



SMASH TESTS IN FINNISH MEN'S PADEL: RANK 1-5 VS. RANK 10-25

TEST DE REMATE EN EL PÁDEL MASCULINO FINLANDÉS: RANKING 1-5 VS. RANKING 10-25

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ABSTRACT

This study examines physical and technical characteristics in high-level men's padel from Finland. 10 top-25 male athletes who were divided into two groups (top-5: $n = 4$, 30.8 (± 4.3) years old, 184.5 (± 5.9) centimeters tall, laterality: three right-handed and one left-handed; and ranking between 10 and 25: $n = 6$, 28.8 (± 4.4) years old, 185.7 (± 5.1) centimeters tall, laterality: 6 right-handed) took part in the study. The following tests were carried out: countermovement jump, medicine ball overhead throw, medicine ball shotput, powerful smash and smash over the fence. Results showed that there were significant differences in the overhead medicine ball throw test ($p = .031$) between the two groups. In conclusion, this study highlights that technical and physical characteristics slightly differ between the best players in Finland (top 5) and those ranked between 10 and 25.

Keywords: racket sports; performance, game analysis, notational analysis.

RESUMEN

Este estudio examina las características físicas y técnicas en el pádel masculino de alto nivel de Finlandia. Participaron en el estudio 10 deportistas masculinos del top-25 divididos en dos grupos (top-5: $n = 4$, 30,8 ($\pm 4,3$) años, 184,5 ($\pm 5,9$) centímetros de altura, lateralidad: tres diestros y un zurdo; y clasificación entre 10 y 25: $n = 6$, 28,8 ($\pm 4,4$) años, 185,7 ($\pm 5,1$) centímetros de altura, lateralidad: 6 diestros). Se realizaron las siguientes pruebas: salto con contramovimiento, lanzamiento de balón medicinal por encima de la cabeza, lanzamiento de balón medicinal, smash potente y smash por encima de la valla. Los resultados mostraron que había diferencias significativas en la prueba de lanzamiento de balón medicinal por encima de la cabeza ($p = ,031$) entre los dos grupos. En conclusión, este estudio pone de relieve que las características técnicas y físicas difieren ligeramente entre los mejores jugadores de Finlandia (top 5) y los clasificados entre el 10 y el 25.

Palabras clave: deportes de raqueta; rendimiento, análisis del juego, análisis notacional.

Introduction

Padel has emerged as one of the most rapidly expanding sports worldwide, boasting representation in over 80 countries under the umbrella of the International Padel Federation (IPF) (International Padel Federation, 2024). This surge in popularity has prompted a notable upswing in scientific research focused on padel (Conde-Ripoll, Escudero-Tena et al., 2024; Dahmen et al., 2023; García-Giménez et al., 2022; Martín-Miguel, Escudero-Tena et al., 2023; Ortega-Caballero et al., 2024).

From a gameplay standpoint, professional padel has evolved in recent years, transitioning into a more intense sport (Ungureanu et al., 2024) characterized by a decline in unforced errors, a trend projected to persist (Conde-Ripoll, Muñoz, Sánchez-Alcaraz et al., 2024). Match-winning pairs produce a higher rate of winners and commit fewer errors compared to match-losing pairs (Escudero-Tena et al., 2021; Sánchez-Alcaraz et al., 2022). Among the technical-tactical actions padel players execute during a match, the smash stands out as one of the shots with a higher ratio of winners to errors (Escudero-Tena et al., 2024; Escudero-Tena, Muñoz et al., 2022; Mellado Arbelo et al., 2019). Furthermore, professional padel players who win, perform more attacking actions in 85% of the points, spend more time in the net area and make more smashes (Sánchez-Alcaraz et al., 2020). On the contrary, losing pairs tend to lose more long points, perform fewer attacking actions per point and per game, perform more groundstrokes with or without wall during the match and make more bandejas (Sánchez-Alcaraz et al., 2020). Thus, there is a direct relationship between winning points and occupying areas close to the net (Courel-Ibáñez et al., 2019; Escudero-Tena et al., 2023).

