
Backhand	2	0.9a	-0.9	4	2.0a	0.9	17	12.5a	0.2	11	11.5a	-0.2	21	12.4a	-0.7	34	14.8a	0.7
Side wall							3	2.2a	0.1	2	2.1a	-0.1	3	1.8a	0.4	3	1.3a	-0.4
Back wall forehand	0	0.0a	-1.0	1	0.5a	1.0	16	11.8a	1.4	6	6.3a	-1.4	8	4.7a	-0.2	12	5.2a	0.2
Back wall backhand	1	0.5a	1.0	0	0.0a	1.0	12	8.8a	1.7	3	3.1a	-1.7	5	2.9a	-0.7	10	4.3a	0.7
Double wall	1	0.5a	-0.1	1	0.5a	0.1	11	8.1a	-2.2	17	17.7b	2.2	11	6.5a	0.9	10	4.3a	-0.9
Fence							2	1.5a	-0.9	3	3.1a	0.9	3	1.8a	1.3	1	0.4a	-1.3
Contrapared	3	1.4a	0.9	1	0.5a	-0.9	10	7.4a	1.4	3	3.1a	-1.4	8	4.7a	2.1	3	1.3b	-2.1
Forehand bajada	8	3.7a	-0.2	8	4.0a	0.2	1	0.7a	0.8	0	0.0a	-0.8	11	6.5a	0.9	10	4.3a	-0.9
Backhand bajada	3	1.4a	-0.1	3	1.5a	0.1	1	0.7a	0.8	0	0.0a	-0.8	2	1.2a	-0.1	3	1.3a	0.1
Forehand volley	26	12.0a	0.4	21	10.6a	-0.4	16	11.8a	1.7	5	5.2a	-1.7	22	12.9a	-1.0	38	16.5a	1.0
Backhand volley	14	6.5a	-1.4	20	10.1a	1.4	23	16.9a	0.9	12	12.5a	-0.9	30	17.6a	0.9	33	14.3a	-0.9
Dropshot	9	4.1a	0.6	6	3.0a	-0.6	2	1.5a	1.2	0	0.0a	-1.2	5	2.9a	2.0	1	0.4a	-2.0
Slow smash	15	6.9a	-0.1	14	7.1a	0.1	2	1.5a	1.2	0	0.0a	-1.2	6	3.5a	-0.8	12	5.2a	0.8
Bandeja	5	2.3a	-1.7	11	5.6a	1.7							12	7.1a	-1.7	28	12.2a	1.7
Vibora	3	1.4a	-0.5	44	2.0a	0.5							3	1.8a	0.8	2	0.9a	-0.8
Smash X3	18	8.3a	0.1	16	8.1a	-0.1							1	0.6a	1.2	0	0.0a	-1.2
Smash X4	11	5.1a	1.0	6	3.0a	-1.0							3	1.8a	-0.8	7	3.0a	0.8
Powerful smash	71	32.7a	0.5	60	30.3a	-0.5												
Fake smash	5	2.3a	-1.0	8	4.0a	1.0												
Recovery smash	14	6.5a	1.9	5	2.5a	-1.9	2	1.5a	0.3	1	1.0a	-0.3	1	0.6a	1.2	0	0.0a	-1.2
Other	3	1.4a	0.9	1	0.5a	-0.9	2	1.5a	-0.4	2	2.1a	0.4						

Note. n: number; %: percentage; CSR: corrected standard residuals; CSR > 1.96: Bold; a, b: indicate significant differences in the Z tests for comparison of column proportions from $p < .05$ adjusted according to Bonferroni.

Table 5. Differences Between Amateur Men's and Women's Last Shots by Zone and Their Effectiveness Shot in Amateur Padel.

