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Padel Scientific Journal es una revista científica editada por la Universidad de Extremadura, de carácter exclusivamente electrónico, que publica artículos científicos relacionados principalmente con el deporte del pádel, y otros deportes de raqueta.

El objetivo fundamental es difundir y divulgar conocimientos e investigaciones de calidad sobre las Ciencias de la Actividad Física y del Deporte aplicadas al pádel y demás deportes de raqueta. Los artículos podrán ser publicados en idioma español y/o inglés. Tendrá una periodicidad semestral (enero-junio, junio-diciembre).

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SERVE ANALYSIS IN U-18 PADEL PLAYERS: AN OBSERVATIONAL STUDY

ANÁLISIS DEL SAQUE EN JUGADORES DE PÁDEL SUB-18: UN ESTUDIO OBSERVACIONAL

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ABSTRACT

Padel has become one of the most practiced sports in Spain. Within this sport, the serve represents 10% of the actions in a match. Many studies have been done on professional players, but research involving young players is low. This study aims to analyze the effectiveness of the serve in U-18 padel players. To this end, a sample of 918 points were analyzed through observational analysis from matches corresponding to the 2024 Under-18 Master Final. The results showed that, in serve direction, 2 out of 3 serves choose glass direction, showing a predominance over other serves. Additionally, sex differences were observed: female players perform 7% more serves toward the glass wall, while boys serve 4% more at the center, and allow 21.1% more rebounds on the side wall compared to male players. It was also detected that winning pairs tend to serve approximately 6% more toward the T zone, a strategy that seems to make returns more difficult for opponents. Finally, it was confirmed that the percentage of points won on serve decreases as the rally duration increases, with this decrease being more pronounced in women than in men. These results highlight the importance of the serve in the competitive performance of youth padel players and suggest the need to design specific training sessions, differentiated by sex and by playing characteristics, to optimize the strategic use of the serve.

Keywords: tactics, strokes, direction, racket sport, U-18.

RESUMEN

El pádel se ha convertido en uno de los deportes más practicados en España. Dentro de este deporte, el saque representa el 10% de las acciones de un partido. Se han realizado numerosos estudios en jugadores profesionales, pero la investigación con jugadores jóvenes es escasa. Este estudio tiene como objetivo analizar la eficacia del saque en jugadores de pádel de categoría sub-18. Para ello, se analizó una muestra de 918 puntos mediante análisis observacional en partidos correspondientes al Máster Final Sub-18 de 2024. Los resultados mostraron que, respecto a la dirección del saque, 2 de cada 3 saques se dirigen hacia el cristal, mostrando un predominio sobre el resto de las direcciones. Además, se observaron diferencias según el sexo: las jugadoras realizan un 7% más de saques hacia la pared de cristal, mientras que los chicos sacan un 4% más al centro y permiten un 21.1% más de rebotes en la pared lateral en comparación con las jugadoras. También se detectó que las parejas ganadoras tienden a sacar aproximadamente un 6% más hacia la zona de la "T", una estrategia que parece dificultar el resto de los oponentes. Finalmente, se confirmó que el porcentaje de puntos ganados con el saque disminuye a medida que aumenta la duración del punto (rally), siendo esta disminución más pronunciada en mujeres que en hombres. Estos resultados

destacan la importancia del saque en el rendimiento competitivo de los jugadores de pádel juveniles y sugieren la necesidad de diseñar sesiones de entrenamiento específicas, diferenciadas por sexo y por características de juego, para optimizar el uso estratégico del saque.

Palabras clave: táctica, golpeos, dirección, deportes de raqueta, Sub-18.

Introduction

Padel is a racket sport played in pairs (2 vs. 2), practiced on a 20 x 10 m court, with a central net, surrounded by glass and electro-welded mesh, allowing the ball to stay in play. This sport has increased in popularity around the world due to its social nature, being played in more than 60 countries, which is characterized by having a wide variety of shots and longer rallies than tennis, thus allowing many people to play it and making it attractive. As a result, federation licenses have increased considerably, reaching 101,326 licenses (Martín-Miguel, Moreno-Holguera, et al., 2025). Due to the increase in players and the growing popularity of padel, the number of scientific studies has increased in recent years, covering different areas such as performance analysis, psychology, methodology, biomechanics, management, etc. (Sánchez-Alcaraz, Cánovas Martínez et al., 2022).

Performance analysis is the most studied area in padel (Sánchez-Alcaraz, Cánovas Martínez, et al., 2022) because of the high potential of transfer in matches. In padel, being near the net as much as possible is crucial, making the serve one of the most important shots. The serve is about 10% of the total number of shots made in a padel match, giving the player the opportunity to take advantage of the point (Sánchez-Alcaraz, Conde et al., 2022), so the tactical involvement in winning points takes on utmost importance. The result of studies observed that, as the number of hits increase during the point, the percentage of points won by the serving pair decreased, with 12 hits being the point where server's advantage disappears in men, and 7 hits in women (Sánchez-Alcaraz et al., 2020). However, the serves win by the serving pair declines throughout the match, reaching its lowest point in the second and third sets (Ramón-Llin et al., 2021), due to multiple causes such as fatigue, the pressure to overcome the match, or having to maintain the lead on the scoreboard (Ramón-Llin et al., 2021).

On the one hand, there has been an increase in the number of young padel players (under 18 years of age), being 12.5% of federation licenses in Spain (Martín-Miguel, Muñoz et al., 2025). Some studies have observed match

dynamics in youth padel, showing that players finishing points from a dominant net position were more likely to hit a winner, whereas those finishing from a non-dominant position tended to commit errors (Escudero-Tena et al., 2025). These patterns reveal the importance of technical and tactical actions at the beginning of the point, making the server or receiver to start with advantage. Regarding the return in high-level U-18 padel, an effective return after serve can decisively influence the development of the point (Cerrillo-Lafuente et al., 2025).

On the other hand, recent studies show that most studies focus on adult players (Martín-Miguel, Escudero-Tena et al., 2025; Martín-Miguel et al., 2023). Due to the lack of studies focusing on young players, the purpose of this study was to analyze the effectiveness of the serve in junior padel.

Material and methods

Research Design

The research methodology is quantitative and involves a descriptive study using an arbitrary code of naturalistic observation (Montero & León, 2007). Furthermore, this work was empirical, nomothetic, longitudinal, and multidimensional (Anguera et al., 2018).

Sample

The sample contained 918 points corresponding to six matches (four semifinals and two finals for men and women) from the 2024 U-18 Masters Final tournament held in the city of Mérida. The matches were played by 16 players: the four best male pairs and the four best female pairs in Spain's under-18 category, according to the junior ranking published on the registration closing date. All variables related to the serve were recorded in both the men's matches ($n = 452$) and the women's matches ($n = 466$).

Variables

- Sex: Classified as male or female.
- Match result: A distinction was made between the winning pair and the losing pair in the match.

- Serving side: A distinction was made between serving on the right side and serving on the left side.
- Serve effectiveness: A distinction was made between first serve and second serve.
- Serve direction: The service square was divided into three equal parts: the T zone, the center zone, and the glass zone.
- Depth of serve: A distinction was made between whether the player returning the serve allowed the ball to touch the side glass, back glass, or did not touch the glass at all.
- Nº of strokes: The strokes made at each point were counted. Strokes were divided into: 1-4 shots, 5-8 shots, 9-12 shots, 13-16 shots and 17-20 shots.

Procedure

The matches analyzed are broadcast live on YouTube and saved on the official channel of the Spanish Padel Federation, where the observation *and data* recording took place. The data was recorded using Excel, where an ad hoc observation sheet was designed to analyze the variables under study: sex, match result, serve side, serve effectiveness, serve direction, serve depth, and number of strokes. The data were analyzed through systematic observation, carried out by two observers with a degree in Sports Science and specialized in pádel, specifically trained for this task. At the end of the training process, each observer analyzed the same match with the aim of calculating inter-observer reliability through the *Multirater Kappa Free* (Randolph, 2005), obtaining values above .90. To ensure data consistency, the intra-observer reliability was analyzed at the end of the observation process, obtaining minimum values of .90. Following Altman (1990), the kappa values obtained allowed consideration of the degree of agreement as very high (>.80).

Data analysis

First, descriptive analysis of the data obtained was performed, and the frequency (n) and percentage (%) of the total sample were calculated. A comparison of serve statistics based on sex and match outcome was performed using Pearson's chi-square test, with subsequent Z-tests comparing column proportions with Bonferroni significance adjustment. The strength of

association between the variables was also calculated using Cramer's V coefficient (V_c) (Field, 2018). Crewson (2006) established the strength of association based on value, considering an association to be small (0.100), low (0.100–0.299), moderate (0.300–0.499), or high (>0.500). A significant level of $p < 0.05$ was established. All data were analyzed using the IBM SPSS 20.0 statistical package for Macintosh (Armonk, NY: IBM Corp.).

Results

Table 1 shows the descriptive statistics for the variables related to serving. As can be seen, players serve approximately 5% more from the right side than from the left. On the other hand, regarding serve effectiveness, junior players play with 85.6% first serves. In terms of serve direction, 2 out of 3 serves go to the glass, while approximately 20% go to the T zone and approximately 10% go to the center. Finally, regarding the depth of the serve, almost 70% of serves do not touch the glass before being returned by the opposing pair, while almost 30% of serves touch the side wall and only 3% touch the back glass.

Table 1

Descriptive results of serve statistics

	Frequency	Percentage
Serve side		
Right	478	52.1
Left	439	47.9
Serve effectiveness		
First serve	785	85.6
Second serve	131	14.3
Serve direction		
T	185	20.3
Center	107	11.8
Glass	618	67.9
Depth of serve		
Touch the side glass	249	27.8
Touch the back glass	28	3.1
Not touch glass	613	68.5

Table 2 shows the differences in serve statistics between men's and women's padel. In this regard, no significant differences were found between sex for the serve side ($\chi^2 = .148$; $p = .700$; $V_c = .13$), nor in the serve efficiency ($\chi^2 = 1.436$; $p = .488$; $V_c = .40$). On the other hand, the direction of the serve showed significant differences between men's and women's padel ($\chi^2 = 5.253$; $p = .042$; $V_c = .76$). Finally, significant differences were also found in serve depth between males and female players ($\chi^2 = 61.069$; $p = .000$; $V_c = .261$).

Table 2

Comparison of serve statistics based on player sex

	Men		Women	
	Frequency	Percentage	Frequency	Percentage
Serve side				
Right	238 _a	52.8	240 _a	51.5
Left	213 _a	47.2	226 _a	48.5
Serve effectiveness				
First serve	389 _a	86.3	396 _a	85.0
Second serve	61 _a	13.5	70 _a	15.0
Serve direction				
T	95 _a	21.3	90 _a	19.4
Center	62 _a	13.9	45 _b	9.7
Glass	288 _a	64.7	330 _b	71.0
Depth of serve				
Touch the side glass	75 _a	17.1	174 _b	38.2
Touch the back glass	10 _a	2.3	18 _a	3.9
Not touch glass	354 _a	80.6	259 _b	56.8

Table 3 shows the differences in serve statistics between the winning pair and the losing pair in the match. No significant differences were found on the serve side ($\chi^2 = .080$; $p = .778$; $Vc = .009$), nor in the effectiveness of the serve ($\chi^2 = 1.091$; $p = .580$; $Vc = .034$), nor in the direction of the serve ($\chi^2 = 5.147$; $p = .076$; $Vc = .75$), nor in the depth of the serve ($\chi^2 = 3.472$; $p = .324$; $Vc = .062$) between winners and losers in the match.

Table 3.

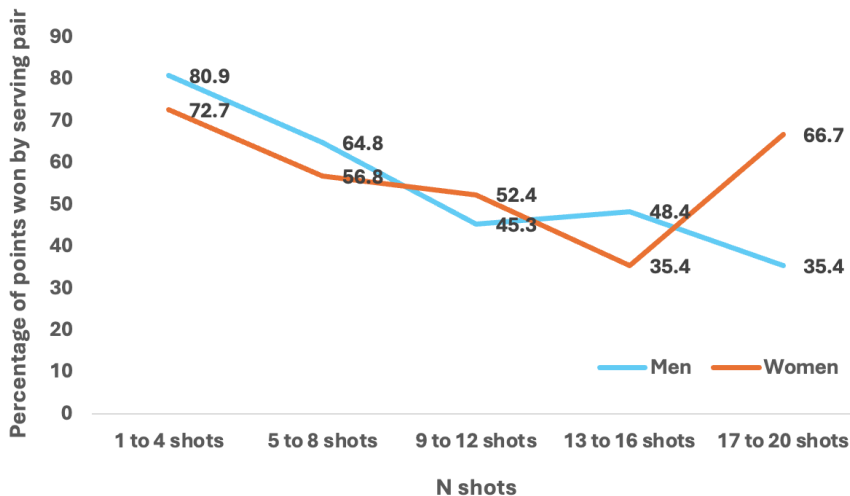
Comparison of serve statistics based on match outcome

	Winning pair		Losing pair	
	Frequency	Percentage	Frequency	Percentage
Serve side				
Right	244 _a	52.6	234 _a	51.7
Left	220 _a	47.4	219 _a	48.3
Serve effectiveness				
First serve	399 _a	86.0	386 _a	85.2
Second serve	65 _a	14.0	66 _a	14.6
Serve direction				
T	107 _a	23.2	78 _b	17.4
Center	49 _a	10.6	58 _a	12.9
Glass	306 _a	66.2	312 _a	69.6
Depth of serve				
Touch the side glass	114 _a	25.2	135 _a	30.5
Touch the back glass	16 _a	3.5	12 _a	2.7
Not touch glass	319 _a	70.6	294 _a	66.4

Figure 1 shows the percentage of points won on serve based on the length of the point in men's and women's padel.

Figure 1.

Percentage of points won on serve based on the length of the point in men's and women's padel



Discussion

The aim of this study was to analyze the effectiveness of the serve in junior padel. Being able to start the point with the first serve is important because it allows players to get advantage, increasing the chance of winning the game (Sánchez-Alcaraz, Conde-Ripoll, et al., 2022).

Regarding serve direction, 2 out of 3 serves choose glass direction, showing a predominance between other serves, similar to professional padel (Bueno García et al., 2024). Other studies have analyzed serve direction and have found that players mostly choose the glass direction because the effectiveness after hitting is lower (Conde-Ripoll et al., 2021), in addition to the fact that, tactically, the aim is to corner the back player in the corner (Bueno García et al., 2024).

Regarding depth of serve, 2 out of 3 serves don't touch glass and almost 1 of 3 serves touch the side glass. This may be due to the possible difficulty of letting the ball bounce off the glass, as well as a tactical intention to speed up the game and make the return faster that the server's volley is made without reaching the net completely.

When it comes to direction of serve between men and women, women players hit the glass approximately 7% more often than men, while men hit the center 4% more often. This seems to be alike professional padel due to the fact that, in men's padel, the side glass is the predominant direction when key points are scored, while in women's padel, it is the main direction when serving (Bueno García et al., 2024).

Regarding the depth of serve, it has been observed that in men's padel, 80% return the serve without touching the glass, compared to only 56.8% in women's padel. The speed of play is higher in men's professional padel, where the number of strokes per second is considerably greater (Muñoz, 2020), including the serve, which is why players tend to return serves without using the glass to reduce the time it takes to hit the ball. Tactically, this makes it more difficult for the serving pair, since the faster the serve, the faster they must move to reach the net to get a better position (Ramón-Llín et al., 2020). Girls, on the other hand, return the serve by hitting the ball against the side glass 38.2% of the time, compared to only 17.1% in men's padel. In women's professional padel, the lob return is the main shot after the serve (Bueno García et al., 2024), in addition to the fact that the speed of play is slower compared to men's padel (Muñoz, 2020), giving the serving pair more time to move up to the net, making the lob a better option for the return. These results show that U-18 padel players have similar patterns to professional players.

Regarding winner and loser pair, it can be seen that the pair that wins the match serves approximately 6% more to the T zone than the losing pair. In both cases the side wall is the predominant serving location for both pairs, then serving to this side causes the receiving pair to make a greater number of errors, due to the bounce of the ball and the presence of the glass itself (Lupo et al., 2018). However, Sánchez-Alcaraz et al. (2022) found that the T-serve causes the opposing player to move further away and creates free space in the double wall zone, which could lead to a second shot after the serve to this zone, creating a difficult situation for the opponent.

When it comes to winning points on serve, it has been observed that men win more points on serve than women in padel (Sánchez-Alcaraz et al., 2020). This can be seen in the graph almost throughout, with values consistently higher than in women's padel, except for 9 to 12 strokes, which may be due to the fact that in women's padel, during the game, the serving pair has already lost the net, either due to a lob or another action during the game. On the other hand, the graph shows that it starts with 1 to 4 hits with 80.9% in men's padel and 72.7% in women's padel, and as the number of strokes increases, the

percentage of points won by the winning pair decreases, except for 12 to 16 points in men's padel and 17 to 20 points in women's padel. Sánchez-Alcaraz et al. (2020) observed that the serve advantage was lost on the 12th shot in men and on the 7th shot in women. Unlike other racket sports such as tennis, where the advantage is lost after the 4th shot, this proves the difficulty of generating winning shots in padel, because even if a pair is dominating the rally, it requires more shots to win it compared to tennis (Ramón-Llin et al., 2019). Furthermore, other studies have shown that the percentage of points won by the serving pair declines throughout the match, reaching its lowest point between the second and third sets (Ramón-Llin et al., 2021), due to multiple causes such as fatigue, the pressure to overcome the match, or having to maintain the lead on the scoreboard (Ramón-Llin et al., 2021). This data seems to be similar to elite padel (Sánchez-Alcaraz et al., 2020).

The information obtained in this study provides us with certain values that may be useful in preparing for the start of a point through the serve. From a practical point of view, it would be interesting to train the following elements:

- Take the initiative with the serve in order to force the receiving pair into making an error or hitting a winning shot against the serving pair.
- Change the ball trajectory parameters: spin, speed, height, direction, and depth.
- Prioritize using the first serve to start the point over the second serve.
- Try to move the returner around to make them hit errors.
- Use the walls to make it difficult to return the ball.
- Prepare plays with your serve so that the return is predictable.
- Serve from different places within the service area so that the ball arrives at a different angle.

This study has some limitations that should be considered when interpreting the results. First, only 6 matches from the under-18 category were analyzed. The number of players used to take the sample should be higher to have more variability in the data and compare other categories such as under-16, under-14, or under-12. Furthermore, the laterality and maturational age of the server and receiver was not considered a variable that could influence the study's results. Also, the strategy followed by the servers (traditional serve or australian strategy) could affect the results. Finally, the sample was limited, so future studies should analyze a greater number and tournaments and padel players.

Conclusions

As this study has shown, the serve in padel is a key element in improving the performance of both professional and junior players, and we can highlight the following:

- Girls serve more times at the glass than boys, while boys serve more at the center.
- Men return serves more without it touching the glass than women.
- Girls return serves more by hitting the ball against the side glass than men.
- The winning pair hits more serves to the T zone than the losing pair.
- In men's padel, more points are won on serve than in women's padel.
- As the number of hits increases, the percentage of points won by the winning pair decreases.

Therefore, these findings suggest the need to design age and gender specific training programs in U-18 padel to optimize performance development from early stages.