From a biomechanical point of view, the smash is one of the most complex actions in padel. Similar to that in tennis with the serve (Elliot, 2006; Kibler, 1995), the proper execution of a powerful smash in padel hinges on a proficient kinetic chain, requiring the coordinated and sequential engagement of multiple body regions (leg, trunk, shoulder, elbow, and wrist). One big difference is that the ball is tossed by the own player in the tennis serve, whereas the ball is received from the opponent, usually through a lob with or without the wall, in the padel smash. In fact, there are also differences in the outcome between a smash in tennis and padel, since a padel smash usually implies a rebound in the opposing back wall that may produce a counterattack. Therefore, physical testing related to the padel smash is a complex action that should involve a kinetic chain from the ground up.

It is worth mentioning that there are two type of tests depending on

where and how they are implemented: laboratory tests and field tests (MacDougall et al., 1991; Reilly et al., 2009). The latter should be simple and practical so that padel coaches could implement the tests on a regular basis with their players (Boullosa et al., 2023). Actually, there should ideally be a large database with results of battery tests and single tests in order to profile athletes depending on their gender, age (both biological and chronological) and level. Similar databases already exist in other sports, such as tennis (Ulbricht et al., 2013). However, this has been scarcely done in padel (Courel-Ibáñez & Herrera-Gálvez, 2020; Courel-Ibáñez & Llorca-Miralles, 2021; Pradas, Sánchez-Pay et al., 2021), which is relatively a new sport. Hence, there is a need to develop these tests in the context of padel, since their peculiarities differ from other racket sports, especially in the context of smash situations, which are more usual and more difficult to solve when compared to tennis.

The aim of the present study was to analyze and contrast the findings of physical and technical evaluations related to the padel smash among male padel competitors positioned in the top 5 ranking versus those positioned between ranks 10 and 25 in Finland. We hypothesized that top-5 players would show better results in both physical and technical tests related to the padel smash than the players ranked between 10 and 25.

Methods

Study variables

The dependent variables of this study were the height of the countermovement jump, the distance of the medicine ball overhead throw, the distance of the medicine ball shotput throw, the distance of the powerful smash and the effectiveness of the smash by three meters. The independent variable was the players' ranking (top-5 group vs. players ranked between 10 and 25).

Countermovement jump (CMJ). To assess lower-limb explosive power, a double leg vertical CMJs without arm swing (i.e., with the hands on the hips) was performed using My Jump Lab app (Balsalobre-Fernández et al., 2015; Bishop et al., 2022). Each player performed 2 maximal attempts interspersed with 45 seconds of passive recovery, and the maximum height (centimeters) was then computed. This test has been carried out in multiple studies (Claudino et al., 2017; Ulbricht et al., 2013).

Overhead medicine ball throw (MBT OH). Holding a two-kilograms medicine ball (Pro's Pro two kilograms, Österreich, Germany), the players stood at a line

facing the throwing direction with the feet side-by-side and slightly apart. After the ball was brought back behind their head with two hands, it was thrown forward as far as possible without moving the feet and not crossing the line, to perform overhead MBT. The distance was measured between the starting line and the point where the ball landed. Each player performed two repetitions, interspersed with 45 seconds of passive recovery and the maximum distance was then computed. This test has been carried out in multiple studies (Sánchez-Alcaraz et al., 2018; Ulbricht et al., 2013).