Zone	Winners						Forced errors						Unforced errors					
	Men's			Women's			Men's			Women's			Men's			Women's		
	n	%	CSR	n	%	CSR	n	%	CSR	n	%	CSR	n	%	CSR	n	%	CSR
1	16	9.1a	0.3	9	8.3a	-0.3	4	4.6a	-2.1	12	13.5b	2.1	17	7.3a	-1.5	26	11.5a	1.5
2	43	24.6a	0.3	25	22.9a	-0.3	19	21.8a	0.3	18	20.2a	-0.3	47	20.3a	2.3	28	12.3b	-2.3
3	40	22.9a	0.5	22	20.2a	-0.5	25	28.7a	1.0	20	22.5a	-1.0	68	29.3a	2.7	42	18.5b	-2.7
4	40	22.9a	-0.7	29	26.6a	0.7	23	26.4a	0.4	21	23.6a	-0.4	43	18.5a	-1.2	52	22.9a	1.2
5	16	9.1a	-1.7	17	15.6a	1.7	6	6.9a	-1.2	11	12.4a	1.2	27	11.6a	-2.9	49	21.6b	2.9
6	15	8.6a	1.0	6	5.5a	-1.0	7	8.0a	0.0	7	7.9a	0.0	30	12.9a	0.0	29	12.8a	0.0
Out court	5	2.9a	1.1	1	0.9a	-1.1	3	3.4a	1.8	0	0.0a	-1.8	0	0.0a	-1.0	1	0.4a	1.0

Note. n: number; %: percentage; CSR: corrected standard residuals; CSR > 1.96: Bold; a, b: indicate significant differences in the Z tests for comparison of column proportions from $p < .05$ adjusted according to Bonferroni.

Table 6. Differences Between Professional Men's and Women's Last Shots by Zone and Their Effectiveness.

Zone	Winners						Forced errors						Unforced errors					
	Men's			Women's			Men's			Women's			Men's			Women's		
	n	%	CSR	n	%	CSR	n	%	CSR	n	%	CSR	n	%	CSR	n	%	CSR
1	25	11.5a	0.0	23	11.6a	0.0	9	6.6a	1.8	13	13.5a	-1.8	18	10.6a	-1.1	33	14.3a	1.1
2	43	19.8a	-0.8	46	23.2a	0.8	24	17.6a	0.4	15	15.6a	-0.4	32	18.8a	-0.3	46	20.0a	0.3
3	66	30.4a	2.8	37	18.7b	-2.8	38	27.9a	1.0	21	21.9a	-1.0	43	25.3a	0.3	55	23.9a	-0.3
4	47	21.7a	0.8	37	18.7a	-0.8	36	26.5a	0.4	23	24.0a	-0.4	31	18.2a	-1.0	51	22.2a	1.0
5	7	3.2a	-4.1	29	14.6b	4.1	13	9.6a	0.6	7	7.3a	-0.6	22	12.9a	1.7	18	7.8a	-1.7
6	17	7.8a	-0.1	16	8.1a	0.1	15	11.0a	-1.5	17	17.7a	1.5	23	13.5a	1.0	24	10.4a	-1.0
Out court	12	5.5a	0.2	10	5.1a	-0.2							1	0.6a	-0.7	3	1.3a	0.7

Note. n: number; %: percentage; CSR: corrected standard residuals; CSR > 1.96: Bold; a, b: indicate significant differences in the Z tests for comparison of column proportions from $p < .05$ adjusted according to Bonferroni.

2022; Sánchez-Alcaraz et al., 2020). This could be because the style of play varied according to the players' gender. Professional men seemed to play a more aggressive game, winning more points through winners, and, at the amateur level, through forced error generators, so that amateur men committed more forced errors than women when trying to return very complicated balls. Conversely, women developed a more conservative game, waiting for the opposing pair to commit an unforced error.