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EFFECTS OF SCORELINE ON POINT- AND GAME-WINNING PROBABILITY IN PROFESSIONAL MEN'S PADEL

EFFECTOS DEL MARCADOR EN LA PROBABILIDAD DE GANAR PUNTOS Y JUEGOS EN EL PÁDEL PROFESIONAL MASCULINO

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ABSTRACT

The influence of scoreline on match outcome has been previously explored in padel, primarily focusing on differences between winning and losing pairs. However, limited evidence exists regarding how each point within the game contributes to the final outcome. Therefore, the aim of this study was to examine the probability of winning both the point and the game as a function of scoreline, as well as to identify game sequences and critical points associated with game outcome. An observational design was used to analyze 2,077 points from 17 professional men's matches on the 2023 Premier Padel circuit. Results revealed a general advantage for the serving pair, with point-winning probabilities exceeding 55% in most scenarios. This advantage was particularly evident in early disadvantage situations (0–30 = 69%; 0–40 = 66%) and at critical moments such as deuce (40–40 = 65%), with point success decreasing by approximately 3% with each additional shot ($\beta = -.031$; OR = .970; $p < .001$). Game-winning probability varied significantly depending on scoreline ($p < .001$; $V_c = .396$), increasing under advantageous conditions (30–0 = 89.80%; 40–15 = 93.91%; 40–0 = 98.73%, ASR = 5.61–5.67) and decreasing markedly under disadvantage (0–30 = 36.21%; 0–40 = 5.56%, ASR = -5.56–6.07). Intermediate scorelines emerged as key transitional moments, where the outcome of a single point led to substantial shifts in winning probability (e.g., from 15–15 = 67.92% to 15–30 = 48.11%; from 30–30 = 66.17% to 30–40 = 39.02%). The most critical situations were identified at deuce (40–40 = 100%) and during break points (30–40 = 65.31%; 15–40 = 45.45%). Furthermore, sequence analysis showed that winning the first two points markedly increases the likelihood of winning the game for both the serving pair (e.g., 15–0; 30–0; 40–0 or 15–0; 30–0; 30–15; 40–15, 27.7%, ASR = 3.12–4.74) and the returning pair (e.g., 0–15; 0–30; 15–30; 15–40 or 0–15; 0–30; 0–40, 15.54%, ASR = 3.92–5.09). In conclusion, scoreline plays a decisive role in padel performance, as not all points contribute equally to the final outcome.

Keywords: racket sports, match analysis, critical moments.

RESUMEN

La influencia del marcador sobre el resultado final ha sido previamente analizada en pádel, centrándose principalmente en las diferencias entre parejas ganadoras y perdedoras. Sin embargo, existe evidencia limitada sobre cómo cada punto dentro del juego contribuye al desenlace final. Por ello, el objetivo de este estudio fue analizar la probabilidad de ganar tanto el punto como el juego en función del marcador, así como identificar las secuencias de juego y los puntos críticos asociados al resultado. Se empleó un diseño observacional para analizar 2,077 puntos correspondientes a 17 partidos masculinos profesionales del circuito Premier Padel 2023. Los resultados mostraron una ventaja general de la pareja al

saque, con probabilidades de ganar el punto superiores al 55% en la mayoría de las situaciones. Esta ventaja fue especialmente evidente en contextos de desventaja inicial (0–30 = 69%; 0–40 = 66%) y en momentos críticos como el iguales (40–40 = 65%). Además, la probabilidad de ganar el punto disminuyó aproximadamente un 3% por cada golpe adicional ($\beta = -.031$; OR = .970; $p < .001$). La probabilidad de ganar el juego varió significativamente en función del marcador ($p < .001$; $V_c = .396$), incrementándose en situaciones favorables (30–0 = 89.80%; 40–15 = 93.91%; 40–0 = 98.73%; ASR = 5.61–5.67) y disminuyendo notablemente en condiciones de desventaja (0–30 = 36.21%; 0–40 = 5.56%; ASR = –5.56–6.07). Los marcadores intermedios emergieron como momentos de transición clave, donde el resultado de un solo punto producía cambios sustanciales en la probabilidad de victoria (por ejemplo, de 15–15 = 67.92% a 15–30 = 48.11%, o de 30–30 = 66.17% a 30–40 = 39.02%). Los contextos más críticos se identificaron en iguales (40–40 = 100%) y en situaciones de punto de break (30–40 = 65.31%; 15–40 = 45.45%). Asimismo, el análisis de secuencias indicó que ganar los dos primeros puntos del juego incrementa notablemente la probabilidad de victoria, tanto para la pareja al saque (por ejemplo, 15–0; 30–0; 40–0 o 15–0; 30–0; 30–15; 40–15, 27.7%; ASR = 3.12–4.74) como para la pareja al resto (por ejemplo, 0–15; 0–30; 15–30; 15–40 o 0–15; 0–30; 0–40, 15.54%; ASR = 3.92–5.09). En conclusión, el marcador desempeña un papel determinante en el rendimiento en pádel, ya que no todos los puntos contribuyen de igual manera al resultado final del juego.

Palabras clave: deportes de raqueta; análisis del rendimiento; momentos críticos.

Introduction

Padel has experienced a marked increase in participation in recent years (Martín-Miguel et al., 2025), largely driven by its social nature and the cognitive, emotional, and well-being benefits associated with regular practice (Pérez-Muñoz et al., 2024; Rodríguez-Cayetano et al., 2023). This growth has contributed to a progressive professionalization of the sport and, consequently, to a rise in scientific research focused on performance analysis and game-related factors (Gutiérrez-Plaza et al., 2025; Martín-Miguel et al., 2023). Nevertheless, existing literature has predominantly examined technical–tactical or temporal aspects of play, with comparatively limited attention given to the specific influence of score-related variables on performance (García-Giménez et al., 2022).

Scoreline represents a potentially critical determinant of performance, as different scoreline situations impose varying levels of psychological pressure

that may affect attentional processes, self-efficacy, and emotional regulation (Hufton et al., 2026; Koehn & Morris, 2012). In other racket sports such as tennis, scoreline-related differences have been linked to variations in performance indicators, including service aces, serve velocity, and stroke effectiveness (Katić et al., 2011), as well as to changes in shot selection and directional patterns (Zhao et al., 2025). In this context, scoreline has been identified as a key factor shaping match dynamics, as favorable situations tend to increase the likelihood of success (Wang et al., 2024), while simultaneously influencing decision-making and tactical behavior according to competitive context (i.e., leading vs. trailing) (Shangguan & Zha, 2025). Therefore, scoreline conditions appear to play a relevant role in determining player performance.

In padel, previous studies have approached scoreline primarily from a global match-performance perspective. Findings indicate that winning pairs tend to exhibit higher percentages of break points converted, greater success in decisive points, and a higher frequency of effective offensive actions such as winners and finishing shots (Martín-Miguel, Muñoz, Escudero-Tena, et al., 2024). Moreover, successful pairs demonstrate greater efficiency in offensive play, including higher success rates in winners executed through smashes, groundstrokes, and volleys (Escudero-Tena et al., 2021), as well as a greater presence in offensive court positions, particularly when executing cross-court volleys and smashes (Ramón-Llín et al., 2020). Differences have also been reported in game patterns and physiological demands, with losing players generally showing higher physical loads (Conde-Ripoll, Jamotte, et al., 2025). However, these studies typically consider performance at the match level, without providing a detailed examination of how specific score situations influence point-by-point performance within the game.

From this perspective, a gap remains in the literature regarding the analysis of score from a microstructural standpoint, which would allow for a more precise understanding of how each point outcome influences the probability of winning the game. This approach is particularly relevant, as certain moments within the game may represent critical points that ultimately shape the final outcome. Accordingly, the aim of the present study was to examine the probability of winning both the point and the game as a function of scoreline, as well as to identify game sequences and critical points associated with game outcome. It was hypothesized that specific scoreline situations exert a decisive influence on game results, leading to performance differences between the serving and returning pair.

Materials and Methods

Research Design

This study adopted a descriptive, observational, cross-sectional design to investigate playing patterns in elite men's padel competition. A quantitative, non-experimental approach was implemented through the retrospective analysis of previously recorded matches, without any form of researcher intervention in the natural competitive environment. Match actions were systematically observed and coded according to predefined criteria, and subsequently examined using inferential statistical procedures (Ato et al., 2013).

Sample

A total of 2,077 points obtained from 17 professional men's padel matches (40 sets) were included in the analysis. Matches corresponded to the quarterfinal, semifinal, and final stages of eight tournaments from the 2023 Premier Padel circuit.

An a priori sample size calculation was conducted using G*Power 3.1 software. Given that the main analyses involved categorical variables, chi-square tests of independence were planned. Assuming a medium effect size ($w = .25$), an alpha level of .05, statistical power ($1 - \beta$) of .80, and a maximum of 49 degrees of freedom (derived from 50 mutually exclusive sequence categories; $df = k - 1$), the minimum required sample size was estimated at 333 points. The final dataset ($n = 2,077$ points) clearly exceeded this requirement, ensuring sufficient statistical power and reducing the risk of type II error.

All matches were recorded between January and December 2023. The sample involved 12 different players (age: 25.32 ± 5.21 years; height: 178.69 ± 6.01 cm), all with experience at the professional level. Only rallies in which both the beginning and the end of the point were clearly visible were included in the analysis. All matches were played with golden point.

The study adhered to the principles of the Declaration of Helsinki (World Medical Association, 2013) and received approval from the corresponding institutional Ethics Committee (Ref. 166//2023). As all data were derived from publicly available sources, no personal or sensitive information was processed.

Variables

All variables were defined according to their categorical nature and level of openness (Anguera & Hernández-Mendo, 2015).

- **Scoreline.** The point score within each game was recorded, including the standard values (0, 15, 30, and 40) and all possible scoreline combinations (e.g., 0–15, 30–30). Additionally, the full progression of the game score was considered (e.g., 0–15; 15–15; 30–15; 40–15 or 0–15; 0–30; 0–40).
- **Grouped scoreline.** Scoreline was further categorized into three conditions: (i) disadvantage, when the server was trailing (e.g., 15–30, 15–40); (ii) neutral, when no clear dominance was established (e.g., 15–15, 30–30); and (iii) advantage, when the server held a clear lead (e.g., 30–15, 40–0).
- **Serve direction.** Serve placement was classified into three categories: T, lateral glass, and body, following previous methodological approaches in the literature (Martín-Miguel et al., 2026; Martín-Miguel, Sánchez-Alcaraz, et al., 2024).
- **Number of strokes.** The total number of strokes per point was recorded separately for the left-side and right-side players, allowing for a more detailed characterization of rally structure.
- **Winning pair.** The outcome of both the point and the game was coded by distinguishing whether the serving pair or the returning pair achieved victory.

Procedures

Data were collected through systematic observation of professional men's padel matches from the 2023 Premier Padel season. All matches were broadcast live and are publicly available on Red Bull TV (<https://www.redbull.com/us-en/event-series/premier-padel>).

Observational coding was conducted using LINC software (Soto-Fernández et al., 2022). Analysis was performed by an observer with formal training in padel and specific instruction on the operational definitions of the study variables. A prior familiarization phase ensured consistent application of coding criteria and reduced observer-related bias.

Data quality was ensured through intra- and inter-observer reliability assessments. Intra-observer reliability was evaluated by reanalyzing a randomly selected subsample of 311 points (≈10–20% of the total sample) after a sufficient interval to minimize recall bias (Schwesig et al., 2020). Inter-observer reliability was assessed by having the same subsample independently coded by a second observer holding a PhD in Sport Sciences, with extensive experience in performance analysis and research. Reliability coefficients exceeded .90 across all variables, indicating high consistency in the observational data (Altman, 1990). Table 1 presents the intra- and inter-observer reliability coefficients (Cohen’s κ) for all coded variables.

Table 1.

Cohen’s Kappa coefficient (κ) for each of the study variables.

Cohen’s K		
Study Variables	Intra-Obersserver	Inter-Obersserver
Game score	1.00	1.00
Grouped game score	1.00	1.00
Serve direction	.97	.98
Number of strokes	.96	.95
Winning pair	1.00	1.00
Total	.98	.98

Statistical Analysis

Descriptive statistics are reported as mean $\pm$ standard deviation. Associations between categorical variables were examined using contingency tables and the chi-square (χ^2) test. Adjusted standardized residuals (ASR) identified cells with observed frequencies significantly deviating from expected values; ASR > |1.96| indicated meaningful differences (Field, 2018).

Association strength was quantified using Cramer's V (V_c) (Field, 2018), with effect sizes classified as trivial ($< .10$), small ($.10-.29$), moderate ($.30-.49$), or large ($> .50$) (Crewson, 2006).

Point criticality was calculated as the absolute difference between the probability of winning the game after winning the point and the probability of winning the game after losing the same point ($\text{Criticality} = |P(\text{win game} | \text{win point}) - P(\text{win game} | \text{lose point})|$). Points were classified into low, moderate, and high criticality using a priori thresholds based on the magnitude of this probability difference (< 20 , $20-40$, and > 40 , respectively), to ensure consistent interpretation and avoid data-driven bias.

A binary logistic regression assessed the contribution of selected predictors to point-winning probability. The dependent variable was point outcome (1 = win; 0 = loss), and independent variables included grouped game score, serve direction, and strokes per point. Model fit was evaluated using the likelihood ratio test ($\Delta\chi^2$) and pseudo- R^2 indices (Nagelkerke, Cox & Snell). Predictive performance was assessed via classification accuracy and area under the receiver operating characteristic curve (AUC). Regression coefficients were expressed as beta values (β) and odds ratios (OR), with corresponding significance levels (p). Multicollinearity was examined using the variance inflation factor (VIF), with values < 5 considered acceptable. Although logistic regression enables simultaneous evaluation of predictors, causal inferences are not justified due to the observational cross-sectional design (Hosmer et al., 2013). The significance level was set at $p < .05$. Analyses were performed using JASP (version .19).

Results

The probability of winning the point on serve varied according to game score (Table 2), ranging from .53 (30–0) to .69 (0–30). Overall, the server exhibited probabilities above 55% in most situations. Notably, higher values were observed both in early disadvantage scenarios (0–30 = .69; 0–40 = .66) and in critical deuce situations (40–40 = .65). In contrast, intermediate scorelines such as 15–30 (.54) and 30–0 (.53) showed relatively lower success probabilities.

Table 2.

Probability of winning the point on serve as a function of game score

Game Score	Valid	Mean	Standard Deviation
0-0	364	.61	.48
0-15	142	.59	.49
0-30	58	.69	.46
0-40	18	.66	.48
15-0	222	.66	.47
15-15	159	.58	.49
15-30	106	.54	.50
15-40	60	.55	.50
30-0	147	.53	.50
30-15	161	.54	.50
30-30	133	.62	.48
30-40	82	.59	.49
40-0	79	.63	.48
40-15	115	.60	.49
40-30	129	.58	.49
40-40	102	.65	.47

The logistic regression model (Table 3), was statistically significant ($\Delta\chi^2 = 41.14$; $p < .001$), although it demonstrated limited explanatory power (Nagelkerke $R^2 = .027$). The dependent variable was coded as point outcome for the returning pair (1 = point won; 0 = point lost), and score categories were dummy-coded using disadvantage as the reference. The number of shots emerged as a significant predictor ($\beta = -.031$; OR = .970; $p < .001$), indicating an approximate 3% decrease in the probability of winning the point for each additional shot.

For scoreline variables, only the advantage condition was significant ($\beta = -.321$; OR = .726; $p = .045$), whereas disadvantage and neutral conditions were not ($p > .05$). Given the coding of the dependent variable, this negative coefficient indicates that, compared to disadvantage, advantage situations reduce the probability of the returning pair winning the point, implying a higher likelihood of success for the serving pair. Serve direction showed no significant effect ($p = .969$). The model achieved an overall classification accuracy of 60.1% and an AUC of .607.

Table 3.

Logistic regression model predicting point outcome

Variable	β (Estimate)	Standard Error	OR	z	p
Intercept	-11.81	324.74	—	-.036	.971
Serve direction (T)	12.74	324.74	—	.039	.969
Serve direction (Lateral glass)	12.76	324.74	—	.039	.969
Serve direction (Body)	12.67	324.74	—	.039	.969
Score (Disadvantage)	-.21	.179	.805	-1.210	.226
Score (Neutral)	-.13	.154	.877	-.848	.397
Score (Advantage)	-.32	.160	.726	-2.008	.045*
Number of shots	-.03	.005	.970	-5.759	< .001

The probability of winning the game according to the point score (Table 4), shows significant differences ($\chi^2 = 326.1$; $df = 15$; $p < .001$; $V_c = .396$), indicating a moderate association. The server's probability of winning the game increased progressively under advantageous conditions, reaching high values at 30–0 (89.80%), 40–15 (93.91%), and 40–0 (98.73%). Conversely, disadvantage situations showed a marked reduction, particularly at 0–30 (36.21%) and 0–40 (5.56%). Intermediate scorelines displayed more balanced probabilities, notably at 15–30 (48.11%) and 30–30 (66.17%). Break-point scenarios such as 15–40 (25.00%) and 30–40 (39.02%) were associated with a high likelihood of losing the game for the server.

Table 4.

Probability of winning the game as a function of point score.

Game Score	Game won by the server			Game won by the returner		
	N	%	ASR	N	%	ASR
0-0	261	71.70	.56	103	28.30	-.56
0-15	83	58.45	-3.26	59	41.55	3.26
0-30	21	36.21	-5.81	37	63.79	5.81
0-40	1	5.56	-6.07	17	94.44	6.07
15-0	178	80.18	3.35	44	19.82	-3.35
15-15	108	67.92	-.74	51	32.08	.74
15-30	51	48.11	-5.18	55	51.89	5.18
15-40	15	25.00	-7.84	45	75.00	7.84

30-0	132	89.80	5.32	15	10.20	-5.32
30-15	131	81.37	3.15	30	18.63	-3.15
30-30	88	66.17	-1.13	45	33.83	1.13
30-40	32	39.02	-6.37	50	60.98	6.37
40-0	78	98.73	5.61	1	1.27	-5.61
40-15	108	93.91	5.67	7	6.09	-5.67
40-30	110	85.27	3.80	19	14.73	-3.80
40-40	67	65.69	-1.09	35	34.31	1.09

The analysis of critical points indicated that point importance varied substantially with game score (Table 5), reflecting the impact of winning or losing a single point on the probability of winning the game. The highest values were observed at deuce (40–40), with a difference of 100%, as well as in break-point scenarios such as 30–40 (65.31%) and 15–40 (45.45%). Intermediate contexts, including 30–30 (51.54%) and moderate disadvantage situations such as 0–30 (44.44%) and 15–30 (34.62%), also showed elevated criticality. In contrast, extreme scorelines exhibited low variability, with minimal differences at 40–0 (3.45%) and 0–40 (8.33%).

Table 5.

Critical points in relation to scoreline and outcome probability.

Game score	Win point	Lose point	Difference	Criticality
0-0	80.18	58.45	21.73	Moderate
0-15	72.94	36.84	36.10	Moderate
0-30	50.00	5.56	44.44	High
0-40	8.33	0.00	8.33	Low
15-0	89.80	61.33	28.47	Moderate
15-15	82.80	46.97	35.83	Moderate
15-30	63.79	29.17	34.62	Moderate
15-40	45.45	0.00	45.45	High
30-0	98.73	79.41	19.32	Low
30-15	91.95	68.92	23.03	Moderate
30-30	85.54	34.00	51.54	High
30-40	65.31	0.00	65.31	High
40-0	100.00	96.55	3.45	Low
40-15	98.57	86.67	11.90	Low
40-30	100.00	64.81	35.19	Moderate
40-40	100.00	0.00	100.00	High

Finally, the analysis of scoring sequences revealed significant differences depending on the game winner ($\chi^2 = 262.7$; $df = 50$; $p < .001$; $V_c = .851$) (Table 6). Games won by the server were primarily characterized by linear and dominant progressions (e.g., 15-0; 30-0; 40-0 = 18.85%; ASR = 4.74), and with an initial lead (e.g., 15-0; 30-0; 30-15; 40-15 = 8.85%; ASR = 3.12). In contrast, games won by the returner were associated with initial server disadvantages (e.g., 0-15; 0-30; 15-30; 15-40 = 9.71%; ASR = 5.09) or descending score trajectories (e.g., 0-15; 0-30; 0-40 = 5.83%; ASR = 3.92). More balanced sequences, including deuce situations, were observed in both groups but occurred less frequently. Additionally, no significant differences were found based on whether the team won the first point of the game ($p > .05$; $V_c = .023-.029$).