Shot put medicine ball throw (MBT SP). Holding a two-kilograms medicine ball (Pro's Pro two kilograms, Österreich, Germany), the players stood at a line, as if they were about to smash, facing sideways the throwing direction with the feet side-by-side and slightly apart. The ball was held on the palm of the dominant hand. Then the ball was brought to the side of the head, bending knees while keeping the no dominant arm raised up. After that, the medicine ball was thrown forward as far as possible. Unlike Sánchez-Pay et al. (2021), in our study, we allowed players to cross the line and move the feet, so that the action was more similar to a padel smash. Each player performed two repetitions interspersed with 45 seconds of passive recovery, and the maximum distance was then computed. It is worth mentioning that Sánchez-Pay et al. (2021) concluded that the MBT shot put test is a reliable test to evaluate an analogous total-body movement pattern similar to the kinetic chain to tennis serve (Sánchez-Pay et al., 2021).

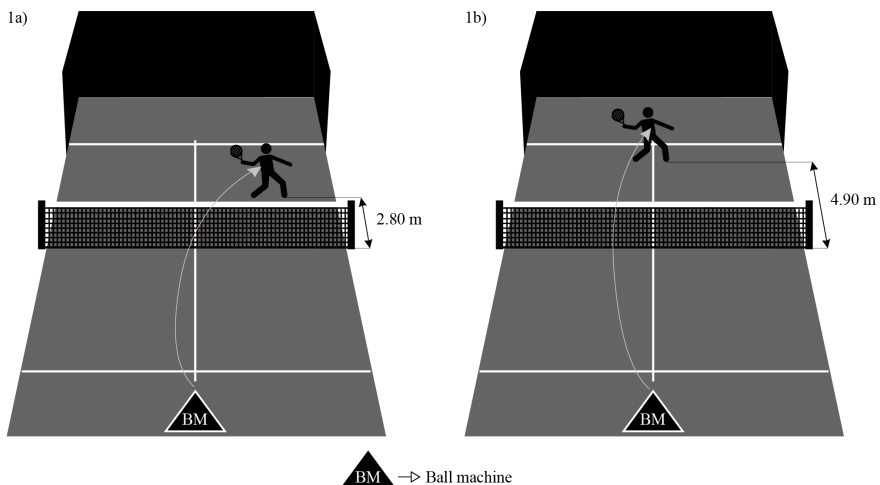
Following extensive discussions among four padel experts, the “Powerful smash” and “Over the fence smash” tests were proposed and subsequently implemented in this study. Among these experts, three hold PhDs and serve as padel coaches and tutors for various federations and universities, while the fourth is a padel coach, tutor and PhD candidate. These tests were designed to be practical and easily implemented by any padel coach.

Powerful smash. The powerful smash test (Figure 1a) consisted of eight down the line smashes, performed 2.80 meters from the net, from the left side of the court (from the right side of the court for left-handed players). Players were asked to smash so as to bring the ball back as close as possible to the own back wall. Each attempt interspersed with 10 seconds of passive recovery and the maximum distance was then computed. The execution was considered correct if the player hit the smash, the ball bounced in the opponent's court, bounced on the opponent's back wall and bounced back in the player's court without touching any other part of the court (i.e. fence). Thus, the total distance of the smash was collected and measured from the

sum of the outward distance of the ball (the distance between the player and the net (2.80 meters) and the distance between the net and the opponent's back wall (10 meters)) and the return distance of the ball (the distance between the opponent's back wall and the net (10 meters) and the distance between the net and the bounce of the ball in one's own court). A ball machine (Spinfire Pro 2, Fitzroy, Australia) was used for this test. New balls (Bullpadel Next FIP) were employed.

Over the fence smash. The over the side fence smash test (Figure 1b), or smash by 3 meters' test, consisted of eight smashes, performed 4.90 meters from the net, from a wide centered position. Each attempt interspersed with 10 seconds of passive recovery and the average distance was then computed. The execution was considered to be correct if the player smashed, the ball bounced in the opponent's court, on the opponent's back wall and over the three-meter high side fence. This is considered to be an effective smash. A ball machine (Spinfire Pro 2, Fitzroy, Australia) was used for this test. New balls (Bullpadel Next FIP) were employed.

Figure 1. Smash tests. Figure 1a represents the set up for the powerful smash test (PS); Figure 1b represents the set up for the over the fence smash test (OFS).