Last Shot Type and Effectiveness

Additionally, we hypothesized that, in both amateur and professional padel play, male players would produce more winners with no-bounce shots compared to female players, whereas female players would commit more errors (both forced and unforced) with any kind of shot. This hypothesis was partially accepted. In amateur padel, to the best of our knowledge, last shot type has not been previously studied. Our results indicated that men produced more winners with the powerful smash than women, although they also committed more unforced errors. On the other hand, women made more winners with the slow smash, although they also committed more unforced errors. This may stem from the fact that, in men's padel, more powerful smashes are executed, while, in women's padel, more slow smashes are executed, probably due to the differences in the anthropometric and strength characteristics of padel players according to their sex. Male padel players are taller, with higher muscle percentages and higher levels of vertical jump and grip strength than female padel players (Muñoz, Toto-Roman, Vergara et al., 2022; Pradas et al., 2021; 2022). This allows them to perform more powerful smashes. Men should train for the powerful smash and women should train for the slow smash, in order to increase winners and decrease unforced errors. In addition, these results indicated that men performed more winners with the smash x3 than women. This coincides with the results presented in the study by Escudero-Tena, Parraca, et al. (2023) carried out on finishing technical-tactical actions in professional padel. Similarly, in amateur padel, women produced more winners with the back wall forehand, and backhand, than men. Previous research carried out on professional padel indicated that women made more winners than men, with shots such as the backhand and, in general, with shots following a bounce, with or without wall rebound (Escudero-Tena et al., 2024; Sánchez-Alcaraz et al., 2022). Furthermore, our results also indicated that, in professional padel, women made more forced errors with the forehand, and double wall, than men. Therefore, it seems that both in amateur and professional level women are better padel defenders than men to such an extent that female players produced more winners than men from the baseline and committed more forced errors than men trying to return even the most difficult rival shots. Additionally, in professional padel, men committed more unforced errors with the contrapared and the dropshot than women. This could be because male players executed these shots with a higher frequency than female players. And, when trying to execute them, men may have tried to be very precise. In general, players use the contrapared as an emergency shot, since the ball tends to come out high and with a spin that favours an offensive smash, which has been shown to be the technical-tactical action with which men achieve most of

their winners (Conde-Ripoll, Martín-Miguel et al., 2024; Mellado Arbelo et al., 2019). Thus, as men have been shown to make more winners through the smash than women (Escudero-Tena et al., 2024), men must make a contrapared that is very deep, sometimes causing the error of the ball hitting the opponent's back wall.

Last Shot Effectiveness and Court Zone

Finally, we hypothesized that male players would produce more winners from areas close to the net compared to female players, whereas errors would be produced in similar areas by both men and women. This hypothesis was partially accepted. To the best of our knowledge, no prior study has analyzed the last shot effectiveness and court zone employed in amateur padel. Thus, our results study is new and should be of considerable interest. Firstly, women made more forced errors than men from zone 1. This can be attributed to the fact that when women got an easy ball, they tended to unload their shots towards the right side of the opponent's back court. In addition, women made more unforced errors from zone 5. This means that women should train their strokes from this left corner of the back court and play balls with more margin for error. Others have found that most errors in professional padel are committed from the back of the court (Escudero-Tena, Gómez-Ruano, et al., 2023). Finally, men made more unforced errors than women from zones 2 and 4, that is, from the right and center areas close to the net. Therefore, men should make better decisions from these zones and distinguish between balls requiring a more conservative stroke and balls allowing them to be more aggressive and try to finish the point with a winner. It is in the areas closer to the net that most winners are made in professional padel (Courel-Ibáñez et al., 2017; Escudero-Tena, Gómez-Ruano, et al., 2023).

On the other hand, in professional padel, men made more winners from zone 4 than women, that is, from the central area near the net; and women made more winners than men from zone 5, that is, from the left baseline corner. This is not surprising, since men made more winners than women with shots such as the smash, recovery smash or backhand volley (shots that usually occur in areas close to the net) while women made more winners than men with shots such as the forehand, backhand, forehand bajada or backhand bajada (shots that usually occur in areas at the back of the court) (Escudero-Tena et al., 2024; Sánchez-Alcaraz et al., 2022). Thus, it seems that while men were more aggressive and effective in areas close to the net, women were better defenders in areas at the back of the court. Therefore, we recommend that men train their defensive skills, thereby spending more time on specific tasks where they are positioned in back court areas. For their part, women should train offensively, performing training tasks where they are located in areas close to the net.

Limitations and Directions for Further Research

Despite the novel and useful findings reported here, for use by researchers, coaches and padel players, some limitations must be considered. Firstly, there is a scarcity of prior scientific literature to help interpret our findings on amateur padel. Likewise, there are

few prior studies related to the padel zones or hitting areas. Furthermore, although this data sample was collected by padel specialists, data regarding the hitting zone might ideally have been collected through specialized software such as kinovea, which would have made the recording even more accurate. Future investigators should replicate our findings using such software and increasing the sample diversity to include the junior category.