Table 6.

Scoreline sequences according to game winner.

Server win			Returner win		
Game score	%	ASR	Game score	%	ASR
15-0; 30-0; 40-0	18.85	4.74	0-15; 0-30; 15-30; 15-40	9.71	5.09
15-0; 30-0; 30-15; 40-15	8.85	3.12	0-15; 15-15; 15-30; 15-40	6.80	4.24
15-0; 30-0; 40-0; 40-15	6.92	2.74	0-15; 0-30; 0-40; 15-40	5.83	3.92
0-15; 15-15; 30-15; 40-15	6.92	2.74	15-0; 15-15; 30-15; 30-30; 30-40	5.83	3.92
15-0; 30-0; 30-15; 30-30; 40-30	4.62	2.22	15-0; 15-15; 15-30; 15-40; 30-40	5.83	3.92
0-15; 15-15; 30-15; 30-30; 40-30	4.62	2.22	0-15; 0-30; 0-40	5.83	3.92
15-0; 15-15; 30-15; 40-15	3.85	1.44	15-0; 30-0; 30-15; 30-30; 30-40; 40-40	4.85	2.17
15-0; 30-0; 30-15; 40-15; 40-30	3.46	1.91	15-0; 15-15; 15-30; 30-30; 30-40	4.85	3.58
15-0; 15-15; 30-15; 40-15; 40-30	3.08	1.80	0-15; 0-30; 15-30; 30-30; 40-30; 40-40	3.88	.60
15-0; 30-0; 40-0; 40-15; 40-30	3.08	1.80	15-0; 30-0; 30-15; 30-30; 40-30; 40-40	3.88	1.37
0-15; 0-30; 15-30; 30-30; 40-30; 40-40	2.69	-.60	15-0; 15-15; 15-30; 15-40	3.88	3.20
0-15; 0-30; 15-30; 15-40; 30-40; 40-40	2.31	1.55	0-15; 15-15; 30-15; 40-15; 40-30; 40-40	2.91	1.18
0-15; 15-15; 15-30; 30-30; 40-30	2.31	1.55	0-15; 0-30; 0-40; 15-40; 30-40; 40-40	2.91	2.08
15-0; 15-15; 30-15; 30-30; 40-30	2.31	.83	15-0; 30-0; 30-15; 30-30; 30-40	2.91	2.76
0-15; 0-30; 15-30; 30-30; 40-30	1.92	1.42	0-15; 15-15; 15-30; 15-40; 30-40	2.91	2.76

0-15; 15-15; 30-15; 30-30; 40-30; 40-40	1.92	1.42	0-15; 0-30; 15-30; 30-30; 30-40	2.91	2.76
15-0; 15-15; 15-30; 30-30; 40-30	1.92	1.42	15-0; 30-0; 30-15; 40-15; 40-30; 40-40	1.94	.58
0-15; 15-15; 15-30; 30-30; 30-40; 40-40	1.92	-.01	15-0; 15-15; 15-30; 30-30; 30-40; 40-40	1.94	1.48
15-0; 15-15; 15-30; 15-40; 30-40; 40-40	1.54	.42	0-15; 15-15; 15-30; 30-30; 30-40; 40-40	1.94	.01
15-0; 30-0; 30-15; 30-30; 40-30; 40- 40	1.54	- 1.37	0-15; 15-15; 30-15; 30-30; 30-40	1.94	2.25
15-0; 15-15; 15-30; 30-30; 40-30; 40-40	1.54	.42	0-15; 15-15; 15-30; 30-30; 40-30; 40-40	1.94	1.48
0-15; 15-15; 15-30; 15-40; 30-40; 40-40	1.54	.42	0-15; 0-30; 15-30; 15-40; 30-40	1.94	2.25
0-15; 15-15; 30-15; 40-15; 40-30	1.54	1.27	0-15; 0-30; 0-40; 15-40; 30-40	1.94	2.25
15-0; 30-0; 30-15; 40-15; 40-30; 40- 40	1.15	-.58	15-0; 15-15; 15-30; 15-40; 30-40; 40-40	.97	-.42
0-15; 15-15; 30-15; 40-15; 40-30; 40-40	1.15	- 1.18	15-0; 30-0; 40-0; 40-15; 40-30; 40-40	.97	.19

Discussion

This study examined the probability of winning both the point and the game as a function of scoreline, and identified game sequences and critical points associated with game outcome. Results showed an overall server advantage, with point-winning probabilities exceeding 55% in most situations, particularly under early disadvantage (0–30 = 69%; 0–40 = 66%) and at critical moments such as deuce (40–40 = 65%). Point success declined by ~3% per additional shot, highlighting the influence of rally length. Accordingly, the server's probability of winning the game increased under advantageous conditions (30–0 = 89.80%; 40–15 = 93.91%; 40–0 = 98.73%) but dropped sharply under disadvantageous scorelines (0–30 = 36.21%; 0–40 = 5.56%). Additionally, intermediate scorelines emerged as key transitional moments, where losing a single point led to large shifts in game-winning probability, such as from 15–15 (67.92%) to 15–30 (48.11%) or from 30–15 (81.37%), and from 30–30 (66.17%) to 30–40 (39.02%), whereas winning the point generated advantageous contexts (e.g., 40–30 = 85.27%). Moreover, the most critical points were observed at deuce (40–40 = 100%) and in break-point situations such as 30–40 (65.31%) and 15–40 (45.45%), followed by intermediate

contexts including 30–30 (51.54%), 0–30 (44.44%), and 15–30 (34.62%). Finally, analysis of scoring sequences indicated that winning the first two points markedly increases the likelihood of winning the game for both the serving pair (e.g., 15–0; 30–0; 40–0 or 15–0; 30–0; 30–15; 40–15) and the returning pair (e.g., 0–15; 0–30; 15–30; 15–40 or 0–15; 0–30; 0–40).

The higher probability of winning the point when serving observed in this study is consistent with previous research in padel (Bueno-García et al., 2024; Martín-Miguel, Muñoz, Lupo, et al., 2024). This advantage has been attributed to several performance-related factors, including the relatively low frequency of extended net exchanges in men's padel (Escudero-Tena et al., 2024), the high effectiveness with the serve (Bueno-García et al., 2024), and the strong performance of the serving pair in offensive positions, particularly at the net (Conde-Ripoll, Martín-Miguel, et al., 2025). Together, these elements contribute to an initial tactical superiority that favors the serving pair in male padel players and may not be directly transferable to female competitions or other performance levels.

In addition, prior studies have suggested that longer rallies tend to reduce the advantage of the serving pair (Martín-Miguel et al., 2026). It has been proposed that, beyond the 11th stroke in professional men's padel, the initial benefit of the serve diminishes, increasing the chances of the returning pair to win the point (Martín-Miguel, Muñoz, Lupo, et al., 2024). The present findings provide further precision to this notion, indicating a progressive decline of approximately 3% in the probability of winning the point for each additional shot. This reinforces the idea that rally length is a key performance constraint, and highlights its practical relevance in shaping point outcomes.

Scoreline dynamics represent another key contribution of this study. Previous research in tennis has demonstrated that the probability of winning a game varies substantially depending on the scoreline. For example, situations such as 30–0 are associated with very high probabilities of success, whereas disadvantage scenarios such as 0–30 considerably reduce the likelihood of winning (Sim & Choi, 2020). A similar pattern was observed in the present padel data, suggesting that scoreline exerts a comparable influence across racket sports. From a theoretical perspective, these variations may be partially explained by psychological factors, as score-related pressure can influence players' emotional states, decision-making processes, and risk-taking behavior (Hill et al., 2010). Specifically, being ahead in the score may facilitate more controlled and confident play, whereas trailing situations may induce greater pressure and constrain performance execution. Nevertheless,

it should be noted that all matches were played under the golden point rule, which may amplify the importance of specific scoreline situations compared to traditional advantage scoring formats.

In line with these findings, the present results highlight that specific scoreline situations act as pivotal moments within the game. Beyond deuce (40–40), traditionally regarded as a decisive context (Martín-Miguel, Muñoz, Escudero-Tena, et al., 2024), intermediate scores such as 15–15 and 30–30 emerge as particularly influential. In these situations, the outcome of a single point can produce substantial shifts in the probability of winning the game, decreasing from ~66% to values between 39–48% if the point is lost, or increasing to approximately 81–85% if it is won. At 15–15, this scoreline represents the first meaningful divergence within the game structure. The result of this point determines whether the server moves into a clear advantage (30–15) or falls into a disadvantage scenario (15–30). This pattern underscores the importance of early-game equal score situations, where small performance differences begin to accumulate and shape subsequent tactical behavior and game control (Gutiérrez-Santiago et al., 2024; Klaassen & Magnus, 2001, 2003). Similarly, the 30–30 scoreline can be considered structurally critical, as it immediately precedes either a potential game point (40–30) or a break-point situation (30–40). From a tactical standpoint, this moment represents a decisive transition, in which a single rally can alter the balance of control between the serving and returning pair (Gutiérrez-Santiago et al., 2024; Klaassen & Magnus, 2001).

Finally, the analysis of scoring sequences provides further insight into game dynamics. The findings indicate that a positive start to the game plays a key role, as winning the first two consecutive points markedly increases the likelihood of securing the game. This pattern was consistent for both the serving pair (e.g., 15–0; 30–0; 40–0 or 15–0; 30–0; 30–15; 40–15) and the returning pair (e.g., 0–15; 0–30; 15–30; 15–40 or 0–15; 0–30; 0–40). Previous research has suggested that consecutive point success may generate momentum-related effects, often described as a “winning mood” (Klaassen & Magnus, 2001), which can enhance confidence and positively influence subsequent decision-making and execution. In this context, the present results reinforce the idea that early point sequences are not merely descriptive patterns, but may play a meaningful role in shaping game outcomes in padel.

Despite the relevance of the findings, several limitations should be considered. First, the current body of research in padel remains relatively limited, which constrains direct comparisons with previous studies. Similarly,

although some studies in other racket sports, particularly tennis, have examined the influence of score on performance, there is still a lack of research addressing how scoreline affects both point and game outcomes in a directly comparable manner. In addition, although the logistic regression model was statistically significant, its explanatory capacity was low, indicating that only a small proportion of the variance in point outcome was explained by the included variables. These results should therefore be interpreted cautiously, without overstating the model's predictive value. This limited explanatory power suggests that point outcome in padel is influenced by multiple contextual and performance-related factors not considered here. Variables such as player identity, ranking, court side, set context, match status, or specific tactical features of the rally may play a substantial role and should be included in future research to improve model accuracy and ecological validity. Finally, the analysis was conducted within a specific competitive setting (elite professional padel), which may restrict the external validity of the results. Performance dynamics, decision-making, and pressure responses may differ across skill levels, competitive formats, or populations. Future research should therefore incorporate larger and more diverse samples, as well as multiple competitive contexts, to validate and extend these findings.

Practical Applications

The present findings offer relevant practical implications for both coaches and players in competitive and training contexts. From a competitive perspective, understanding the influence of scoreline allows for more informed tactical decision-making, enabling players to adapt their behavior according to the importance and context of each point. In particular, critical situations such as 15–30, advantageous contexts such as 30–0, or structurally decisive moments like 30–30 may require differentiated tactical approaches to optimize performance.

From a training standpoint, these score-specific scenarios can be systematically replicated to enhance players' adaptation to high-pressure situations. Designing practice tasks that simulate critical scorelines may improve players' ability to manage game dynamics, make effective decisions, and respond more efficiently to the contextual demands imposed by the score during competition. However, coaches should consider that these applications are derived from professional men's padel played under the golden point format, and training designs may need adjustment for female players, youth categories, amateur levels, or competitions using traditional scoring rules.

Conclusions

The findings of this study indicate that scoreline is a key determinant in the development of the game, as not all points contribute equally to the final outcome. Although the serving pair generally holds an advantage in point-winning probability, the impact of each rally is strongly modulated by the score context.

In particular, intermediate scorelines such as 15–15 and 30–30, as well as break-point situations, emerge as critical moments that can substantially alter the likelihood of winning the game. These results suggest that performance in padel is not solely dependent on technical or tactical proficiency, but also on players' ability to interpret and strategically manage score-related situations throughout the game.

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INFLUENCIA DE LA PRESIÓN DE LA PELOTA EN LA CARGA EXTERNA DE JUGADORES DE PÁDEL CON DISCAPACIDAD INTELECTUAL

INFLUENCE OF BALL PRESSURE ON THE EXTERNAL LOAD OF PADEL PLAYERS WITH INTELLECTUAL DISABILITY

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RESUMEN

La manipulación del material deportivo es una estrategia común para adaptar las demandas del juego en deportes de raqueta. Sin embargo, existe una carencia de datos objetivos sobre cómo estas adaptaciones afectan la carga física en el pádel adaptado. El objetivo de este estudio fue analizar cómo la modificación de la presión de la pelota influye en la carga externa de jugadores de pádel con discapacidad intelectual (DI). Para ello, participaron 12 jugadores varones (25.6 ± 5.23 años) con DI. Se analizaron un total de 53 registros de 16 partidos disputados bajo dos condiciones experimentales: pelota de baja presión (punto verde) y pelota estándar. Se cuantificaron diversas variables de carga externa relativizadas por hora de juego mediante dispositivos de seguimiento electrónico Wimbu Pro™. El análisis estadístico se realizó en RStudio mediante la prueba de Kruskal-Wallis y el cálculo del tamaño del efecto (ϵ^2). No se hallaron diferencias estadísticamente significativas en ninguna de las variables de carga externa analizadas ($p > .05$). La Distancia Relativa (2076 ± 996 vs 1955 ± 573 m/h) y el Player Load Relativo (22.0 ± 5.43 vs 23.0 ± 5.79 u.a./h) se mantuvieron estables entre la condición de pelota verde y estándar, respectivamente. El tamaño del efecto fue nulo para todas las comparaciones ($\epsilon^2 < .01$). La carga externa en jugadores recreativos con DI no se ve alterada de forma significativa por el tipo de pelota utilizado. El uso de la pelota estándar se presenta como una opción adecuada que no incrementa las demandas físicas del juego, permitiendo a los técnicos seleccionar el material bajo criterios pedagógicos o técnicos sin riesgo de modificar la carga de trabajo de los deportistas.

Palabras clave: Pádel adaptado; deportistas con discapacidad intelectual, Sensores inerciales; Distancia recorrida; Aceleraciones; Equipamiento deportivo.

ABSTRACT

Modifying sports equipment is a common strategy for adapting the demands of the game in racket sports. However, there is a lack of objective data on how these adaptations affect the physical load in adapted padel. The goal of this study was to analyse how modifying the ball's pressure affects the external load on padel players with an intellectual disability (ID). Twelve male players (25.6 ± 5.23 years) with ID participated. A total of 53 records from 16 matches played under two experimental conditions were analysed: low-pressure ball (green dot) and standard ball. Various external load variables were quantified relative to playing time using Wimbu Pro™ electronic tracking devices. Statistical analysis was performed in RStudio using the Kruskal-Wallis test and the calculation of effect size (ϵ^2). Results: No statistically significant differences were found in any of the external load variables analysed ($p > .05$). Relative Distance (2076 ± 996 vs 1955

± 573 m/h) and Relative Player Load (22.0 ± 5.43 vs 23.0 ± 5.79 u.a./h) remained stable between the green ball and standard ball conditions, respectively. The effect size was null for all comparisons ($\epsilon^2 < .01$). The external load on recreational players with intellectual disabilities is not significantly affected by the type of ball used. The use of a standard ball is a suitable option that does not increase the physical demands of the game, allowing coaches to select equipment based on pedagogical or technical criteria without risking changes to the athletes' workload.

Keywords: Adapted padel; Players with intellectual disability; Inertial sensors; Distance covered; Accelerations; Sports equipment.

Introducción

Paralelamente a su crecimiento social, el pádel ha experimentado un aumento exponencial en la literatura científica en los últimos años, evidenciado por recientes revisiones sistemáticas que destacan el interés investigador en áreas como el rendimiento, la condición física y la salud (Sánchez-Alcaraz et al., 2022; Sánchez-Alcaraz y Courel-Ibáñez, 2022). Este auge investigador responde a la gran popularidad del deporte, la cual está motivada principalmente por los altos niveles de diversión, los vínculos de amistad y la satisfacción intrínseca que genera en sus practicantes (Rodríguez-Cayetano et al., 2023). De hecho, su enorme poder socializador ha propiciado su reciente inclusión como herramienta educativa, destacando sus beneficios fisiológicos y sociológicos en programas de actividad física de carácter formativo y escolar (Cachón-Zagalaz et al., 2023). Estos beneficios lúdicos, sociales y psicológicos resultan de especial interés cuando se adaptan a poblaciones con discapacidad intelectual, donde la motivación y el bienestar emocional son claves para la adherencia deportiva.

En personas con discapacidad, la práctica de actividad física estructurada se asocia con mejoras en la condición física, el bienestar psicológico y la integración social (Jacob et al., 2023). Según Hutzler y Korsensky (2010) tanto el ejercicio como las actividades deportivas parecen contribuir a la mejora de la forma física y el nivel de habilidad en esta población, mejorando su percepción de autoeficacia y competencia social. No obstante, las personas con discapacidad intelectual (DI), especialmente aquellas con Síndrome de Down, suelen presentar niveles de actividad física significativamente inferiores a los recomendados, condicionados por barreras estructurales y características fenotípicas como la hipotonía muscular y la laxitud ligamentosa (Muñoz-Jiménez et al., 2015; Oreskovic et al., 2020). Además, las personas con DI participan en actividades físicas (AF) con menos frecuencia que sus pares de desarrollo tí-

pico, lo que contribuye a un mayor riesgo de complicaciones de salud (Borland et al., 2020).

La literatura científica sugiere que el pádel adaptado puede inducir mejoras sustanciales en la conducta adaptativa y la competencia motriz de jugadores con DI, facilitando su integración social y autonomía personal (de la Vega et al., 2013; Silva-Ortiz et al., 2020). Sin embargo, para que estos beneficios sean efectivos y seguros, es imperativo que el diseño de las tareas y el equipamiento deportivo se ajusten a las capacidades físicas de los practicantes. La literatura sobre adaptaciones del material deportivo ha demostrado que el uso de pelotas de baja presión puede facilitar el aprendizaje técnico y aumentar la continuidad del juego en deportes de raqueta, como el tenis (Kilit et al., 2024; Piquer-Piquer et al., 2025). En pádel, el uso de pelotas de baja presión ha demostrado ser una estrategia eficaz para escalar el juego a las necesidades del usuario (Sánchez-Pay et al., 2020), siendo ya obligatorio el uso de la pelota de punto verde en las competiciones de la categoría II (Adaptada), establecidas en el reglamento de la Federación Española de Deportes con Discapacidad Intelectual (Normativa Técnica Pádel, s.f.).

Específicamente, respecto a la carga interna en etapas de iniciación, se ha observado que el empleo de pelotas de baja presión altera la dinámica del juego, reduciendo la respuesta fisiológica de los jugadores (frecuencia cardíaca media y máxima) sin comprometer la estructura temporal del partido (Sánchez-Pay et al., 2020). Si bien existen estudios que analizan las demandas cinemáticas en otras modalidades de pádel adaptado, como el pádel en silla de ruedas (Navas et al., 2020; Navas-Sanz et al., 2018), así como se analizan los niveles de actividad física general en niños y adolescentes con DI (Wouters et al., 2018); la evidencia sobre cómo la manipulación del material afecta la carga externa en jugadores con discapacidad intelectual es todavía escasa. Comprender esta relación es fundamental, ya que una carga externa mal gestionada puede derivar en fatiga prematura o falta de adherencia al ejercicio en esta población.