Participants

Non-randomized convenience sampling was carried out two weeks prior to a Finnish Padel Tour tournament. Ten adult high-level (top 25 in Finland)

male padel players from Finland agreed to take part in the study. Players were classified according to their ranking in two groups: top level (TL) (n = 4; ranking = 1-4 Finnish Ranking) and non-top level (NTL) (n = 6; ranking = 10-25 Finnish Ranking). The mean age of the players was 29.4 ± 4.06 years, with a mean height of 185.2 ± 5.15 centimeters. The specific characteristics of each player are shown in Table 1. Written informed consent was obtained from all participants. At the time of the measurements, none of the athletes had physical injuries, nor were they using any medication. Furthermore, none of the participants had any hindrance to their involvement in the study. The study was in accordance with the Helsinki Declaration (World Medical Association, 2013). Previously, the current investigation had been approved by the Ethics Committee of the European University of Madrid with the code CIPI/22.303.

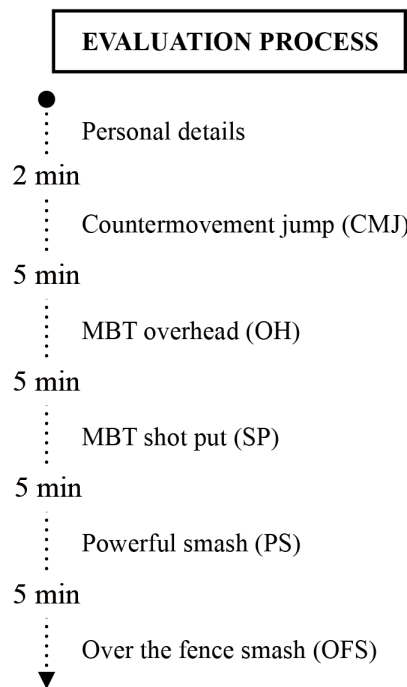
Table 1. *Characteristics of the participants.*

Player	Finland Ranking	Age (years)	Height (centimeters)
1	1	28	188
2	2	36	191
3	3	26	180
4	4	32	179
5	11	30	177
6	12	35	183
7	15	26	185
8	16	29	189
9	18	29	190
10	23	23	190

Procedures

Testing protocols were conducted in the same day, during a regular training session. To ensure standardization of test administration all tests were performed into the same order, using the same testing devices, measurement protocols and operators (Figure 2). The test session was performed at the Padel Club Tampere Linnakallio New, a sports complex with indoor, official padel courts and an air-conditioning system, which keeps the club at around 18 Celsius degrees all year round. The test session was performed between 9:30 and 11:00 hours, 24 hours after the last training session and 2 hours post-prandial. A specific dynamic warm-up routine was carried out before the tests, consisting of static bicycle activation, jumping jacks, dynamic joint mobility exercises, elastic band and isometric strength exercises, and plyometric strength exercises. Each test session lasted approximately 25-35 minutes. All participants were familiarized with the tests before the evaluation began and they could hydrate at will in breaks between tests. No injuries or incapacities were reported.

Figure 2. *Experimental protocol*



Statistical analysis

A Shapiro-Wilk test was used to test the normality of the distribution of the data and it indicated that it is parametric. The mean and standard deviation have been determined as descriptive analysis. Next, inferential analyzes were carried out to analyze the differences between the physical and technical factors with the independent variable ranking (top level/non-top level). Independent sample t-tests were used. Additionally, effect sizes (Cohen's d) were calculated and can be interpreted as small (.20 to .49), moderate (.50 to .79) and large ($d \geq .80$) (Cohen, 1988). All data were analyzed using the statistical package SPSS for Macintosh v.25.0 (SPSS Inc, Chicago, IL, United States). A p value of less than .05 was considered to be statistically significant.

Results

Table 2 shows the differences in the tests between top-5 ranked and players ranked between 10 and 25.

Table 2. Differences in physical and technical tests between players ranked top-5 and players ranked between 10 and 25.