Conclusions

In this study, we showed that the type of technical-tactical action in last shots in both professional and amateur padel, their effectiveness, and the area of the court where they are performed are related to the sex of the players (men's and women's). Thus, coaches must adjust their training to the gender and level of play of their players and must design specific training tasks. Specifically, in amateur padel, men performed more winners than women; and, in professional padel, men committed more forced errors than women, whereas the latter committed more unforced errors. Concerning the shot type, in amateur padel, men made more winners with the smash ×3 and the powerful smash than women, while women made more winners with the slow smash, back wall forehand and backhand than men. In addition, men committed more unforced errors with the powerful smash than women, and women committed more unforced errors with the slow smash than women. On the other hand, in professional padel, women committed more forced errors with the double wall, and forehand than men. While men committed more unforced errors with the contrapared, and the dropshot than women.

Finally, regarding the hitting zone in amateur padel, women committed more forced errors than men from zone 1, and also committed more unforced errors from zone 5. For their part, men committed more unforced errors than women from zones 2 and 4. In professional padel, men made more winners from zone 4 than women, and women produced more winners than men from zone 5.

Declaration of Conflicting Interests

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Ethical Statement

Ethical Approval

The research protocol was approved in advance by University of Extremadura Ethics Committee (154/2020).

Informed Consent

As we were observing public play that was intended to be observed, no informed participant consent was necessary.

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References

- Anguera, M. T., & Hernández-Mendo, A. (2016). Avances en estudios observacionales de Ciencias del Deporte desde los mixed methods. *Cuadernos de Psicología del Deporte*, 16(1), 17–30.
- Conde-Ripoll, R., Martín-Miguel, I., Muñoz, D., & Escudero-Tena, A. (2024). Performance dynamics in professional padel: Winners, forced errors, and unforced errors among men and women players. *International Journal of Performance Analysis in Sport*, 1–17. <https://doi.org/10.1080/24748668.2024.2397197>
- Conde-Ripoll, R., Muñoz, D., Escudero-Tena, A., & Courel-Ibáñez, J. (2024). Sequential mapping of game patterns in men and women professional padel players. *International Journal of Sports Physiology and Performance*, 19(5), 454–462. <https://doi.org/10.1123/ijssp.2023-0484>
- Conde-Ripoll, R., Muñoz, D., Sánchez-Alcaraz, B. J., & Escudero-Tena, A. (2024). Analysis and prediction of unforced errors in men's and women's professional padel. *Biology of Sport*, 41(4), 3–9. <https://doi.org/10.5114/biolSport.2024.134763>
- Courel-Ibáñez, J., Sánchez-Alcaraz Martínez, B. J., & Cañas, J. (2017). Game performance and length of rally in professional padel players. *Journal of Human Kinetics*, 55(1), 161–169. <https://doi.org/10.1515/hukin-2016-0045>
- Courel-Ibáñez, J., Sánchez-Alcaraz Martínez, B. J., & Muñoz Marín, D. (2019). Exploring game dynamics in padel: Implications for assessment and training. *The Journal of Strength & Conditioning Research*, 33(7), 1971–1977. <https://doi.org/10.1519/jsc.0000000000002126>
- Crewson, P. (2006). *Applied statistics handbook* (Vol. 1, pp. 103–123). AcaStat Software.
- Díaz-García, J., Grijota-Pérez, F. J., Robles-Gil, M. C., Maynar, M., & Muñoz, D. (2017). Estudio de la carga interna en pádel amateur mediante la frecuencia cardíaca. *Apunts. Educación Física y Deportes*, 1(127), 75–81. <https://doi.org/10.5672/apunts.2014-0983.es>
- Escudero-Tena, A., Almonacid, B., Martínez, J., Martínez-Gallego, R., Sánchez-Alcaraz, B. J., & Muñoz, D. (2024). Analysis of finishing actions in men's and women's professional padel. *International Journal of Sports Science & Coaching*, 19(3), 1384–1389. <https://doi.org/10.1177/17479541221139970>
- Escudero-Tena, A., Gómez-Ruano, M. A., Ibáñez, S. J., Sánchez-Alcaraz, B. J., & Muñoz, D. (2023). Importance of maintaining net position in men's and women's professional padel.