A pesar del auge del pádel adaptado en programas de integración social y deportiva para personas con discapacidad física e intelectual (Barbero-Montesinos y Barbero-Reyes, 2011), la cuantificación objetiva de la carga externa (distancia recorrida, aceleraciones, Player Load, desplazamientos específicos, etc) mediante tecnologías de monitorización (GPS/IMU/acelerometría) es prácticamente inexistente en esta población. De igual manera, aunque existen descripciones aplicadas de adaptaciones materiales (sillas específicas, palas ligeras, modificaciones reglamentarias), no se han identificado estudios experi-

mentales que analicen sistemáticamente el impacto de dichas modificaciones en jugadores con DI. Esta ausencia contrasta con la abundante literatura existente sobre carga externa en pádel convencional de alto rendimiento (Miralles et al., 2024) y carga externa en deportes paralímpicos de mayor tradición investigadora (Stieler et al., 2023), evidenciando un claro sesgo hacia poblaciones élite y disciplinas consolidadas que deja desatendidas las necesidades metodológicas de contextos recreativos, formativos e inclusivos.

Por ende, el objetivo de esta investigación es analizar cómo la modificación de la presión de la pelota influye en la carga externa de jugadores de pádel con discapacidad intelectual, utilizando tecnología de seguimiento de última generación para proporcionar datos objetivos que orienten la práctica profesional y el entrenamiento deportivo. En este contexto, la hipótesis principal de la presente investigación plantea que la modificación de la presión de la pelota no generará diferencias significativas en las variables de carga externa de los jugadores recreativos con DI, asumiendo que las exigencias del desplazamiento estarán más condicionadas por la capacidad motriz funcional de los participantes que por el tipo de material utilizado.

Material y métodos

Participantes

Los participantes de este estudio fueron 12 jugadores de pádel, todos ellos hombres, con una edad media de 25.6 ± 5.23 años. La muestra presentó una etiología diversa, incluyendo participantes con una o varias condiciones de discapacidad intelectual o trastornos del neurodesarrollo. La distribución de los diagnósticos fue la siguiente: retraso mental ligero o moderado ($n= 5$); Síndrome de Down ($n= 3$); discapacidad expresiva ($n= 2$); Síndrome de X Frágil ($n= 1$); Síndrome West ($n= 1$); Trastorno Espectro Autista ($n=1$). Se analizaron un total de 16 partidos, al mejor de 3 sets de 6 juegos, disputados en 4 días diferentes, con una duración media de 28 minutos ($\pm 11'$) cada partido.

Todos los jugadores son practicantes habituales de pádel, con 1 hora y 30 minutos de práctica por semana y una media de 7 años de experiencia en el pádel (± 2.77), a parte de otros deportes. Los jugadores compiten regularmente en la Categoría II (Adaptada) de pádel de la FEDDI (Normativa Técnica Pádel, s.f.). La elección de este nivel competitivo garantiza que los jugadores poseen un grado de autonomía funcional y competencia técnica homogéneas, ya que se juega con pelota de punto verde y solo se permite 1 bote.

Los jugadores participaron de forma voluntaria, proporcionando el consentimiento informado firmado por sus padres previamente al inicio del estudio, así como el certificado médico correspondiente que les autoriza a la práctica deportiva. Durante todo el procedimiento se siguieron los principios éticos de la Declaración de Helsinki, así como se obtuvo la aprobación del protocolo por parte del Comité de Ética de la Universidad de Valencia (2025-FIS-3843453).

Instrumentos

Para registrar la información sobre la carga de los jugadores se utilizaron EPTS (Electronic Performance and Tracking Systems). Concretamente, el dispositivo utilizado fue el Wimbu Pro™ (RealTrack Systems, Almería, España), un EPTS híbrido que integra tanto la tecnología del Sistema de Posicionamiento Local (LPS) en instalaciones interiores, como la del Sistema Global de Navegación por Satélite (GNSS) en instalaciones exteriores, además de sensores inerciales (IMU) (acelerómetros, giroscopios, magnetómetros, barómetros) en una sola unidad (Kim et al., 2023).

La evidencia respalda que los dispositivos EPTS y concretamente el Wimbu Pro™, es válido y fiable para la cuantificación objetiva y detallada de la carga física en tenistas y otros deportistas (Duffield et al., 2010; Hernández-Belmonte et al., 2019). Estudios demuestran que tanto la tecnología GPS (10 Hz) como la UWB (20 Hz) son válidas y fiables para el análisis de tiempo-movimiento en deportes de equipo como el fútbol (Bastida-Castillo et al., 2018). Especialmente los acelerómetros triaxiales (componentes de las IMUs) han sido validados por su excelente fiabilidad intra- e inter-dispositivo y muy alta fiabilidad en diversas localizaciones anatómicas, validando su uso para calcular variables de carga externa o los impactos (Gómez-Carmona et al., 2019).

En este estudio, todos los registros de datos se realizaron en pistas de pádel semi-cubiertas con lona, no obstante, se garantizó la calidad de la señal GNSS con una frecuencia de muestreo de 18 Hz, y de 1000 Hz para los sensores inerciales. Además, los registros reflejaron una media de número de satélites de 13.68 (*satcount*) y un valor de error de la señal (PDOP) menor de 1.5, en consonancia con valores similares en otros estudios (Castellano et al., 2011; Granero-Gil et al., 2021). Tras eliminar los registros inválidos por falta de calidad de la señal, finalmente 53 registros fueron incluidos en el análisis.

Procedimiento

Los dispositivos Wimbu Pro™ fueron calibrados sobre una superficie estable entre 30 y 15 minutos antes del inicio de los partidos, para garantizar la máxima precisión y conectividad GNSS. Antes de los partidos, los jugadores fueron instrumentados con las bandas de frecuencia cardíaca y los chalecos de seguimiento con el dispositivo Wimbu Pro™ activado. Después de un calentamiento en pista de 5 minutos, se iniciaban los partidos. Se utilizaron pelotas nuevas en cada uno de los grupos. Se registraron datos desde que iniciaron los partidos con el primer saque del jugador, hasta que finalizaba el partido. Después de los partidos, los datos se analizaron con el software SPro (versión 2.3.1) mediante el monitor Intervals Pro, adaptando los valores de velocidad a los jugadores.

Los partidos se disputaron durante las horas de entrenamiento de los jugadores, de tal forma que la toma de datos se realizó en 4 días diferentes. Con el objetivo de comparar diferencias con dos tipos de pelotas, los dos primeros días se disputaron partidos con la pelota de punto verde, y los dos últimos con la pelota estándar. De esta forma, todos los jugadores disputaron partidos en ambas condiciones.

Variables

Las variables seleccionadas para el análisis se corresponden con las principales variables de carga externa presentes en la literatura. Miralles et al. (2025) utiliza estas variables en su estudio comparativo de carga externa en jugadores de pádel profesionales, las cuales se definen en Interval Variables (s.f.) como:

- Distancia relativa (m/h): distancia total recorrida durante los partidos, normalizada por hora de juego.
- Explosividad Relativa (m/h): distancia total recorrida con una aceleración superior a 1,12 m/s² durante los partidos, normalizada por hora de duración de la sesión.
- HIBD Relativa (m/h): distancia de frenado de alta intensidad, es la distancia recorrida con una desaceleración superior a 2 m/s², normalizada por hora de duración de la sesión.
- Aceleraciones Relativas (n/h): número total de aceleraciones iguales o superiores a 1.12 m/s², normalizadas por hora de partido.

- Desaceleraciones Relativas (n/h): número total de desaceleraciones a -1.12 m/s^2 , normalizadas por hora.
- Player Load Relativo (u.a.): suma vectorial de las aceleraciones a lo largo de los tres ejes ortogonales (vertical, anteroposterior y lateral). Esta variable se utiliza para evaluar la carga neuromuscular en diferentes atletas y se calcula como la suma vectorial de las aceleraciones a lo largo de tres ejes (anteroposterior, lateral y vertical), incluyendo tanto las aceleraciones como las deceleraciones. Se analiza una medida acumulativa y una medida de intensidad, lo que ofrece información sobre la tasa de estrés ejercida sobre el cuerpo, normalizada por hora de duración de la sesión (u/h).
- Hig Acc Player Load Relativo (u.a.): valor de la carga del jugador a alta intensidad, cuando el valor del acelerómetro está por encima de un umbral establecido en 4G, normalizada por hora de duración de la sesión.
- Tiempos activos (cnt): número de veces en las que la intensidad FFT de la señal ACELT estuvo por encima del umbral de .02. Esta variable representa la acumulación de todos los periodos de trabajo.
- Recuperaciones (cnt): número de veces en las que la intensidad FFT de la señal ACELT estuvo en el umbral de 0,02 o por debajo de él. Esta variable representa la acumulación de todos los periodos de recuperación entre esfuerzos.

Análisis Estadístico

El tratamiento de los datos se realizó mediante el software estadístico RStudio (versión 2023.12.1). En primer lugar, se aplicó la prueba de normalidad de Shapiro-Wilk, la cual determinó que los datos no seguían una distribución normal. Por consiguiente, se empleó la prueba no paramétrica de Kruskal-Wallis para analizar las diferencias en la carga externa entre las dos condiciones experimentales (pelota de punto verde frente a pelota estándar).

Para determinar la magnitud de las diferencias, se calculó el tamaño del efecto mediante el coeficiente epsilon cuadrado (ϵ^2), interpretándose según los umbrales de Cohen: efecto pequeño ($.01 \leq \epsilon^2 \leq .08$), mediano ($.08 \leq \epsilon^2 \leq .26$) y grande ($\epsilon^2 \geq .26$) (Cohen, 1988). El nivel de significación estadística se estableció en $p < .05$.

Resultados

Los resultados del análisis comparativo entre el uso de la pelota de punto verde y la pelota estándar no mostraron diferencias estadísticamente significativas en ninguna de las variables de carga externa analizadas ($p > .05$).

Como se observa en la Tabla 1, las variables cinemáticas de volumen y de intensidad presentaron valores muy similares en ambas condiciones. La distancia relativa fue ligeramente superior con la pelota de punto verde (2076 ± 996 m/h) frente a la estándar (1955 ± 573 m/h), aunque sin alcanzar la significación estadística ($\chi^2 = .0160$; $p = .89$). De igual modo, la distancia explosiva relativa y el número de aceleraciones relativas mostraron valores casi idénticos en ambos grupos ($p = .871$).

Respecto a la carga neuromuscular, el player load relativo no varió significativamente ($\chi^2 = 0.3131$; $p = .576$), con valores de 22.0 ± 5.43 u.a./h para la pelota verde y 23.0 ± 5.79 u.a./h para la estándar. El análisis de los tiempos de juego reveló que tanto el tiempo activo ($p = .978$) como el tiempo de recuperación ($p = .626$) se mantuvieron estables independientemente del material utilizado. El tamaño del efecto para todas las comparaciones fue nulo o muy pequeño ($\epsilon^2 < .01$), lo que refuerza la similitud de las demandas físicas entre ambas pelotas.

Tabla 1.

Comparación de variables de carga externa según el tipo de pelota.

	Pelota verde	Pelota estándar	χ^2	p	ϵ^2
Distancia_Rel (m/h)	2076 $\pm$ 996	1955 $\pm$ 573	.0160	.899	.0003
Explosividad Relativa (m/h)	128 $\pm$ 124	104 $\pm$ 53.3	.0264	.871	.0005
HIBD_Rel (m/h)	32.0 $\pm$ 36.9	23.8 $\pm$ 17.5	.1577	.691	.0030
Aceleraciones Rel (n/h)	310 $\pm$ 153	324 $\pm$ 122	.0264	.871	.0005

Desaceleraciones Rel (n/h)	314 ± 150	330 ± 120	.0160	.899	.0003
Player Load Rel (u.a.)	22.0 ± 5.43	23.0 ± 5.79	.3131	.576	.0060
Hig Acc P.L. Rel (u.a.)	.860 ± .48	.957 ± .45	.5477	.459	.0105
Tiempo activo (cnt)	390 ± 192	398 ± 191	.0007	.978	.00001
Recuperación (cnt)	1578 ± 577	1555 ± 469	.2375	.626	.0045

Nota: Los datos se presentan como Media ± Desviación Estándar. χ^2 : Chi-cuadrado de Kruskal-Wallis; p: significación; ϵ^2 : tamaño del efecto.

Discusión

El objetivo de esta investigación fue analizar el impacto de la presión de la pelota en la carga externa de jugadores de pádel con discapacidad intelectual (DI). Los hallazgos principales indican que no existen diferencias estadísticamente significativas en ninguna de las variables cinemáticas o neuromusculares analizadas entre el uso de la pelota de baja presión (punto verde) y la pelota estándar.

La falta de diferencias observada puede explicarse a través de la capacidad funcional limitada de los participantes. En jugadores con discapacidad, la intensidad del desplazamiento no suele estar determinada por las propiedades elásticas del material, sino por las limitaciones intrínsecas del deportista. Según Oreskovic et al. (2020), los adultos con Síndrome de Down y otras discapacidades intelectuales suelen operar dentro de rangos de actividad física condicionados por su eficiencia mecánica y fuerza muscular. Esto sugiere que, aunque la pelota estándar ofrece un rebote más rápido, los jugadores no poseen la velocidad de reacción o la potencia de desplazamiento necesaria para aumentar su carga de trabajo, manteniéndose en un estado estable físico.

Nuestros resultados coinciden parcialmente con lo hallado por Sánchez-Pay et al. (2020) y Rodríguez-Campos et al. (2026) en jugadores de iniciación,

quienes reportaron que, si bien la pelota de baja presión facilita el éxito técnico, no altera drásticamente la estructura temporal del juego en niveles donde el volumen de golpeo es bajo. En esta línea, Kilit et al. (2024) demostraron en tenis que el cambio de pelota afecta más a la percepción del esfuerzo y a la técnica del golpeo que a la distancia total recorrida. En el caso de nuestros participantes, con una práctica semanal limitada, la experiencia técnica podría actuar como un factor limitante que impide aprovechar el mayor rebote de la pelota estándar para generar un juego más intenso, igualando así la carga con la pelota de punto verde.

Tal y como explican Sánchez-Alcaraz & Courel-Ibáñez (2022), las características intermitentes del pádel lo sitúan como una actividad muy favorable para la salud, especialmente en programas de pádel adaptado refleja un alto potencial para mejorar la condición física de este colectivo, respaldando estudios previos que evidencian mejoras tras intervenciones de entrenamiento inclusivo (Gallotta et al., 2024). Para garantizar el éxito y la seguridad de los jugadores con discapacidad, las adaptaciones del pádel adaptado, como el uso de la pelota verde o permitir hasta dos botes de la pelota en el suelo antes del golpeo en algunas categorías, facilitan la continuidad del juego y mitigan eficazmente las barreras impuestas por las limitaciones motrices y el déficit en el desarrollo motor grueso que frecuentemente experimentan, sin impactar sobre los beneficios cardiovasculares que aporta el pádel.

Desde una perspectiva clínica, la consistencia de los datos entre grupos es un hallazgo de gran relevancia. Los niveles de Player Load Relativo (22.0 vs 23.0 u.a.) indican que el cambio a una pelota no supone un incremento del riesgo de lesiones por sobrecarga neuromuscular. Esto es coherente con las recomendaciones de Silva-Ortiz et al. (2020), quienes enfatizan que la actividad física en personas con DI debe priorizar la continuidad y la seguridad. Que la carga externa no varíe permite a los entrenadores utilizar la pelota baja presión como un estímulo pedagógico para mejorar la percepción óculo-manual sin temor a exceder los límites de fatiga recomendados para esta población. En este sentido, los hallazgos de la presente investigación reafirman la necesidad de diseñar e implementar intervenciones deportivas atractivas y accesibles, como el pádel, para contrarrestar los riesgos asociados, como la obesidad, la hipotonía y las alteraciones cardiovasculares.

A pesar de los resultados positivos documentados, es indispensable interpretarlos bajo ciertas limitaciones metodológicas, tales como el tamaño de muestra reducido y la heterogeneidad clínica de los participantes quienes, aunque se encuentran en la misma categoría, presentan unas características

únicas, lo que dificulta la generalización estadística. Asimismo, es necesario señalar el diseño puramente secuencial, donde las condiciones experimentales no fueron aleatorizadas ni contrabalanceadas. La ausencia de un diseño cruzado aleatorizado podría llegar a influir en la interpretación de los datos debido a posibles efectos de aprendizaje, adaptación al medio o fatiga acumulada hacia los últimos días de registro, aunque este hecho se trató de evitar espaciando la toma de datos en un mes. Futuras investigaciones deberían enfocarse en aumentar la cantidad de participantes, incluso de otras categorías, realizar estudios longitudinales y ensayos controlados aleatorizados más robustos para establecer con mayor exactitud los efectos causales a largo plazo del pádel en esta población. Además, resultaría de gran valor científico profundizar en cómo las variables cinemáticas de carga externa pueden ser evaluadas y optimizadas específicamente para deportistas con discapacidad intelectual o motriz, permitiendo así una prescripción del entrenamiento de pádel mucho más precisa, individualizada y segura.

Conclusiones

El presente estudio demuestra que el empleo de pelotas con diferentes niveles de presión no altera de manera significativa la carga externa en jugadores de pádel con discapacidad intelectual. La ausencia de diferencias estadísticas y los tamaños del efecto nulos en todas las variables analizadas confirman que la demanda física, medida a través de la distancia relativa, las aceleraciones y el Player Load, se mantiene estable independientemente de si se utiliza una pelota de baja presión o estándar. Estos hallazgos sugieren que, en esta población específica con un volumen de práctica recreativo, la carga de trabajo podría estar más condicionada por la capacidad motriz y funcional intrínseca del deportista que por las propiedades elásticas del material deportivo.

Desde una perspectiva práctica, los resultados proporcionan evidencia científica sobre la seguridad clínica del uso de pelotas de baja presión en programas de pádel adaptado, al no observarse un incremento en el estrés físico o en los tiempos de recuperación en comparación con la pelota estándar. Por consiguiente, los técnicos y entrenadores pueden seleccionar el equipamiento basándose exclusivamente en objetivos pedagógicos, técnicos o perceptivos, con la garantía de que la integridad física y la fatiga del jugador no se verán comprometidas. Esta versatilidad en el uso del material facilita la transición hacia contextos competitivos reglamentarios y de mayor exigencia técnica, promoviendo la igualdad de oportunidades en la práctica deportiva sin nece-

sidad de modificar las intensidades de entrenamiento previamente establecidas.

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REASONS FOR TENNIS PRACTICE AMONG PLAYERS IN THE PROVINCE OF HUELVA: SEX AND AGE DIFFERENCES

MOTIVOS DE PRÁCTICA DEL TENIS EN JUGADORES DE LA PROVINCIA DE HUELVA: DIFERENCIAS SEGÚN SEXO Y EDAD

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ABSTRACT

The aim of this study was to analyze the motives for practicing tennis in the province of Huelva, examining differences according to sex and age. A total of 182 participants (161 men and 21 women) completed the Motives for Physical Activity Measure-Revised (MPAM-R). A non-experimental, cross-sectional, correlational design was applied. Mann-Whitney U and Kruskal-Wallis tests were used after checking the non-normal distribution of the data. Results showed that enjoyment was the most valued motive (men: 5.4; women: 5.8), whereas appearance was the least relevant (3.1 in both sexes). No significant differences were found according to sex, whereas differences across age groups were observed in enjoyment ($p = .010$) and competence ($p = .010$). These findings suggest that, in the sample analyzed, age may be more closely associated than sex with certain motivational dimensions of tennis practice.