Test	TL		NTL		p	d	
	M	SD	M	SD			
Physical	CMJ (centimeters)	38.25	5.79	38.62	8.57	.943	.05
	MBT OH (meters)	13.13	1.29	11.40	.94	.039*	1.60
	MBT SP (meters)	15.06	1.43	14.96	1.53	.917	.07
Technical	PS (meters)	30.01	.90	30.67	.79	.255	.79
	OFS (percentage)	84.38	6.25	58.33	28.14	.074	1.41

Note. TL = top level (top-5); NTL = non-top level (ranking 10-25); M = mean of the maximum attempts of each player; SD = standard deviation; p = p-value; d = Cohen's d; CMJ = countermovement jump; MBT = medicine ball throw; OH = overhead; SP = shot put; PS = powerful smash; OFS = over the fence smash; *p < .05

Top-5 players performed significantly better at the MBT OH test (p = .039) compared to players ranked between 10 and 25.

Discussion

The study aimed to analyze and contrast the findings of physical and technical evaluations related to the padel smash among male padel competitors positioned in the top 5 ranking versus those positioned between ranks 10 and 25 in Finland.

The results demonstrated that neuromuscular strength values obtained by jump height in a CMJ do not differentiate between top-5 and 10-25 ranked players in Finland. The CMJ jump height exhibited values between 36-37 centimeters. These values are slightly lower than those reported by Sánchez-Muñoz et al. (2020), who found an average jump height of 43.3 centimeters in professional players with active participation in the World Padel Tour (WPT). This suggests that the data may indicate that, due to a lower level of professionalization of players in Finland compared to WPT players, the physical preparation is not as demanding, resulting in lower values. Conversely, the presented results are more similar, although slightly higher than those proposed by Pradas, García-Giménez et al. (2021) and Pradas, Sánchez-Pay et al. (2021), which indicate jump height values in the CMJ between 31-34 centimeters in WPT players. Consequently, the proposed results, in conjunction with those indicated in these studies, can establish optimal average jump height values of approximately 37 centimeters, with a range of 31 to 43 centimeters. It is therefore important to continue analysing this issue. A comparison of the results with previous studies reveals a difference of 10 centimeters in jump height between female professional players (Ortega-Zayas et al., 2024) and players aged 14 and 16 (Pradas et al., 2022). This indicates that the reference values should be adjusted according to the characteristics of the player, taking into account gender and maturational age. Finally, it is important to highlight the values obtained by Bustamante-Sánchez et al. (2024), which showed a difference of approximately 10 centimeters in jump height between world top-20 players and those obtained in this study. This discrepancy may be attributed to a lack of familiarity with the jumping protocols, as the authors suggest, with the more specialized the athlete is in these movements, the better the resulting values.

In rotational power sports such as padel, the generation of maximum angular velocity in the strokes is dependent on the ability of the athlete to perform explosive movements in the transverse and oblique planes (Earp & Kraemer, 2010). Consequently, medicine ball throws such as the MBT-OH and MBT-SP offer a highly effective replication of padel strokes, particularly in the case of overhead shots (smashes). In relation to these parameters, the results

demonstrate a difference between both groups in the throwing distance, with the top-level group achieving .12 meters more in the MBT-SP, and 1.72 meters more in the MBT-OH. Notably, the latter test was significantly higher in favour of the higher-ranked players. Previous studies on padel players, which have analyzed medicine ball throws, have used a weight of 3 kilograms (Courel-Ibáñez & Llorca-Miralles, 2021; Müller & Del Vecchio, 2018), making it impossible to compare the results. Nevertheless, strength is known as a crucial factor in athletic performance (Suchomel et al., 2016), with the force applied during overhead throws serving as a differentiating factor between top-5 and 10-25 ranked players. Consequently, a greater application of force in this movement may be associated with a greater application of force in the different overhead shots (bandeja, vibora, smashes and off the wall smash).