- Perceptual and Motor Skills*, 130(5), 2210–2225. <https://doi.org/10.1177/00315125231194026>
- Escudero-Tena, A., Mancha-Triguero, D., Pozo-Ayerbe, C., & Ibáñez, S. J. (2022). Diferencias entre pádel profesional masculino y femenino en función del rendimiento según el set, la ronda y el tipo de torneo. *Padel Scientific Journal*, 1(1), 23–37. <https://doi.org/10.17398/2952-2218.1.23>
- Escudero-Tena, A., Muñoz, D., Sánchez-Alcaráz, B. J., Coronado, M., & Robles-Gil, M. C. (2023). Análisis de las características de las palas utilizadas por jugadores de pádel amateur masculino. *E-balonmano com*, 19(3), 209–218. <https://doi.org/10.17398/1885-7019.19.209>
- Escudero-Tena, A., Muñoz, D., Sánchez-Alcaraz, B. J., García-Rubio, J., & Ibáñez, S. J. (2022). Analysis of errors and winners in men's and women's professional padel. *Applied Sciences*, 12(16), 8125. <https://doi.org/10.3390/app12168125>
- Escudero-Tena, A., Parraca, J. A., Sánchez-Alcaraz, B. J., Muñoz, D., Sánchez-Pay, A., García-Rubio, J., & Ibáñez, S. J. (2023). Análisis de los remates finalistas en pádel profesional. *E-balonmano com*, 19(2), 117–126. <https://doi.org/10.17398/1885-7019.19.117>
- Fernandez-de-Osso, A., Pecci, J., Sánchez-Trigo, H., Muñoz, D., Escudero-Tena, A., & León, J. (2023). Differences between genders and competitive levels on technical-tactical parameters in padel: Implications for training. *International Journal of Sports Science & Coaching*, 19(3), 1349–1356. <https://doi.org/10.1177/17479541231211667>
- Fernandez-de-Osso, A. I. (2019). *Diseño de una herramienta de análisis de indicadores de rendimiento técnico-táctico en pádel: análisis y comparación en diferentes niveles de juego y sexo* (Doctoral dissertation). Universidad Pablo de Olavide.
- Field, A. (2018). *Discovering statistics using IBM SPSS statistics* (5th ed.): Sage Publications Ltd.
- Harriss, D. J., Macsween, A., & Atkinson, G. (2019). Ethical standards in sport and exercise science research: 2020 update. *International Journal of Sports Medicine*, 40(13), 813–817. <https://doi.org/10.1055/a-1015-3123>
- Igartua, J. J. P. (2006). *Métodos cuantitativos de investigación en comunicación*. Bosh.
- Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33(1), 159–174.
- Lupo, C., Condello, G., Courel-Ibáñez, J., Gallo, C., Conte, D., & Tessitore, A. (2018). Efecto del género y del resultado final del partido en competiciones profesionales de pádel. [Effect of gender and match outcome on professional padel competition]. *RICYDE. Revista Internacional de Ciencias del Deporte*, 14(51), 29–41. <https://doi.org/10.5232/ricyde2018.05103>
- Martín-Miguel, I., Escudero-Tena, A., Muñoz, D., & Sánchez-Alcaraz, B. J. (2023). Performance analysis in padel: A systematic review. *Journal of Human Kinetics*, 6(89), 213–230. <https://doi.org/10.5114/jhk/168640>
- Mellado Arbelo, Ó., Baiget Vidal, E., & Vivès Usón, M. (2019). Analysis of game actions in professional male padel. *Cultura Ciencia Deporte*, 14(42), 191–202. <https://doi.org/10.12800/ccd.v14i42.1332>