Keywords: Motivation, racket sports, amateur, categories.

RESUMEN

El objetivo del presente estudio fue analizar los motivos de práctica del tenis en la provincia de Huelva, examinando las diferencias en función del sexo y la edad. Participaron 182 sujetos (161 hombres y 21 mujeres) que completaron la Escala de Motivos para la Actividad Física-Revisada (MPAM-R). Se realizó un diseño no experimental, transversal y correlacional. Se emplearon pruebas U de Mann-Whitney y Kruskal-Wallis tras comprobar el incumplimiento del supuesto de normalidad. Los resultados indicaron que el disfrute fue el motivo más valorado (hombres: 5.4; mujeres: 5.8), mientras que la apariencia fue el menos relevante (3.1 en ambos sexos). No se observaron diferencias significativas en función del sexo, mientras que sí se hallaron diferencias según la edad en disfrute ($p = .010$) y competencia ($p = .010$). Los hallazgos sugieren que, en la muestra analizada, la edad podría estar más asociada que el sexo a determinadas dimensiones motivacionales de la práctica del tenis.

Palabras clave: Motivación, deportes de raqueta, amateur, categorías.

Introduction

Tennis is a sport that has gained popularity worldwide due to its challenging nature and its ability to improve players' physical and mental health. In recent years, padel has experienced exponential growth in Spain, which has increased scientific interest in racket sports in recreational contexts. Within the field of racket sports, motivation towards sport participation has been related to intrinsic, social, and enjoyment-related factors. In padel players, Rodríguez-Cayetano et al. (2023) observed that the most highly valued motive for participation was friendship/peer group, whereas social status was the least relevant factor. Likewise, the authors noted that players' intrinsic satisfaction was mainly linked to motivation and enjoyment of sport participation. These findings reinforce the importance of analyzing motives for participation in racket sports from a perspective that considers both recreational and social components. Even so, in provinces such as Huelva, participation in this sport remains limited. This may be explained by low participation and the limited availability of facilities. According to the Federación Andaluza de Tenis (n.d.), the province has the lowest number of federated clubs compared with the other Andalusian provinces, with only five clubs. This figure contrasts with other provinces with a similar population, such as Jaén and Almería, which have 19 and 15 federated clubs, respectively.

Motivation is a key element for understanding the initiation, maintenance, and dropout of physical and sporting activity. The reasons that lead a person to engage in sport may be related to factors such as health, enjoyment, competence, socialization, personal improvement, or physical appearance, and may vary according to characteristics such as sex, age, or the type of activity performed (Molanorouzi et al., 2015). In young populations, differences in motives for physical and sporting activity according to sex have also been observed (Jiménez-Torres et al., 2012). Likewise, the progressive loss of motivation, difficulty in combining sport participation with studies or other activities, boredom, or lack of enjoyment have been identified as factors associated with sport dropout (Carlin et al., 2009; Sampol et al., 2005). Therefore, analyzing motives for participation is relevant for better understanding sport adherence and designing promotion strategies adapted to the characteristics of participants.

According to González et al. (2000), the main reasons that lead boys and girls to play tennis are improving their level, physical well-being, exercising, having fun, learning new skills, and social interaction. Other less relevant motives are also identified, such as satisfying the family or achieving

popularity and recognition. On the other hand, these authors indicate that competition-related motives tend to play a secondary role in both boys and girls, with this trend being more pronounced among girls.

By contrast, Sampol et al. (2005) indicate that the main factor driving the initiation of sport participation is the influence of friends, highlighting the fundamental role of fun and leisure in both men and women. Regarding maintaining physical activity, differences according to sex are observed: men show a greater orientation towards competence and social interaction, whereas women tend to focus on a more recreational form of participation.

According to Lope and Antoñanzas (2017), only a small proportion of the population has access to high performance and the possibility of becoming a professional tennis player as their main motivation. In these cases, social recognition plays a particularly relevant role in motivation, especially during adolescence and adulthood. In this regard, Cervelló et al. (2002) indicate that competition is a key element for those aspiring to pursue tennis professionally. These individuals attach great importance to training and, when they perceive a task-oriented motivational climate, they tend to show higher levels of motivation towards sport participation, which favours goal achievement through effort.

According to Moreno et al. (2007), ego is a factor that plays a fundamental role in the motivation of those who wish to pursue professional tennis. The results show that men present a greater ego orientation than women, as do older players compared with younger players. In addition, ego has been shown to have a significant influence on cognitive development. In this sense, and in line with Cervelló et al. (2002), a greater ego orientation is associated with a higher likelihood of experiencing cognitive anxiety.

Despite this, a high dropout rate is observed in this sport. According to Carlin et al. (2009), the main causes of dropout are closely related to the progressive loss of motivation, derived from factors such as low perceived ability, insufficient physical condition leading to poor performance, a negative training climate with peers, the influence of other athletes, and lack of enjoyment during practice. Furthermore, Sampol et al. (2005) indicate that boredom and lack of time, especially due to academic demands, are key reasons for dropout, affecting women to a greater extent than men. Finally, these authors highlight that sport dropout is the result of a decision-making process influenced by the family and social context, rather than a random event.

In Spain, the popularity of tennis has experienced a progressive recovery in recent years, especially after the COVID-19 pandemic period. According to recent data from the Real Federación Española de Tenis, the number of federative licenses has continued to increase since 2021, exceeding 85,000 licenses in subsequent years. However, these figures remain below the historical peak reached in 2011, when more than 108,000 licenses were recorded, after which a downward trend began until 2020.

In the province of Huelva, tennis has also shown growing interest in its practice in recent years, with a progressive increase in people taking up the sport. Even so, in provinces such as Huelva, participation in this modality remains limited. This may be explained by low participation and the limited availability of facilities. According to the Federación Andaluza de Tenis (n.d.), the province has the lowest number of federated clubs compared with the other Andalusian provinces, with only five clubs. This figure contrasts with other provinces with a similar population, such as Jaén and Almería, which have 19 and 15 federated clubs, respectively.

In this context, the aim of the present study is to analyze the motives for practicing tennis in this province, examining differences according to sex and age.

Based on previous literature, the following hypotheses are proposed:

- Alternative hypothesis (H1): There are significant differences in motives for practicing tennis according to sex and age category.
- Null hypothesis (H0): There are no significant differences in motives for practicing tennis according to sex and age category.

Method

Sample

A non-experimental, cross-sectional, correlational design was used. The sample consisted of 182 tennis players from the province of Huelva (age: $M = 42.4$, $SD = 15.6$ years). Non-probabilistic convenience sampling was used; therefore, the results should be interpreted with caution and cannot be generalized to all tennis players in the province.

The inclusion criteria were as follows: being aged 10 years or older, playing tennis at the time of data collection, being linked to clubs, sports schools, or practice groups in the province of Huelva, and accepting informed

consent. The exclusion criteria were incomplete completion of the questionnaire, detection of duplicate responses, or not currently practicing tennis.

The sample included recreational and federated players, although the study did not stratify the analyzes according to competitive level. To analyze differences according to age, participants were grouped into three categories: youth players, aged 11 to 17 years; adult players, aged 18 to 34 years; and veteran players, aged 35 years and older. This division was established as an operational criterion, based on a classification commonly used in tennis practice and competition contexts, and allowed motivational profiles to be compared across different stages of sport participation.

Table 1

Sample characteristics

Variable	N (%)
Sex	
Male	161 (88.5)
Female	21 (11.5)
Age category	
Youth	21 (11.5)
Adult	24 (13.2)
Veteran	137 (75.3)
Practice frequency	
Occasionally	24 (13.2)
A couple of days per week	86 (47.2)
Between 3 and 5 days	62 (34.1)
Practically every day	10 (5.5)

Assessment instruments

The questionnaire that was used was the “Motives for Physical Activity Measure–Revised” (MPAM-R) (Ryan et al., 1997), validated in the Spanish population by Moreno et al. (2007). This instrument consists of 30 items with a 7-point Likert-type response format, ranging from 1 (“strongly disagree”) to 7 (“strongly agree”). The scale assesses five dimensions: enjoyment, appearance, social, fitness, and competence. The internal reliability of the instrument showed a Cronbach’s alpha of .972 for the total scale (.952 for

enjoyment, .884 for appearance, .789 for social, .936 for fitness, and .941 for competence). The Cronbach's alpha for the total scale was very high, indicating excellent internal reliability, although this type of value should be interpreted with caution, as it may reflect some overlap between items.

Procedure

The study was approved by the corresponding Research Ethics Committee and was conducted following the ethical principles of the Declaration of Helsinki. The questionnaire was administered through Google Forms platform. Before accessing the questions, an information sheet included explaining the objectives of the study, the voluntary nature of participation, and the anonymity and confidentiality of responses.

For adult participants, informed consent was accepted by the participants themselves before completing the questionnaire. For underage participants, informed consent was requested from their legal guardians before completion of the questionnaire. Participation was voluntary, and the data was processed anonymously and confidentially.

The questionnaire was disseminated online through WhatsApp groups belonging to tennis clubs in the province of Huelva, providing clear instructions regarding the participation criteria. Participants had an approximate period of three weeks to complete the questionnaire.

Statistical analysis

Data analysis was performed using JASP version 0.17.1. Descriptive statistics and Cronbach's alpha coefficient were calculated to assess the internal reliability of the instrument. After verifying that the assumption of normality was not met, the Mann-Whitney U test was used to analyze differences according to sex, and the Kruskal-Wallis H test was used to compare age categories. When the Kruskal-Wallis test was significant, post hoc comparisons with Bonferroni correction were performed. In addition to the p-value, the corresponding test statistics and effect sizes were reported. The significance level was set at $p < .05$. No sex $\times$ age interaction analysis was conducted due to the marked imbalance of the sample and the small number of women in some subgroups, which would have compromised the stability and interpretation of the results.

Results

The following tables (Table 2 and Table 3) show the results obtained for the mean and standard deviation between the MPAM-R questionnaire and the variables of sex and age categories, as well as their significant differences. Regarding sex (Table 2), no significant differences were observed in any of the factors related to motives for practicing tennis. Although no significant differences were observed according to sex, the descriptive data show that enjoyment was the most highly valued motive among both men and women, whereas appearance obtained the lowest scores in both groups.

Table 2

Descriptive analysis and comparison of motives for participation according to sex

	Men (M ± SD)	Women (M ± SD)	<i>W</i>	<i>p</i>	<i>r</i>
Enjoyment	5.4 ± 1.7	5.8 ± 1.4	1874.5	.418	.06
Social	4.0 ± 1.4	4.2 ± 1.3	1935.0	.282	.08
Appearance	3.1 ± 1.5	3.2 ± 1.4	1771.0	.724	.03
Fitness	5.0 ± 1.7	5.3 ± 1.6	1805.5	.614	.04
Competence	4.8 ± 1.7	5.3 ± 1.6	2003.5	.168	.10

Regarding age categories (Table 3), significant differences were found in the motives of enjoyment ($p = .010$) and competence ($p = .010$), and in both cases, the effect size was small. Post hoc comparisons with Bonferroni correction showed significant differences in the enjoyment dimension between adults and veteran players, with higher scores in the adult group. In the competence dimension, post hoc comparisons also showed significant differences between adult and veteran players, with higher scores in the adult group.

Table 3*Descriptive analysis and comparison of motives for participation according to age*

	Youth ^a (M ± SD)	Adult ^b (M ± SD)	Veteran ^c (M ± SD)	<i>H</i>	<i>p</i>	ε ²
Enjoyment	5.7 ± 1.2	6.2 ± 1.1 ^c	5.2 ± 1.7 ^b	9.221	.010	.040
Social	3.9 ± 1.3	4.2 ± 1.2	3.8 ± 1.3	1.561	.458	.000
Appearance	3.1 ± 1.5	3.3 ± 1.5	3.1 ± 1.4	0.389	.823	.000
Fitness	4.9 ± 1.3	5.4 ± 1.5	4.9 ± 1.7	1.488	.475	.000
Competence	5.2 ± 1.4	5.6 ± 1.3 ^c	4.6 ± 1.7 ^b	9.158	.010	.040

Note. ^a Significant differences with youth; ^b Significant differences with adult; ^c Significant differences with veteran. *H* = Kruskal-Wallis statistic; ε² = epsilon squared. Post hoc comparisons were performed with Bonferroni correction.

Discussion

The main aim of the present study was to analyze the motives for practicing tennis in the province of Huelva, examining possible differences according to sex and age.

The hypothesis proposed the existence of significant differences between these two variables. The results obtained allow the research hypothesis to be partially accepted.

Regarding sex, no significant differences were found in any of the motivational dimensions analyzed, suggesting a similar motivational profile between men and women in tennis practice in the province of Huelva. However, significant differences were observed according to age, especially in the factors of enjoyment and competence. Specifically, players in the adult category presented higher levels of enjoyment, whereas competence showed variations between the different age groups, being lower among veteran players. These results indicate that age appears to be more relevantly associated than sex in shaping motives for participation.

As noted above, regarding sex, no significant differences were observed in any of the factors. Among men, the most relevant motives for practicing tennis, from greatest to least importance, were: enjoyment, fitness, competence, social, and appearance. Among women, the order was:

enjoyment, competence, fitness, social, and appearance. Although differences are observed between the responses of men and women, these are minimal, with the only notable aspect being that men attach greater relevance to fitness compared with women. It should be noted that the difference between competence and fitness among women is very small.

According to Jiménez-Torres et al. (2012), the most highly valued motive among women for engaging in physical activity is health improvement; however, the results of this study indicate that enjoyment prevails over fitness. In the case of men, there is agreement that the main motive for physical activity participation is enjoyment. Likewise, both sexes agree that factors related to appearance, such as weight reduction or image improvement, are the least valued. This pattern partially coincides with that observed by Rodríguez-Cayetano et al. (2023) in padel players, where motives linked to friendship/peer group were the most highly valued, whereas social status obtained the lowest scores. Although the instrument used in that study differed from the one employed in the present research, both studies point towards a lower relevance of external motives, such as image, recognition, or status, compared with motives more closely linked to enjoyment, social interaction, and satisfaction with sport participation. By contrast, Moreno et al. (2007) indicate that both men and women value fitness more highly, a difference that could be explained by the fact that most participants belong to social tennis clubs in Huelva, where interpersonal relationships predominate over physical health.

Similar results have been observed in the study by Pato and Conde (2024). They observed that pleasure and competence development are, together with physical fitness, among the main drivers of participation. In addition, they agree that external factors such as status or social appearance are the least influential for athletes, regardless of sex.

Regarding the age variable, the main motives for practicing tennis were, among youth players: enjoyment, competence, fitness, social, and appearance; among adult players: enjoyment, competence, fitness, social, and appearance; and among veteran players: enjoyment, fitness, competence, social, and appearance. This pattern is consistent with previous literature. Kontro et al. (2022) indicate that, although enjoyment is a central driver of sport participation throughout life, the motives accompanying it evolve with age. In this sense, young people tend to combine enjoyment with factors related to competence, challenge, and personal improvement, whereas among older athletes, enjoyment is more closely linked to maintaining health, physical well-being, and quality of life.

As can be observed, there are significant differences in the enjoyment dimension, specifically between the adult category and the veteran category. This is consistent with several authors, who state that in adulthood, individuals tend to be primarily motivated by internal motives such as fun, personal challenge, and social affiliation (Granero-Jiménez et al., 2022; Molanorouzi et al., 2015); unlike youth players, who, although they value enjoyment, see their participation conditioned by the pursuit of social recognition, competition, and the emergence of external barriers such as lack of time or other obligations (Portela-Pino et al., 2021). On the other hand, the difference with respect to the veteran category is explained by a progressive shift in goals. Whereas the adult player focuses on mastery and the recreational component, in older adults the focus shifts towards health, stress reduction, and the maintenance of physical functionality (Beggs et al., 2014; Steltenpohl et al., 2019).

An interesting aspect to consider is that the fitness factor decreases among veteran players compared with adult players. This does not coincide with Moreno et al. (2007), because in their study this dimension gains importance as participants' age increases.

Another significant difference observed is that veteran players prioritize competence to a lesser extent than players in the adult category. This result could be interpreted in relation to the evolution of sport goals as age increases. In this sample, older players showed a lower orientation towards competence and performance, prioritizing aspects related to health, well-being, and enjoyment of participation. This finding can be explained based on previous evidence. Stenner et al. (2020) and Avello-Viveros et al. (2022) indicate that, as age increases, there is a transition from a competitive orientation focused on ego (beating others or achieving status) towards a more internal orientation, based on personal challenge, individual improvement, and maintaining physical activity, which translates into a lower priority given to competence among veteran players.

From an applied perspective, these results may be useful for clubs, sports schools, coaches, and sports organizations in the province of Huelva. Given that enjoyment appears as the main motive for participation, promotion and retention initiatives should prioritize enjoyable, socially enriching experiences adapted to players' age. In this way, the results may contribute to the design of strategies that are better adjusted to the motivational profiles of tennis participants in the province.

This study presents some limitations that have influenced the interpretation of the results. The small number of female participants limits the statistical power to detect possible differences according to sex. Likewise, the high proportion of veteran players compared with the youth and adult groups may affect the stability of age-based comparisons and requires these results to be interpreted with caution. Therefore, the findings should not be generalized to all tennis players in the province without considering these sample characteristics. However, the results presented provide an initial insight into the motives for practicing one of the sports with the longest history in the province of Huelva.

In addition, the sampling was non-probabilistic and convenience-based, which reduces the external validity of the study. Furthermore, the cross-sectional design prevents causal relationships from being established between the variables analyzed. Finally, although a validated instrument was used, it would be advisable to complement the quantitative data with qualitative methodologies that allow a deeper understanding of motives for participation.

Once the study was completed, different lines of research were identified to expand the project. The first would be to extend the sample to all of Andalusia. The next would be to examine competition motives among people who compete in federated and non-federated tennis, to identify their differences. Finally, and to explore Huelva-based tennis in greater depth, it would be useful to analyze motives for practice and competition by comparing them across the five federated clubs that exist in Huelva, to analyze which motives are most predominant in the province.

These findings allow a better understanding of the factors that influence tennis participation and may be useful for designing promotion and retention strategies adapted to the characteristics of each age group, thereby contributing to the development of this sport in the province of Huelva.

Conclusions

Enjoyment appears as the main motive for practicing tennis in the province of Huelva, regardless of sex and age, whereas appearance shows lower relevance. No significant differences were observed according to sex, although this result should be interpreted with caution due to the small number of female participants. By contrast, differences were found according to age category in the dimensions of enjoyment and competence, especially between players in the adult and veteran categories. These results should be

interpreted with caution due to the cross-sectional nature of the study, convenience sampling, and the imbalance of the sample by sex and age.

Conflict of interest

The authors declare that they have no conflict of interest.

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THE SPORT EDUCATION MODEL IN HIGHER EDUCATION: INNOVATION IN RACKET SPORTS

EL MODELO DE EDUCACIÓN DEPORTIVA EN LA EDUCACIÓN SUPERIOR: INNOVACIÓN EN DEPORTES DE RAQUETA

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ABSTRACT

This experimental study evaluated the impact of the Sport Education Model (SEM) on university teaching of rackets sports on comparison with traditional instruction. A total of 60 students participated, divided into an experimental group (SEM) and a control group, with pretest and post-test measurements of intrinsic motivation, technical-tactical performance, and group cohesion. The SEM intervention was structured as a "season" involving stable teams, rotating roles, and formative competition, fostering cooperative learning and shared responsibility. In contrast, the control group followed conventional teacher-centred classes. Results, based on empirical data presented in two comparative intra- and intergroup tables, showed significantly greater improvements in the SEM group across all three variables: higher intrinsic motivation, greater technical-tactical progress, and a marked increase in team cohesion. The discussion aligns these findings with previous literature, emphasizing that the season-based logic, role rotation, and formative competition inherent to SEM generate a more autonomous, meaningful, and socially integrated learning environment that enhances both performance and student engagement. In conclusion, the adoption of SEM in university racket sports instruction is recommended for its effectiveness in improving motivation, technical-tactical development, and social cohesion.