Concerning the technical tests, no significant differences were found between the two groups in the powerful smash (Top-5: 29.16 meters; ranking 10-25: 29.62 meters) and in the over-the-fence smash (Top-5: 84.38 %; ranking 10-25: 58.33 %). However, in the latter, there is a 26 % difference in effectiveness in favor of the pair with the higher ranking. Although this difference is not significant, probably due to the small sample size, it may be a differentiating factor influencing the ranking of the players. It has been observed that smashes are a significant factor in determining the outcome of a match in padel (Sánchez-Alcaraz et al., 2023), particularly in men's padel, where they are used to achieve a high number of winners (Conde-Ripoll, Muñoz, Escudero-Tena et al., 2024; Escudero-Tena, Almonacid et al., 2022; Mellado Arbelo et al., 2019), resulting this in a crucial factor differentiating the winning and losing pair (Martín-Miguel, Muñoz et al., 2023). In this context, a lower efficacy in the over-the-fence smash by lower-ranked players may be a limiting factor at these levels, since the counter-smash (off the wall(s) smash executed after the opponent's smash) provides an important number of winners in men's padel (Martín-Miguel et al., 2024). Consequently, the results may indicate that a lower efficacy in the smash by lower-level players is attributable to both physical and technical factors. On the one hand, this may be due to a lower ability to apply force in overhead shots, which could be attributed to physical limitations (Girard et al., 2005; Hernández-Davó et al., 2019). On the other hand, it could be attributed to a lower ability to perform the shot efficiently, which could be attributed to technical limitations (Rebelo et al., 2013; Söğüt, 2017). Therefore, coaches of lower-ranked players should focus on improving the physical capabilities of the players, as well as the technical qualities in overhead shots.

Practical applications

The use of MBT in sports training is growing as practitioners see the wide range of skills that can be trained or simulated, so strength and conditioning coaches could use medicine balls to train the specific biomechanical variables required for success in their particular sport (Genevois et al., 2013; Stockbrugger & Haennel, 2001; Szymanski et al., 2007).

Strengths

This study was strengthened by the novelty of the sample (high-level padel players from Finland) and because it is important to note that the use of field tests enhance replicability and applicability to the training practice (Pyne et al., 2014).

Limitations and future studies

The research was limited by a small sample size ($n = 10$) consisting solely of male players from Finland. Therefore, future studies should consider including female players to explore potential sex differences, as well as examining variations across different age groups and skill levels from other countries. Despite these limitations, the findings provide valuable insights into physical and technical assessments related to the padel smash among high-level players.

Moving forward, it would be beneficial to incorporate a broader range of strength exercises commonly prescribed by strength and conditioning coaches (e.g., squats, bench press, tricep curls). This expansion would enable a more comprehensive investigation into the direct relationship between these exercises and padel performance.

Furthermore, future research should focus on validating the proposed smash tests and developing a rating score to evaluate smash technique. These steps are crucial for advancing the sport and enhancing the accuracy of performance assessments.

Conclusions

Minor differences in physical and technical parameters have been found among top-level male padel players, which may influence competitive performance. Regarding physical parameters, the CMJ and MBT SP values do not differ between groups. The results demonstrated a jump height of 36.88-37.04 centimeters and shot put throw distance of 14.69-14.81 meters, which

can be utilized as optimal reference values in the physical preparation of padel players. The MBT OH exhibited a difference of 1.72 meters with superior values from the top-5 group. This test can be replicated to technical padel strokes such as groundstrokes, which may indicate a greater application of strength and better tolerance to fatigue in competition in these strokes by the top-5 players. However, the technical parameters do not show significant differences between groups. The group with a ranking of 10-25 obtained 26.05 % less effectiveness in the over the fence smash. This reduced effectiveness can be extrapolated to competition, resulting in a diminished advantage with this shot and the potential for more counterattacking options for the opposing pair.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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Declaration of interest

The authors declare no conflict of interest.

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