- Muñoz, D., Coronado, M., Robles-Gil, M. C., Martín, M., & Escudero-Tena, A. (2022). Incidence of upper body injuries in amateur padel players. *International Journal of Environmental Research and Public Health*, 19(24), Article 16858. <https://doi.org/10.3390/ijerph192416858>
- Muñoz, D., Toro-Román, V., Courel-Ibáñez, J., Sánchez-Pay, A., & Sánchez-Alcaraz, B. J. (2022). La altura como factor de rendimiento en pádel profesional: Diferencias entre géneros. *Acciónmotriz*, 29, 93–103.
- Muñoz, D., Toro-Román, V., Vergara, I., Romero, A., Fernández de Ossó Fuente, A. I., & Sánchez-Alcaraz, B. J. (2022). Análisis del punto de oro y su relación con el rendimiento en jugadores profesionales de pádel masculino y femenino (Analysis of the gold point and its relationship with performance in male and female professional padel players). *Retos*, 45, 275–281. <https://doi.org/10.47197/retos.v45i0.92388>
- Pradas, F., Sánchez-Pay, A., Muñoz, D., & Sánchez-Alcaraz, B. J. (2021). Gender differences in physical fitness characteristics in professional padel players. *International Journal of Environmental Research and Public Health*, 18(11), 5967. <https://doi.org/10.3390/ijerph18115967>
- Pradas, F., Toro-Román, V., Ortega-Zayas, M. Á., Montoya-Suárez, D. M., Sánchez-Alcaraz, B. J., & Muñoz, D. (2022). Physical fitness and upper limb asymmetry in young padel players: Differences between genders and categories. *International Journal of Environmental Research and Public Health*, 19(11), 6461. <https://doi.org/10.3390/ijerph19116461>
- Priego, J. I., Olaso Melis, J., Llana Belloch, S., Pérez Soriano, P., González García, J. C., & Sanchís Almenara, M. (2013). Padel: A quantitative study of the shots and movements in the high-performance. *Journal of Human Sport and Exercise*, 8(4), 925–931. <https://doi.org/10.4100/jhse.2013.84.04>
- Ramón-Llin, J., Guzmán, J., Llana, S., James, N., & Vučković, G. (2017). Analysis of padel rally characteristics for three competitive levels. *Kinesiology Slovenica*, 23(3), 39–49.
- Ramón-Llin, J., Guzmán, J., Llana, S., Vuckovic, G., Muñoz, D., & Sánchez-Alcaraz, B. J. (2021). Análisis de la distancia recorrida en pádel en función del nivel de juego y el número de puntos por partido. *Retos*, 39, 205–209.
- Sánchez-Alcaraz, B., Jiménez, V., Muñoz, D., & Ramón-Llin, J. (2021). Diferencias en los parámetros de carga externa entre el pádel masculino y femenino profesional. *Journal of Sport & Health Research*, 13(3), 445–454.
- Ramón-Llin, J., Llana, S., Guzmán, J., Vuckovic, G., Muñoz, D., & Sánchez-Alcaraz, B. J. (2020). Análisis de la distancia recorrida en pádel en función de los diferentes roles estratégicos y el nivel de juego de los jugadores. *Acción Motriz*, 25, 59–67.
- Sánchez-Alcaraz, B. J., Cánovas, J., Sánchez-Pay, A., & Muñoz, D. (2023). Investigación en pádel. Revisión sistemática. [Research on padel. A systematic review]. *Padel Scientific Journal*, 1(1), 71–105. <https://doi.org/10.17398/2952-2218.1.71>
- Sánchez-Alcaraz, B. J., Courel-Ibáñez, J., Muñoz, D., Infantes-Córdoba, P., de Zumarán, F. S., & Sánchez-Pay, A. (2020). Análisis de las acciones de ataque en el pádel masculino profesional. *Apunts. Educación Física y Deportes*, 4(142), 29–34. <https://doi.org/10.5672/apunts.2014-0983.es>

- Sánchez-Alcaraz, B. J., Muñoz, D., Escudero-Tena, A., Martín-Miguel, I., & García, J. M. (2022). Análisis de las zonas de golpeo en pádel profesional. *Revista Kronos*, 21(2), 1–9.
- Sánchez-Alcaraz, B. J., Siquier-Coll, J., Toro-Román, V., Sánchez-Pay, A., & Muñoz, D. (2021). Análisis de los parámetros relacionados con el marcador en el circuito world padel tour 2019: diferencias por género, ronda y tipo de torneo. *Retos*, 39, 200–204. <https://doi.org/10.47197/retos.v0i39.78402>
- Thomas, J. R., Martin, P. E., Etnier, J. L., & Silverman, S. J. (2023). Research methods in physical activity (8th Edition). Human Kinetics.

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