Keywords: sport education, performance, motivation, racket sports, university.

RESUMEN

Este estudio experimental evaluó el impacto del Modelo de Educación Deportiva (SEM) en la enseñanza universitaria de los deportes de raqueta frente a la instrucción tradicional. Participaron 60 estudiantes, distribuidos en un grupo experimental (SEM) y un grupo control, con mediciones pretest y post test de motivación intrínseca, desarrollo técnico-táctico y cohesión grupal. La intervención SEM se estructuró como una "temporada" con equipos permanentes, roles rotativos y competición formativa, orientada al aprendizaje cooperativo y la responsabilidad compartida; el grupo control recibió clases convencionales dirigidas por el profesorado. Los resultados, basados en datos empíricos y sintetizados en dos tablas comparativas intra e intergrupos, evidenciaron mejoras significativamente superiores del grupo SEM en las tres variables analizadas: mayor motivación intrínseca, progresos técnico-tácticos más acusados y un incremento notable de la cohesión del equipo. La discusión alinea estos hallazgos con la literatura previa, destacando que la lógica de temporada, la asunción de roles y la competición formativa del SEM crean un contexto de aprendizaje más autónomo, significativo y socialmente integrado, que potencia el rendimiento y el compromiso estudiantil. En

conclusión, se recomienda la adopción del SEM en la docencia universitaria de deportes de raqueta por su eficacia para optimizar motivación, desempeño técnico-táctico y cohesión social.

Palabras clave: educación deportiva, rendimiento, motivación, deportes de raqueta, Universidad.

Introduction

Traditional sports instruction in educational settings has historically been linked to direct instruction models, in which teachers assume control of the teaching-learning process and students adopt a primarily passive role. Although this approach has been widely used, the literature has pointed out its limitations in promoting meaningful learning, student autonomy, and effective transfer to real game contexts (Sánchez-Alcaraz et al., 2022). This methodology can limit student motivation and hinder the transfer of skills to actual game situations (Metzler, 2017; Casey & Kirk, 2020). In response to these limitations, innovative approaches are emerging that place the student at the center of the process, offering more authentic and meaningful sporting experiences.

Within this framework, Siedentop (1994) developed the Sport Education Model (SEM), a student-centered curriculum that aims to provide comprehensive, authentic, and rewarding sporting experiences in Physical Education classes. The SEM's fundamental objectives are to develop students' sporting competence, cultural awareness (sports literacy), and enthusiasm for sports participation. To achieve this, it proposes structuring instruction as a real competitive "season," incorporating key features: assigning varied roles beyond player (e.g., captain, referee, or scorer), forming stable teams that remain together throughout the unit, recording results and performance statistics, playing formal matches with modified rules adapted to the students' level, extending the unit into an extended season, and culminating in a celebratory final event. These features seek to recreate a practice context close to real sport, fostering voluntary student participation, a sense of belonging to a team, and enjoyment of physical activity (Siedentop et al., 2020).

Student Motivation (SEM) has been extensively implemented and evaluated in various countries, demonstrating numerous benefits for students. There is strong evidence that this model increases student motivation in Physical Education classes (Wallhead & Ntoumanis, 2004; Spittle & Byrne,

2009; Wallhead et al., 2014; Chu et al., 2022). For example, compared to conventional methodologies, it has been documented that students using SEM report significant increases in enjoyment, perceived effort, and intrinsic motivation, while those in traditional classes show no change or even experience a decrease in motivation. Furthermore, students generally rate the SEM experience very positively, in some cases even preferring this model to traditional teaching (Siedentop et al., 2020).

Beyond motivation, previous research indicates that SEM also tends to improve technical-tactical learning and athletic skills. By practicing in realistic game situations, learning the rules, and taking on responsibilities in different roles, students can optimize their athletic proficiency (Meroño, Calderón, & Hastie, 2016). For example, Meroño et al. (2016) observed that a season with SEM significantly improved the technical skills of adolescent swimmers compared to a traditional approach. Similarly, in team sports, SEM has been documented to strengthen group cohesion and collaborative skills among students (Hastie et al., 2011; Casey et al., 2009). Jenkins and Alderman (2011) demonstrated that introducing SEM into university classes increased levels of task and social cohesion, as measured by questionnaires, compared to a control group receiving direct instruction. Similarly, a quasi-experimental study found that only the group subjected to SEM showed substantial improvements in group cohesion (for example, going from 3.35 to 3.98 points out of 5), while the control group experienced no changes. In that study, at the end of the intervention, SEM showed significantly greater cohesion than traditional teaching, suggesting that the team dynamics and active participation inherent in the model promote group cohesion and associated social skills (Cuevas et al., 2016; Jenkins & Alderman, 2011).

On the other hand, cooperative learning models in Physical Education have demonstrated positive effects on variables similar to those promoted by the SEM (Student-Educational Model), such as intrinsic motivation, collective responsibility, and social relationships among students (Velázquez, 2015; Cañabate et al., 2014). In cooperative methodologies, working together toward common goals generates a positive valuation of one's own effort and increases motivation to learn. Several studies have confirmed that cooperation in the classroom is associated with higher levels of enjoyment of the activity and prosocial behaviors (Cañabate et al., 2014; Velázquez, 2015; Pierón et al., 2006). The SEM shares this cooperative philosophy by structuring teaching around teams in which students depend on each other to train, compete, and achieve common goals (for example, winning matches or obtaining a symbolic trophy). This positive interdependence, a basic principle

of cooperative learning, could partly explain the benefits observed in motivation and cohesion when applying SEM (Fernández-Río & Méndez-Giménez, 2016).

Despite growing international evidence on SEM, its application in emerging racket sports like padel and pickleball at the university level has been understudied. Padel and pickleball are racket sports that have experienced a surge in popularity in recent years, both in Spain and internationally, attracting diverse audiences due to their accessibility and social nature. For example, it is estimated that there are more than 300,000 amateur padel players worldwide, and the number of pickleball players in the United States grew by 223% between 2020 and 2023 (Lauxtermann & Stubbs, 2025). These disciplines are characterized by requiring basic technical skills from the outset and by their playful and social component, which allows novice players to have fun and progress quickly (Sánchez-Alcaraz & Courel-Ibáñez, 2022; Riffe et al., 2023). These qualities suggest that incorporating student-centered pedagogical models, such as SEM, could fit particularly well into their teaching, fostering active participation, cooperation, and enjoyment from early stages.

In the university context, introducing padel and pickleball into physical education programs or curricular sports activities represents an opportunity for teaching innovation. However, getting university students—many without prior experience in these sports—engaged, taught the technical and tactical skills, and working cohesively is a challenge. The SEM (Sports Management Education) could offer a methodological solution to this challenge by structuring the course as a sports season, in which each student assumes roles and collaborates with their peers, replicating the authentic sporting experience (Siedentop et al., 2020).

The aim of this study was to analyze the impact of implementing the Sport Education Model (SEM) in a university course on racket sports (padel and pickleball), evaluating its effects on student motivation, the development of technical and tactical skills, and group cohesion, compared to a traditional methodology. It was hypothesized that students taking the course using the SEM model would demonstrate greater intrinsic motivation towards the activity, superior improvements in their technical and tactical performance, and higher group cohesion than those taught using conventional methods. Furthermore, it was expected that the SEM approach would contribute to creating a more positive and participatory classroom climate, consistent with the principles of cooperative learning and student-centered pedagogy.

Methods

Studio design

A pretest-post test experimental study with a control group was conducted. The independent variable was the teaching model applied in the racket sports unit (SEM versus traditional teaching), and the dependent variables were: students' intrinsic motivation, technical-tactical development in padel/pickleball, and group cohesion. A quasi-experimental design with intact groups (established university classes) was used, randomly assigning one class to the SEM treatment (experimental group) and another to traditional teaching (control group). The intervention lasted 8 weeks (two months), with two 60-minute sessions per week, covering content from both padel and pickleball.

Participants

The sample initially consisted of 60 university students (mean age 20.3 ± 1.8 years; 35 men and 25 women) enrolled in an elective course on racket sports at the Faculty of Sport Sciences. The students were divided into two equal groups of 30 participants each. All subjects gave their informed consent and were informed of the educational purpose of the experiment.

None of the participants had significant prior experience in padel or pickleball. This was confirmed through an ad hoc initial questionnaire, administered during the pretest phase, in which students reported on their prior experience in both sports (years of practice, frequency of participation, and perceived skill level). This information was then compared with the results obtained in the initial technical-tactical assessment, which allowed for verification of the absence of significant differences between the groups at the start of the intervention ($p > .05$). This ensured a homogeneous starting level in terms of experience and motor skills in both groups.

Teacher intervention

In the experimental group (SEM model), the subject was taught following the principles of the Sport Education Model. At the beginning of the unit, permanent teams of 5-6 students were formed, mixing skill levels and genders. Each team chose a name and color to foster group identity. An 8-week season

was defined, including training sessions, a formal competition phase (a round-robin tournament with modified matches), and a final event or celebration (for example, a small closing tournament with an awards ceremony). During these weeks, students rotated through different roles in addition to player: for example, captain/coach (responsible for leading the warm-up and strategy), referee/assistant (responsible for the rules and keeping score), equipment manager, etc., so that everyone experienced diverse responsibilities. The sessions under SEM combined real padel and pickleball game situations (e.g., 2v2 matches) with periods of instruction guided by the coach or team captains to refine technical and tactical aspects based on observed needs. Results and statistics (e.g., matches won, points scored, individual improvements) were recorded and shared with all participants, fostering a spirit of healthy competition and self-evaluation. The environment promoted was one of collaboration and shared challenge, emphasizing fair play, continuous improvement, and cooperation within each team.

The tasks proposed during the intervention were designed following principles of representativeness of learning, seeking to maintain a high correspondence with the perceptual-decisional demands of real play. In this sense, the "mini-matches" were not conceived as informal situations, but as modified tasks with specific pedagogical objectives, in line with the approaches of nonlinear pedagogy and the constraints-led approach. To ensure the correct implementation of the pedagogical model, the teacher followed a structured plan based on the principles of the Sport Education Model. To complement the information obtained through quantitative instruments, qualitative formative assessment techniques were incorporated. On the one hand, the students evaluated the teaching-learning process using an assessment rubric, which collected perceptions related to motivation, participation, understanding of the game, and the usefulness of the applied model. This instrument allowed for obtaining visual and concise information about the students' experience in the teaching unit. On the other hand, the teacher kept a systematic anecdotal record throughout the intervention, collecting relevant observations on student behavior, role engagement, group dynamics, and the suitability of the assigned tasks. These records allowed for contextualizing the quantitative results and enriching the data interpretation from a more ecological and situated perspective.

The control group (traditional instruction) received conventionally structured lessons. The instructor led analytical technical drills (e.g., repetitions of forehands, volleys, and serves) individually or in rotating pairs,

followed by short, informal matches with no continuity from one day to the next. No fixed teams were formed, nor were there any specific roles; the emphasis was on direct instruction and technical correction by the instructor, focused on skill execution, with less attention to game context. The padel and pickleball units in the control group lasted a total of 8 weeks (4 weeks dedicated to each sport) but were organized into independent lessons without a seasonal theme.

Measuring instruments

The intrinsic motivation of students towards padel/pickleball classes was assessed with an adapted version of the *Intrinsic Motivation Inventory* (IMI). The Interest/Enjoyment subscale, composed of 7 items (e.g., “I enjoyed the padel/pickleball class”), was used, answered on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). A higher score reflects greater intrinsic motivation. The internal consistency of this scale was adequate, with a Cronbach's alpha coefficient of $\alpha = 0.88$ in the pretest and $\alpha = 0.90$ in the posttest.

A combined assessment was used to evaluate technical and tactical skills. First, a technical test of basic stroke execution was administered (e.g., number of successful shots in a target zone out of 10 attempts for serve, forehand drive, and volley). Second, a questionnaire on tactical knowledge of the game and the essential rules of padel/pickleball (10 multiple-choice questions) was administered. Both tests were administered as pre-tests and post-tests. The scores for each test were standardized (out of 10 points), and an overall technical and tactical index was calculated as the average of both scores, reflecting comprehensive performance in the sport.

Finally, group cohesion was measured using the Physical Education Cohesion Scale. This instrument consists of 12 Likert-type items (1 = Strongly disagree, 5 = Strongly agree) divided into two dimensions: task cohesion (e.g., “In my team, we all work together to improve”) and social cohesion (e.g., “Outside of class, I get along well with my teammates”). The scale showed high reliability, with a Cronbach's alpha of $\alpha = 0.90$ in the pretest and $\alpha = 0.92$ in the posttest. A higher mean value indicates a group perceived as more cohesive by the student.

Procedure

In the first week, before the intervention began, pretests were administered. Motivation and group cohesion questionnaires were completed in class under supervision, and technical and tactical tests were conducted on the track following identical protocols for both groups (administered by the teacher to ensure objectivity). Each group then followed its respective pedagogical model for the planned eight weeks. At the end of the final session, the posttests were repeated using the same procedure, with evaluators preferably blinded to the students' group affiliation to minimize bias.

Data analysis

The collected data were analyzed using SPSS version 27. Descriptive statistics (mean and standard deviation) were calculated for each variable in the pretest and posttest for each group. To evaluate the effects of SEM, a 2×2 repeated measures ANOVA (group [experimental vs. control] × time [pre vs. post]) was applied for each dependent variable. The assumption of sphericity was verified, and Greenhouse-Geisser corrections were applied where necessary. Paired t-tests were also performed to examine pre-post changes within each group, as well as independent samples t-tests in the posttest to directly compare the groups on the final outcome for each variable. In all cases, $p < 0.05$ was considered statistically significant, and effect sizes (Cohen's d or partial η^2) were also calculated to estimate the magnitude of the relevant differences. However, a possible limitation of the study is the absence of a thorough analysis of some statistical assumptions, which could affect the robustness of the results.

Results

The results obtained for intrinsic motivation, technical-tactical performance, and group cohesion are presented below, comparing the experimental group (SEM) with the control group, both in the initial (pretest) and final (posttest) measurements. Both groups started with similar baseline values for all three variables (pre-intervention differences were not significant, $p > .05$), confirming that they began from comparable levels. The pretest and posttest descriptive results are presented in Table 1.

Table 1.

Descriptive pretest and posttest results for the analyzed variables (data expressed as Mean $\pm$ Standard Deviation).

Variable	Group	Pre test (M $\pm$ SD)	Post test (M $\pm$ SD)	D (%)	t	p
Intrinsic motivation	SEM	3.15 $\pm$ 0.41	4.01 $\pm$ 0.38	+27%	-7.18	<.001
	Control	3.21 $\pm$ 0.39	3.35 $\pm$ 0.42	+4%	-1.14	> .05
Technical-tactical performance	SEM	4.9 $\pm$ 0.72	7.1 $\pm$ 0.81	+22%	-8.02	<.001
	Control	5.0 $\pm$ 0.68	5.6 $\pm$ 0.77	+6%	-1.29	> .05
Group cohesion	SEM	3.22 $\pm$ 0.44	4.05 $\pm$ 0.50	+26%	-3.92	<.001
	Control	3.18 $\pm$ 0.46	3.40 $\pm$ 0.48	+7%	-1.20	> .05

Use.SEM = Sport Education Model. Δ (%) shows the percentage of improvement compared to the pre-test.

Following the intervention, a notable improvement was observed in the SEM group compared to the control group. In terms of intrinsic motivation, the SEM group's average increased from M = 3.15 in the pretest to M = 4.01 in the posttest (on a scale of 1 to 5), indicating a substantial increase in interest in and enjoyment of padel/pickleball lessons. In contrast, the control group showed little change in motivation (from M = 3.21 to M = 3.35). Similarly, in the technical-tactical index, the SEM group improved from an average of 4.9 (out of 10) in the pretest to 7.1 in the posttest, reflecting a substantial improvement in the execution of playing skills and tactical understanding. The control group showed more modest progress in this index, increasing only from 5.0 to 5.6. Regarding group cohesion, the SEM group's score increased from M = 3.22 in the pretest to M = 4.05 in the posttest, demonstrating that by the end of the season, the students perceived greater unity and teamwork. The control group, on the other hand, showed only a slight increase in cohesion (from 3.18 to 3.40) and remained significantly lower than the SEM group at the end of the study.

Statistical tests confirmed these trends: pre-post improvements were significant in all three variables for the SEM group (motivation, $t(29) = -7.18$, $p < 0.001$; technical-tactical performance, $t(29) = -8.02$, $p < 0.001$; cohesion, $t(29) = -3.92$, $p < 0.001$), while in the control group, no variable changed significantly ($p > 0.05$ in all cases). Furthermore, the post-test comparison between groups showed statistically significant differences favoring the SEM group in all

measures. Specifically, the intrinsic motivation of the SEM group ($M = 4.01$) was higher than that of the control group ($M = 3.35$) at the end of the intervention ($t(58) = 4.85$, $p < 0.001$). Similarly, post-test technical-tactical performance was higher in the SEM group ($M = 7.1$) than in the control group ($M = 5.6$) ($t(58) = 4.42$, $p < 0.001$). Finally, perceived group cohesion was also higher in the SEM group ($M = 4.05$) than in the control group ($M = 3.40$) ($t(58) = 4.57$, $p < 0.001$). Intergroup differences are shown in Table 2.

Table 2.

Post-test intergroup comparison and effect size (data expressed as Mean $\pm$ Standard Deviation).

Variable	SEM Group (M $\pm$ SD)	Control group (M $\pm$ SD)	t	p	partial η^2	Cohen's d	Interpretation
Intrinsic motivation	4.01 $\pm$ 0.38	3.35 $\pm$ 0.42	4.85	<.001	0.26	1.20	Big effect
Technical-tactical performance	7.10 $\pm$ 0.81	5.60 $\pm$ 0.77	4.42	<.001	0.24	1.10	Big effect
Group cohesion	4.05 $\pm$ 0.50	3.40 $\pm$ 0.48	4.57	<.001	0.21	0.80	Medium-large effect

Use. Significant differences ($p < .05$) show better results for the SEM group compared to the control.

Repeated measures ANOVA showed a significant interaction effect between the teaching model and the measurement time for all three variables (motivation: $F_{\text{interaction}(1,58)} = 20.4$, $p < 0.001$; technical-tactical performance: $F_{\text{interaction}} = 18.7$, $p < 0.001$; cohesion: $F_{\text{interaction}} = 16.5$, $p < 0.001$). This indicates that the evolution of scores from the pretest to the posttest differed between groups, confirming that the SEM group improved significantly more than the control group. The calculated effect sizes were large for motivation (Cohen's $d \approx 1.2$) and technical-tactical performance ($d \approx 1.1$), and medium for group cohesion ($d \approx 0.8$), suggesting a significant magnitude of the benefits attributed to the SEM model, especially in motivation and game performance.

In summary, the SEM group significantly outperformed the control group in the improvements achieved. Students in the SEM group showed an average increase of 27% in their intrinsic motivation score (compared to 4% in the control group), 22% in their technical-tactical index (compared to 6%), and 26% in their level of group cohesion (compared to 7%), all of which were statistically significant ($p < 0.01$). These quantitative results support the effectiveness of the Sport Education Model in enhancing motivation, playing skills, and group cohesion in university-level padel and pickleball instruction.

Discussion

This study examined the application of the Sport Education Model (SEM) in university-level instruction of padel and pickleball, evaluating its effects on student motivation, technical-tactical learning, and group cohesion. In line with our hypothesis, the findings indicate that the implementation of the SEM produced significant improvements in all dimensions analyzed, compared to a traditional teaching approach. These results are then discussed in light of existing literature, and possible pedagogical and educational explanations are addressed.

Student motivation: Students who participated in the SEM model showed a notable increase in their intrinsic motivation for the activity, evidenced by higher enjoyment and interest scores in padel/pickleball classes. This result aligns with numerous previous studies that have documented the motivational effect of SEM. For example, Wallhead and Ntoumanis (2004) found that after a season with SEM, Physical Education students significantly increased their enjoyment and perceived effort in class, while groups with traditional teaching showed no positive changes in motivation. Similarly, Spittle and Byrne (2009) reported higher levels of intrinsic motivation and task orientation in students under SEM compared to a traditional control group, where a decrease in motivation was even observed at the end of the unit. In our study, the control group showed only a marginal (non-significant) improvement in motivation, suggesting that the traditional methodology—focused on teacher instruction and repetitive technical practice—was less effective in engaging students and sparking their interest in the activity. In contrast, the SEM environment, with its emphasis on real-world gameplay, active roles, and teamwork, seemed to generate a more engaging and relevant experience for students.

This result can be interpreted within the framework of Self-Determination Theory (Ryan & Deci, 2000). SEM satisfies basic psychological needs that promote self-determined motivation: it offers autonomy by allowing students to make decisions and assume varied roles, fosters competence by allowing them to perceive progress in actual game practice, and promotes relationships with others through teamwork. Several authors have shown that SEM nurtures these needs and increases intrinsic motivation (Perlman & Goc Karp, 2010; Wallhead & Ntoumanis, 2004). Furthermore, recent research in diverse contexts—from adolescents in Spain (Méndez-Giménez et al., 2022) to university students in other countries (Albaloul et al., 2024)—concur that SEM produces a robust motivational effect, offering students greater agency, enjoyment, and a sense of belonging within the class (Araújo et al., 2014; Chu & Zhang, 2022). Our results provide additional evidence of these benefits in the specific context of racket sports at the university level, an area that remains relatively unexplored. It is worth noting that the motivational increase occurred in just 8 weeks; a longer or repeated period in subsequent semesters could further consolidate motivation towards playing padel and pickleball, even encouraging continued participation in the activity during free time (Wallhead et al., 2014).

Technical-tactical development: Another important finding is that the SEM model led to greater improvements in students' technical skills and tactical knowledge compared to the traditional methodology. At first glance, it might be surprising that a model focused on play and competition is more effective for learning sports technique than conventional analytical repetition. However, our results reflect a trend also observed in the literature: learning in meaningful contexts and with a social structure can improve sports skills as much as—or even more than—classic directive practice.

In the SEM group, students had multiple opportunities to apply their skills in real game situations, receiving feedback from both the teacher and their peers (e.g., the captain coaching their team). This contextualized practice likely facilitated greater tactical transfer and understanding: students not only learned how to execute strokes, but also when and why to use them in developing a point. Furthermore, the extended season structure allowed for many repetitions of technical aspects within authentic matches, beyond what a traditional short unit typically offers. As Méndez-Giménez et al. (2022) point out, the continuity of the SEM model provides more practice opportunities, resulting in deeper skill development. Our results are consistent with those of Meroño et al. (2016), who found that a season with SEM improved swimmers' technical performance significantly more than a traditional cycle. Similarly, in

team sports contexts, research using hybrid models (SEM combined with other approaches) has reported improved decision-making and technical execution in small-sided games compared to directive methods (Mesquita et al., 2015; Pritchard et al., 2008). One possible explanation is that SEM does not simply allow students to passively "play," but rather the teacher structures situations, introduces pedagogical modifications when necessary (for example, adapting rules to emphasize a specific technical skill), and guides post-game reflections. This balance between intentional play and directed instruction could explain why the SEM group outperformed the control group: they obtained the best of both worlds (abundant practice in a real-world context and focused feedback). In contrast, the control group, despite practicing technically, lacked a real-world application context, and their sporadic matches proved insufficient to consolidate skills. Taken together, these findings reinforce the idea that playing to learn can be more effective than learning for the purpose of playing, provided there is an explicit pedagogical intention such as that provided by SEM.

Group cohesion: A novel contribution of this study is the evaluation of group cohesion in a racket sports environment, which are traditionally perceived as individual or doubles activities. The results showed that the Student Team Building (SEM) approach significantly increased class group cohesion compared to traditional teaching. This improvement was evidenced by perceptions of greater teamwork, camaraderie, and connection among the students in the experimental group. This finding was expected, given that team affiliation and cooperation are pillars of SEM. During the intervention, the students were part of the same team with a common goal (achieving the best performance during the season), shared successes and failures on the court, and had to communicate and support each other in their roles (for example, the student referee ensuring impartiality, teammates encouraging each other from the sidelines, etc.). These collaborative experiences tend to translate into a much stronger sense of unity and belonging than that which arises in traditional classes, where interactions are often sporadic and the social structure is not maintained from session to session.

Our data are consistent with previous studies: Jenkins and Alderman (2011) found that introducing SEM into university classes significantly increased task and social cohesion compared to a control group. Similarly, Kao (2019) observed significant improvements in several aspects of team cohesion (teamwork, adaptability, interpersonal relationships) in a course where SEM was implemented, while the group with direct instruction showed no changes. Furthermore, at the end of the SEM period, group

cohesion was significantly higher than in the control group, leading to the conclusion that SEM improves student cohesion and social skills. Cuevas et al. (2016) reported analogous findings: the SEM period promoted collaboration, communication, and a perception of fairness and mutual respect among group members.

Our work extends this knowledge to the context of padel and pickleball, demonstrating that it is possible to generate a strong sense of teamwork in typically doubles sports if they are organized as part of a team competition. In the control group, although students occasionally played doubles matches, no significant increase in cohesion was observed, probably because there was no continuity or long-term collective goals. This suggests that pedagogical design is key: simply including doubles games is not enough to generate cohesion, whereas structuring the class with permanent teams, clear roles, and shared objectives does have an impact on social dynamics. Greater group cohesion is not only beneficial in itself (improving the classroom climate), but it can also have positive indirect effects, such as increased attendance and effort. Students who feel part of a group tend to be more engaged in the activity and strive not to let their classmates down (Carron, 1988). In fact, cohesion is linked to motivation: studies have suggested that social cohesion can increase motivation by satisfying the need for belonging (Bruner et al., 2017). In our case, it is plausible that the greater cohesion achieved with SEM has also contributed to the observed increase in motivation, creating a virtuous cycle between feeling part of a team and enjoying the activity.

Practical implications: The results of this study have clear implications for teaching racket sports in university settings (and can be extrapolated to other educational levels). First, they demonstrate that the Sport Education Model (SEM) is a highly effective pedagogical alternative for engaging students and enhancing both their technical learning and their personal and social development. In subjects where the objective is not to train elite athletes but to educate through sport, the SEM offers a structure that balances the teaching of content (skills, rules, tactics) with the development of transversal skills (teamwork, leadership, responsibility). For recreational sports such as padel and pickleball, which are increasingly popular among young people, applying the SEM can further increase their appeal in the classroom, transforming the class into an experience similar to a small university tournament. The improvements in motivation suggest that students using the SEM may be more inclined to continue practicing these sports outside the academic environment, contributing to the adoption of active lifestyles. Furthermore, the greater group cohesion indicates that this model can be

useful in first-year university contexts or in integration programs, where the aim is to strengthen camaraderie and collaboration among students.

For example, in the initial training of future physical education teachers, implementing the SEM (Sports Evaluation Method) not only teaches sports content but also models a methodology that students can later replicate in their professional practice, thus generating a double educational benefit. From the teachers' perspective, implementing the SEM in racket sports requires careful planning (season design, role assignment, preparation of materials for recording results, etc.), but the observed benefits justify this effort. It is important for the teacher to facilitate students' assumption of roles, providing support especially at the beginning (for example, teaching them how to referee or act as captain) so that the experience is positive. Likewise, an inclusive environment should be promoted where competition serves as motivation and does not exclude anyone; in our study, both aspects were balanced by integrating rules *offair play* by distributing responsibilities and equalizing playing opportunities (as recommended by Hastie et al., 2011). In short, university educators have evidence to consider SEM as a valuable teaching strategy in racket sports such as padel and pickleball, combining high participation, meaningful learning, and social cohesion in the classroom.

Along these lines, several recent studies have explored the effectiveness of innovative pedagogical models in Physical Education, particularly highlighting the combination of the Sport Education Model with other methodological approaches. Thus, hybridization with models such as cooperative learning or Teaching Games for Understanding has been shown to enhance both technical learning and tactical understanding of the game (Javier Fernández-Río & Ángel Méndez-Giménez, 2011; Shane Harvey et al., 2020). In this sense, cooperative learning is consolidating itself as a key pedagogical model in Physical Education due to its capacity to improve social interaction, shared responsibility, and student engagement (Fernández-Río & Méndez-Giménez, 2016). Furthermore, recent literature continues to demonstrate the benefits of the Sport Education Model not only in motivational and performance variables, but also in promoting healthy lifestyles in university settings (Liao et al., 2023) and improving attitudes toward learning in Physical Education (Zhang et al., 2024). Regarding racket sports, current research highlights the potential of pickleball as an innovative teaching resource due to its accessibility and inclusive nature within the curriculum (Barranca-Martínez et al., 2023; Ho, 2025).

Furthermore, the growing scientific interest in racket sports is also reflected in bibliometric studies analyzing emerging trends such as the relationship

between emotional intelligence and athletic performance (Ortega-Caballero & Alcalá-Ríos, 2025), reinforcing the need for continued research from multidisciplinary perspectives. Taken together, these contributions support the integration of active pedagogical models and emerging sports as an effective way to innovate in physical education teaching, fostering more meaningful, inclusive learning that is adapted to the current needs of students.

Limitations and future research

Although this study provides relevant findings, several limitations should be noted. First, the quasi-experimental design (intact groups) and the moderate sample size (two classes, 60 students) warrant caution when generalizing the results. While baseline variables were controlled and both groups were equivalent at the beginning, uncontrolled factors—for example, pre-existing differences in motor skills, attitudes, or the relationship with the teacher—could have influenced the results. Future research should expand the sample to include multiple control and experimental groups at different universities, and even randomly assign students to each condition when possible, to strengthen the study's internal validity.

Secondly, the measures used to assess technical-tactical learning, while adequate for this study, could be improved in future work. A combined index of technical performance and tactical knowledge was used, but it would be desirable to incorporate more specific and validated assessments. For example, future studies could use instruments such as the *Game Performance Assessment Instrument* (GPAI) to analyze tactics in real game situations, or to apply standardized technical tests specific to padel and pickleball, which would improve the accuracy of motor learning measurements. Furthermore, this study focused on quantitative measurements; it would be useful to complement it with qualitative methods to gain a deeper understanding of the students' experience. Interviews or focus groups with students about their perception of learning under SEM versus traditional methods could provide information on why the model impacts motivation and cohesion from the participants' own perspective.

Furthermore, another area of interest would be to explore the long-term follow-up of the observed effects. For example, it would be valuable to investigate whether the elevated motivation persists for weeks or months after the unit ends, or whether students continue playing padel and pickleball on their own initiative in university recreational programs. Such follow-up assessments could clarify the durability of the SEM effects on attitudes and behaviors toward physical activity. Finally, since this study addressed padel and pickleball together as part of the same design, future studies could analyze each sport separately. This would allow

researchers to determine whether the impact of SEM is consistent across both sports or whether one benefits more than the other, possibly due to its specific characteristics (for example, pickleball, being a relatively new sport, might generate different levels of motivation than the more established padel).

Conclusions

The implementation of the Sport Education Model (SEM) in university-level padel and pickleball instruction produced significant positive effects on student motivation, technical and tactical development, and group cohesion, compared to a traditional approach. SEM proved to be an effective pedagogical strategy for actively engaging students in the learning process by recreating an authentic sporting experience in the classroom. Students using SEM not only learned to play better—improving their skills and understanding of the game—but also enjoyed learning more and felt more united as a group, demonstrating the holistic nature of this model, which addresses motor, cognitive, and socio-affective objectives. These findings support the feasibility of incorporating SEM into higher-level Physical Education programs or university sports courses, especially for participatory sports like padel and pickleball, which benefit from a cooperative and playful approach.

In light of the evidence presented, teachers and curriculum developers are encouraged to consider adopting the Sport Education Model when the goal is to foster committed and sustained participation of young people in physical activity. In the field of racket sports, the SEM offers a structured framework for teaching not only technique but also values such as teamwork, sportsmanship, and independent learning. By placing the student at the center—giving them roles, a voice, and responsibility—this model facilitates meaningful learning that extends beyond the classroom: students develop a more positive connection with the sport and with their peers, which can translate into greater well-being and a stronger sporting habit. Ultimately, the Sport Education Model is presented as an ideal pedagogical innovation for teaching padel, pickleball, and other sports at the university level, promoting high-quality physical education focused both on mastering the sport and on the student's holistic development.

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**ANALYSIS OF TACTICAL INDICATORS IN PROFESSIONAL PADEL: A
NARRATIVE REVIEW OF THE SERVE, RETURN, AND POINT FINISHING**

**ANÁLISIS DE LOS INDICADORES TÁCTICOS EN PÁDEL PROFESIONAL: UNA
REVISIÓN NARRATIVA SOBRE EL SAQUE, EL RESTO Y LA FINALIZACIÓN**

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ABSTRACT

Professional padel has undergone a considerable technical and tactical evolution over the last decade, which requires continuous updating of scientific knowledge. The aim of this narrative review was to provide an integrated analysis of the current scientific evidence on three critical phases of play: the serve, the return, and point finishing. A bibliographic search was conducted in the Web of Science, Scopus, and PubMed databases, and 21 original articles published between 2020 and 2025 that focused on elite performance were selected. The findings show that the serve acts as the main catalyst for positional advantage, although its effectiveness erodes more rapidly in women's padel than in men's padel. The return emerges as the key neutralization tool, showing a marked sex-based dimorphism in the use of the lob and the direct return. Finally, point finishing is defined as a sequential process in which the net is the critical space and the smash stands out not only as a winning shot but also as a generator of forced errors. It is concluded that contemporary padel is moving towards greater tactical stability, in which the reduction of unforced errors and functional specialization according to playing side are decisive. This review provides an updated interpretive framework for optimizing training processes in high-performance contexts.

Keywords: performance analysis; success indicators; tactics; racket sport; elite.

RESUMEN

El pádel profesional ha experimentado una notable evolución técnica y táctica a lo largo de la última década, lo que exige una actualización continua del conocimiento científico. El objetivo de esta revisión narrativa fue proporcionar un análisis integrado de la evidencia científica actual sobre tres fases críticas del juego: el saque, el resto y la finalización del punto. Se realizó una búsqueda bibliográfica en las bases de datos Web of Science, Scopus y PubMed, seleccionando 21 artículos originales publicados entre 2020 y 2025 que se centraran en el rendimiento de élite. Los hallazgos muestran que el saque actúa como el principal catalizador de la ventaja posicional, aunque su eficacia se desgasta más rápidamente en el pádel femenino que en el masculino. El resto emerge como la herramienta clave de neutralización, mostrando un marcado dimorfismo según el sexo en el uso del globo y del resto directo. Finalmente, la finalización del punto se define como un proceso secuencial en el que la red es el espacio crítico y el remate (*smash*) destaca no solo como un golpe ganador, sino también como un generador de errores forzados. Se concluye que el pádel contemporáneo avanza hacia una mayor estabilidad táctica, en la que la reducción de errores no forzados y la especialización funcional según el lado de juego son decisivas. Esta revisión proporciona un marco interpretativo actualizado para optimizar los procesos de entrenamiento en contextos de alto rendimiento.

Palabras clave: análisis del rendimiento, indicadores de éxito, táctica, deportes de raqueta, élite.

Introduction

During recent years, professional padel has undergone a notable evolution in its technical-tactical patterns, which has stimulated growing scientific interest in understanding the factors that condition competitive performance. Although game analysis has traditionally focused on global indicators of effectiveness, recent literature has shown the need to decompose the point into specific functional units that allow more precise interpretation of how advantage is built, neutralized, and resolved during the rally. In this context, the study of the serve, the return, and point finishing has become an especially useful framework for examining the internal logic of the game.

With regard to this initial phase, the serve is no longer understood as a mere action that starts play but rather as a tactical unit that conditions spatial occupation, net acquisition, and the probability of success in the first shots of the exchange. Several studies have shown that the advantage associated with serving is not uniform, but depends on sex, rally duration, and contextual variables such as serve direction, side of execution, and the tactical formation employed (Sánchez-Alcaraz et al., 2020a; Ramón-Llin et al., 2021a; Martín-Miguel et al., 2024a; Conde-Ripoll et al., 2024a; Conde-Ripoll et al., 2025; Mauro et al., 2025). This evidence suggests that the serve should be analyzed not only according to its immediate outcome, but also according to its capacity to generate favorable offensive contexts.

In relation to the response to the serve, the return appears as a less studied action, although it is decisive for neutralizing the initial advantage of the serving pair and reorganizing the tactical structure of the point. The studies by Escudero-Tena et al. (2023) and Sánchez-Alcaraz et al. (2020a) show that the return in elite padel is characterized by high continuity, but also by considerable variability according to sex, side of the court, serve direction, and competitive context. Likewise, more recent research has highlighted that the return should not be interpreted as an isolated response, but as a key link within the serve-return-third-shot sequence, in which the tactical formation of the serving pair conditions the continuity of the exchange (Martín-Miguel et al., 2024a).

Within this framework, point finishing represents the most extensively developed block in the current literature, particularly in relation to the effectiveness of the last shot, the type of terminal action, the execution zone, and the sequences preceding the outcome. Studies agree that competitive performance is associated with a higher production of winners and a lower

frequency of errors, particularly unforced errors (Escudero-Tena et al., 2022a, 2022b; Conde-Ripoll et al., 2024b, 2025b; López-Sierra et al., 2025). Differential patterns have also been identified according to sex, playing side, handedness, and spatial location, highlighting the offensive role of overhead actions and the relevance of the net as the preferred space for resolving the point (Ampuero et al., 2023, 2025; Fernández de Ossó et al., 2025; Martín-Miguel et al., 2025).

Despite advances in research, the available evidence remains dispersed across studies focused on specific phases of play or isolated performance variables. It is therefore appropriate to develop an integrated and updated perspective on the main findings regarding the serve, return, and point finishing. This need is further justified by the dynamic nature of padel, whose tactical demands and playing patterns have shown progressive modifications in recent seasons, both because of the evolution of competitive level and because of the functional specialization of players (Conde-Ripoll et al., 2024b; Ampuero et al., 2023; Fernández de Ossó et al., 2025). Consequently, a theoretical review of these three blocks makes it possible not only to synthesize accumulated knowledge, but also to provide an updated interpretive framework for understanding how performance is structured in contemporary padel.

Unlike previous literature, which often analyzes game actions in isolation, the originality of this review lies in offering a sequential and integrative approach. This perspective makes it possible to understand not only performance in each phase (serve, return, and finishing), but also the tactical interdependence among them in contemporary padel.

Methods

For the preparation of this narrative review, a structured search strategy was followed, aimed at ensuring transparency and comprehensiveness in the selection of scientific evidence.

Search Strategy and Databases

A comprehensive bibliographic search was conducted in the international databases Web of Science (WOS), Scopus, and PubMed. The search period was limited to studies published between 2020 and 2025. English and Spanish descriptors were used and combined with Boolean operators: ("padel" OR

"paddle tennis") AND ("match analysis" OR "performance analysis" OR "tactical analysis" OR "performance indicators").

Selection Criteria

The inclusion criteria were: (a) original peer-reviewed articles; (b) studies focused on the technical-tactical performance of elite male and female players (World Padel Tour or Premier Padel circuits); and (c) investigations that analyzed serve, return, or finishing variables. Conference communications, books, and studies whose samples were exclusively amateur or from developmental categories were excluded, as were purely physical or physiological studies.

Screening and Data Extraction Procedure

The literature selection process was structured into three sequential phases: identification, screening, and inclusion. After the initial database search, duplicate records were removed. Titles and abstracts were then assessed, excluding studies that did not fit the topic or that addressed non-professional samples. Full texts were subsequently evaluated by strictly applying the eligibility criteria, resulting in a final sample of 21 original articles. Data extraction was carried out by systematizing the findings into three major tactical blocks: serve, return, and finishing. For each block, the design, sample, main variables, and magnitudes of effectiveness described in the literature were identified. The coverage analysis showed that 100% (n = 21) of the studies were indexed in WOS, 81% (n = 17) in Scopus, and 57% (n = 12) in PubMed.

Table 1.

Summary of the articles included in the narrative review

Author(s) and Year	Sample (n)	Variables Analyzed	Main Findings
Ampuero et al. (2025)	10,321 shots	Court zones, shot type, effectiveness	The net is the zone with the highest terminal effectiveness; the baseline concentrates unforced errors.
Bueno et al. (2024)	8 matches	Serve direction, return height and	In men, the serve to the side glass exceeds 78%, and the serving pair tends to win more

Author(s) and Year	Sample (n)	Variables Analyzed	Main Findings
	(422 points)	direction, player hitting after the return, point outcome, number of shots	often. In women, the side glass is also the main direction; the serve advantage is smaller. Longer points reduce the advantage of the serving pair.
Cáceres et al. (2024)	40 matches	Winning/losing pairs, errors, winners	Winners commit significantly fewer unforced errors in critical moments.
Cerrillo et al. (2025)	915 points	Return effectiveness, return type, direction, height, player hitting after the return, and point outcome	The return was predominantly a continuity action: 90.2%. Return errors appeared in 9.1%, and winning returns accounted for only 0.8%. Sex differences were observed in direction and height: boys used more down-the-line and low returns; girls used more cross-court returns and lobs.
Conde- Ripoll et al. (2024a)	46 matches	Unforced errors, gender, outcome	The frequency of unforced errors has decreased, indicating greater tactical stability.
Conde- Ripoll et al. (2025)	3,520 shots	Forced-error generators, serve/return	The serve acts as a generator of forced errors, facilitating indirect finishing.
Courel- Ibáñez et al. (2021)	120 matches	Return trajectory, gender	Predominance of the direct return in men and the lob in women to recover the net.
Courel- Ibáñez et al. (2024)	32 matches	Handedness, playing side, tactics	The presence of a left-handed player on the right side balances winner production within the pair.
Escudero- Tena et al. (2021)	120 matches	Performance indicators 2015- 2019	Net effectiveness and winner volume are the best predictors of victory.
Escudero- Tena et al. (2022)	14 matches	Finishing actions, gender	The smash and the volley are the shots with the highest success rate for closing the point.
Escudero- Tena et al. (2023)	20 matches (880 smashes)	Point-finishing smash, smash effectiveness, hitting zone, type of smash,	Point-finishing smashes were predominantly winners. The most effective were flat, down the line, and executed close to the net, especially when the ball went out by x3 or x4.

Author(s) and Year	Sample (n)	Variables Analyzed	Main Findings
		direction, and mode of finishing	
Escudero- Tena et al. (2024a)	64 matches	Gender disparities, finishing actions	Women show greater tactical variability under pressure than men.
Escudero- Tena et al. (2024b)	28 matches	Altitude, performance, gender	Altitude increases game speed and modifies smash effectiveness.
Fernández de Ossó et al. (2025)	80 players	Level (Amateur/Pro), errors, shot	Professional players commit fewer backhand errors and manage double-wall situations more effectively.
García- Benítez et al. (2021)	40 matches	Errors and winners by playing side	The backhand-side player assumes greater finishing responsibility in the men's circuit.
García- Benítez et al. (2024)	82 matches	Shot effectiveness, winning teams	Winning teams are more efficient in the defense-to-attack transition (lob-net).
López- Sierra et al. (2025)	120 matches	Tactical indicators, terminal effectiveness	The flat smash and forehand volley are the most determinant shots in 2024-2025.
Martín- Miguel et al. (2024a)	24 matches	Serve-return-third- shot sequence	The Australian formation conditions serve direction and the intervention of the server.
Martín- Miguel et al. (2024b)	24 matches	Off-the-wall smash, effectiveness	The off-the-wall smash is mainly a shot for continuity and advantage construction.
Martín- Miguel et al. (2025)	4,962 shots	Two-shot sequences, effectiveness	Sequences such as volley-smash are critical predictors of point success.
Mauro et al. (2025)	80 matches	Serve tactics, direction, effectiveness	The serve to the T from the right side with Australian formation is highly effective.
Muñoz et al. (2021)	80 matches	Serve and return strategies, gender	The flat serve increases the probability of winning the point directly in men.
Muñoz et al. (2023)	160 matches	Rally length, performance	Short exchanges favor the serving pair; long exchanges favor the returning pair.

Author(s) and Year	Sample (n)	Variables Analyzed	Main Findings
Ramírez-Ortega et al. (2025)	8 matches (1,068 shots)	Last shot of the point, winning shot, error, court zone, type of finishing	No significant sex differences were found in the zone of the last shot; men and women finished approximately 40% of points from the middle zone. Men produced more winners by bringing the ball back to their own court, whereas women finished more often through a double bounce. Approximately half of the errors ended in the net.
Sánchez-Pay et al. (2023)	1,080 serves	Serve direction and speed-accuracy parameters	Speed and accuracy increase with category, weekly training hours, and experience. Serve side and direction did not have a relevant influence on speed/accuracy.
Sánchez-Alcaraz et al. (2024)	80 matches	Serve tactics, game dynamics	The sidespin serve facilitates net acquisition and third-shot control.

Results

Serve

In general, the superiority of the serving pair has been observed to a greater extent in men than in women and decreases as the length of the exchange increases. In men, this superiority is maintained until approximately the 12th shot, whereas in women it is lost after the 7th shot. In addition, the second serve increases the likelihood of losing the point.

Consistent with this trend, Bueno-García et al. (2024) observed in professional padel that, in the men's category, the serving pair tends to win the point regardless of the tactic employed, whereas in the women's category the difference between winning and losing the point on serve is smaller, especially when a traditional strategy is used. In addition, men recorded an average of 9.64 shots per point, winning service points with shorter exchanges and losing them when the exchanges extended to an average of 11.56 shots; in women, the average was 11.09 shots, with a similar trend between points won and lost on serve.

Mauro et al. (2025) indicate that decisive combinations exist among serve direction, side of execution, and tactical formation. Serving to the middle and center of the court from the left side with a conventional formation increased

the probability of winning, whereas doing so from the right side reduced it. Regarding court side, the serve toward the side wall predominates on the left side, while the frequency of serves to the center of the court increases on the right side, especially in the Australian formation. Ramón-Llin et al. (2021a) observed that the serving pair won a higher percentage of points when using the traditional tactic than when using the Australian tactic, with this effect becoming even more pronounced when the point was extended. With regard to depth, most serves did not reach the back wall and did not show an isolated significant effect, although they did show an effect in interaction with direction.

Complementarily, Bueno-García et al. (2024) confirmed that the serve toward the side glass is the predominant direction in both professional men and women. In men, this direction exceeded 78% of serves and was especially frequent in key points, whereas in women it ranged approximately between 71% and 89% depending on the type of point.

From a more technical-conditional perspective, Sánchez-Pay et al. (2023) analyzed 1,080 serves by 45 male amateur players and showed that serve speed increases progressively with category, from under-14 to senior level. In addition, weekly training hours had a positive influence on speed and accuracy, and greater experience was associated with greater serve accuracy. However, serve side and direction—glass or “T”—did not significantly influence speed or accuracy in amateur serves.

At the level of point performance, the service situation is associated with greater production of winners and shots that generate forced errors. The serving pair obtains better results in short exchanges, producing more winners and fewer errors, especially when it belongs to the set-winning pair. Finally, two out of every three off-the-wall smashes were executed by the serving pair.

Return

Practically all serves are returned in professional padel (with effectiveness above 90%), confirming the limited presence of aces. Escudero-Tena et al. (2023) observed that the direct return predominates in men, whereas the lob is more frequent in women. Serves directed at the server are mostly returned directly, whereas those directed at the partner are more frequently returned with a lob. In golden points, lob use increases significantly. Women use the backhand and cross-court trajectories more frequently. Likewise, from the left side, more down-the-line returns and more backhands are observed, whereas on the right side there is a more balanced distribution.

Bueno-García et al. (2024) provide convergent findings in professional padel, indicating that in men the return is distributed in a balanced manner between lob and flat return, whereas in women the lob is the predominant height, appearing in approximately six out of every ten returns. Regarding direction, in men the down-the-line return was more frequent in non-key points and the cross-court return in key points, whereas in women a slight tendency toward the cross-court return was observed.

In the high-level U-18 context, Cerrillo-Lafuente et al. (2025) observed that the return behaves fundamentally as a continuity action: the point continued after the return on around 90% of occasions, return error occurred in approximately 9%, and the winning return barely reached 1%. In addition, most returns were executed with the backhand, with a frequency close to 60%.

The formation of the serving pair affects the third shot: in the Australian formation, if the serve goes to the side wall, the server is more likely to intervene; if it goes to the T, the intervention of the partner increases. With a conventional formation, serving to the side wall clearly increases the probability that the server's partner will intervene. After the return, the backhand volley predominates in serves to the side wall and the bandeja in those directed to the T.

Cerrillo-Lafuente et al. (2025) also showed that the serve strategy conditions return direction in U-18 padel: with the traditional formation, the cross-court return predominated, whereas with the Australian strategy the use of the down-the-line return increased. In addition, U-18 female players used the lob approximately 12% more than male players and used the cross-court return around 15% more than their male counterparts.

With respect to effectiveness, pairs that lost the set showed a higher frequency of unforced errors on the return. Although forced errors generally increase in return situations, winning pairs in long exchanges achieved more winners and fewer forced errors than losing pairs. Along the same lines, Bueno-García et al. (2024) indicated that, in men, the serving pair tends to win the point regardless of return height, return direction, or the player hitting after the return, although the use of the lob reduces the percentage of points won on serve. In women, flat and cross-court returns, as well as the intervention of the server's partner after the return, were associated with more balanced situations and even with a higher probability of success for the returning pair.

Point Finishing

Points frequently end through a winner or an unforced error. In general, men's padel shows a higher proportion of winners and a lower presence of errors than women's padel, and set-winning pairs record more winning actions and fewer errors than losing pairs. The frequency of unforced errors has decreased progressively in recent seasons. In the comparison by sex, men committed more unforced errors and women more forced errors. Specifically, women committed more forced errors with the backhand and the double wall, whereas men did so with the counter-wall shot and the drop shot.

Ramírez-Ortega et al. (2025) specifically examined the distribution of winners and errors in professional padel, showing that both men and women performed approximately 40% of finishing shots from the middle or transition zone, with no significant sex differences in the execution zone of the last shot. This result reinforces the growing role of the middle zone as a relevant space not only for construction, but also for resolving the point.

Overhead actions are the most effective for producing winners. In men, smash variants predominate, whereas in women the bandeja and the forehand volley stand out. The flat and topspin smashes show winner percentages close to 60%, whereas the off-the-wall smash, which mainly generates continuity, presents the highest proportion of errors. The bandeja includes both offensive construction actions and a relevant proportion of unforced errors, whereas the backhand volley accounts for more forced errors.

Escudero-Tena et al. (2024), in their analysis of point-ending smashes at the Qatar Major Premier Padel 2023, observed that flat and topspin smashes, executed down the line and from areas close to the net, were the most effective for finishing the point, especially when the ball left the court by three or four meters. By contrast, sliced and cross-court smashes were associated with a higher probability of error, particularly when the ball remained in the player's own court or hit the fence or glass of the opponent's court directly.

Among winning shots, Ramírez-Ortega et al. (2025) further reported that men finished more often by bringing the ball back into their own court, whereas women did so mainly through a double bounce in the opponent's court. Regarding errors, the net was the most frequent destination in both men and women, followed by the back wall.

From a sequential perspective, sequences such as volley-smash, volley-volley, or lob-recovery smash are especially effective. Men showed greater effectiveness in patterns culminating in a smash, whereas women stood out

in sequences involving lobs, shots after the bounce, and transition actions. With regard to match moments, in men's padel the difference between errors and winners increases in critical moments, whereas women reduce this difference under maximum pressure.

With regard to space, volleys and smashes proliferate at the net and show high probabilities of producing a winner; the transition zone is relevant for the *bandeja* and the smash, which are associated with continuity, winners, and unforced errors; and the baseline concentrates continuity actions and unforced errors. With regard to handedness, right-handed players recorded a higher proportion of winning shots and cross-court trajectories, whereas left-handed players used more down-the-line shots. Finally, left-side players performed a higher proportion of winners and switching displacements, whereas right-side players performed a higher percentage of continuity shots.

Discussion

The reviewed evidence supports the view that the serve in padel should not be interpreted merely as an action that puts the ball into play, but rather as an initial tactical unit that conditions spatial occupation, positional advantage, and the probability of success in the early phases of the rally. The findings show that the service patterns most frequently used by professionals do not always coincide with the most effective ones, revealing a margin for tactical optimization. Likewise, the association of the serve with a greater production of shots that generate forced errors suggests that the serve favors the construction of offensive scenarios and the capacity to impose the initial rhythm of play, rather than the immediate achievement of the point. The subsequent dynamic, such as the frequency of off-the-wall smashes by the serving pair, confirms that the serve initiates a sequence in which the pair takes the net, forces the opponent's lob, and has opportunities to finish.

The findings of Bueno-García et al. (2024) reinforce this interpretation, as they show that serve advantage depends on sex, point type, and rally duration. The tendency of servers to win shorter points and to lose advantage when the exchange is prolonged confirms that the serve generates an initial advantage, but does not guarantee success if the returning pair manages to stabilize the rally.

Likewise, the data reported by Sánchez-Pay et al. (2023) broaden the understanding of the serve beyond the professional context by indicating that service quality in amateur players is more strongly conditioned by

developmental factors—category, experience, and training hours—than by serve side or direction. This suggests that, in non-professional stages, improvement in the serve may depend primarily on technical-conditional consolidation rather than tactical sophistication.

For its part, the return constitutes a decisive action for neutralizing the initial advantage of the serve and reorganizing the tactical structure of the rally. Since direct service points are almost absent at the elite level, the return emerges as a highly stable and low-terminality response that seeks tactical continuity. The variations observed according to sex, direction, and the opponents' formation suggest that the return is not a homogeneous response, but rather an action highly modulated by the spatial context and the player's tactical profile.

Consistent with this interpretation, Cerrillo-Lafuente et al. (2025) confirm in high-level U-18 padel that the return is an action with high stability and low terminality, since it allows point continuity on the vast majority of occasions and rarely produces a direct winner. In addition, the differences observed according to sex and serve strategy indicate that the return should be trained according to the tactical context, especially in traditional or Australian formations.

Regarding point finishing, the general evidence indicates that competitive performance depends on maximizing winners and minimizing errors, which aligns with the progressive decrease in unforced errors in the professional circuit and points to a clear evolution towards greater tactical and technical stability. The data confirm the existence of sex-specific technical-tactical patterns, involving a more decisive men's style based on powerful offensive actions (smash variants) and a women's style with greater relative effectiveness in construction shots.

The contributions of Ramírez-Ortega et al. (2025) allow this interpretation to be refined by showing that finishing does not depend exclusively on the net or the baseline, but that the middle zone assumes a leading role in resolving the point. In addition, the differences between men and women in how winning shots are achieved—bringing the ball back to their own court in men and through a double bounce in women—reveal differentiated finishing profiles.

It is essential to emphasize the spatial and sequential dimension of finishing. Proximity to the net is confirmed as the decisive factor in terminal effectiveness, which indicates that point finishing cannot be explained solely by the type of shot, but also by the location from which it is executed. Likewise,

terminal success depends on immediately preceding construction patterns, such as the volley-smash sequence. This perspective broadens the traditional view centered on the isolated last shot, demonstrating that finishing should be understood in interdependence with the serve and the return.

In the specific case of the smash, Escudero-Tena et al. (2024) reinforce the importance of location and shot type by showing that point-ending smashes are more effective when executed close to the net, with a down-the-line trajectory and through flat or topspin smashes. These findings support the idea that effective finishing does not depend solely on shot power, but on the combination of smash type, direction, execution zone, and the way in which the ball concludes the point.

Finally, the differences observed according to court side reinforce the existence of highly specialized functional roles within the pair: a backhand-side player with a markedly offensive and finishing profile, and a forehand-side player oriented toward construction, balance, and maintenance of the exchange. The integration of these findings makes it possible to distinguish between the shot that directly wins the point and the shot that resolves it indirectly, offering a deeper understanding of how elite players build and materialize competitive advantage.

Conclusions

This review proposes an integrated interpretation of the internal logic of professional padel, concluding that performance does not depend on isolated actions, but on the tactical interdependence among the three phases of the point.

First, the serve is established as the main generator of positional advantage. Its effectiveness does not lie in power, but in the interaction between direction and control of the third shot, especially through the use of the Australian formation. This superiority is concluded to be an ephemeral advantage that disappears significantly faster in women's padel than in men's padel, establishing a critical threshold of rally duration according to sex.

Second, the return is confirmed as the essential neutralization tool. There is a marked dimorphism in this phase: men prioritize the direct return to accelerate the transition and force the error at the net, whereas women use the lob as a strategic resource to reverse the initiative. Technical stability in this phase, by minimizing unforced error, is a distinctive feature of elite pairs.

Third, finishing has evolved towards a sequential model in which the net is the critical space for resolution. Success in closing the point depends not only on the winning shot (winner), but also on the capacity to execute previous actions that act as generators of forced errors in the opponent, thereby redefining the concept of terminal effectiveness.

Finally, it is concluded that padel is moving towards greater technical stability and functional specialization of players according to their playing side. Future research should integrate new metrics of sequential analysis to continue deepening the understanding of this constantly evolving sport.

The main contribution of this work is to overcome the fragmented view of game analysis by demonstrating that effectiveness in contemporary elite padel is based on an interdependent tactical sequence.

Practical applications

With regard to intervention guidelines for the serve-return sequence, this review suggests that training should be approached as an integrated technical-tactical sequence rather than as isolated actions, since both phases decisively condition the initial organization of the point. In this sense, on-court work should be oriented toward training directions, intentions, and responses following the serve and the return, enabling the player to learn to use the serve to generate spatial or temporal advantage and the return to neutralize the opponent's initiative or assume control of the exchange. These tasks should also be developed in representative contexts, with real opposition and temporal structures close to competition, adjusting their complexity to the player's category. In this way, serve-return training ceases to focus exclusively on the mechanical effectiveness of the gesture and becomes oriented toward the player's capacity to make functional decisions from the beginning of the point.

With regard to finishing, intervention should be aimed at training situations in which the player recognizes a real opportunity to close the point and executes a technical response consistent with the advantage previously constructed. Based on the evidence presented in this review, finishing should not be understood as an isolated terminal shot, but as the result of a tactical construction sequence that generates imbalance in the opponent and creates the appropriate context for defining the point. Therefore, on-court work should include tasks that promote the identification of attackable balls, the selection of the appropriate moment to accelerate or change direction, and

effective spatial occupation after the finishing shot. All of this should be adapted to competitive category and maintained within representative game situations, so that improvement in finishing responds not only to criteria of technical precision, but also to the tactical understanding of when and how to close the point effectively.

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