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ANALYSIS OF PADEL RALLY CHARACTERISTICS FOR THREE COMPETITIVE LEVELS

ZNAČILNOSTI POSAMEZNIH AKTIVNIH FAZ V ODVISNOSTI OD KAKOVOSTNE RAVNI V PADEL IGRI

ABSTRACT

The analysis of match performance, movement and shots, can identify the variables that distinguish performance levels in sport and are of particular importance in planning training schedules. National (n=20), Regional (n=20) and Recreational (n=20) padel players were compared in competition matches (n=15) filmed by two video cameras and analysed using the SAGIT tracking system. National players have significantly higher ($p < .05$) speed of movement and rate of play (shots per second) compared to Regional players. Recreational players significantly ($p < .001$) differed from the other two levels on rally time (s), number of shots per point, distance covered, rate of play, speed during active play and the proportion of time spent at different movement intensities. The highest-level players tended to play more at the net (volley, tray and smash) and returned more using wall shots (back, side and doubles). These findings provide a guide for players aspiring to improve their performance by focussing on the characteristics that determine successful performance. Future studies need to consider how tactics impact on performance, in particular the variation in match characteristics depending on rally duration.

Keywords: performance analysis, movement, padel tennis, shots

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IZVLEČEK

Z analizo tekmovalnega nastopa je možno določiti kazalce s katerimi je moč ugotavljati razlike med kakovostnimi ravni igranja in so obenem pomembni za ustrezno planiranje trenažnega procesa. Namen študije je bil analizirati igralce na državni (n=20), regionalni (n=20) in rekreativni (n=20) ravni v padelu. V ta namen so bile tekme (n=15) posnete z dvema video kamerama in procesirane s sledilnim sistemom SAGIT. Pri tem so bili analizirani čas posamezne aktivne faze (s), število udarcev v posamezni aktivni fazi, pot gibanja, število udarcev v sekundi, hitrost gibanja v aktivnem delu igre in čas gibanja v posameznem hitrostnem razredu. Igralci na državni ravni so imeli statistično značilno ($p < .05$) višjo hitrost gibanja in večje število udarcev v sekundi od igralcev regionalne ravni. Rekreativni igralci so imeli statistično značilno ($p < .001$) nižje vrednosti v vseh omenjenih spremenljivkah v primerjavi z igralci ostalih dveh ravni. Igralci višje kakovostne ravni so obenem igrali bližje mreži (volej, tray in smeš udarce) in z retetni žogo večkrat udarili proti steni (zadnjo, stransko ali obe). Ti rezultati nakazujejo smernice igranja za igralce, ki želijo razviti svoje sposobnosti na višjo raven igranja. V prihodnje bi bilo smiselno podrobneje analizirati taktiko in njen vpliv na igralno uspešnost ter igralne značilnosti v odvisnosti od trajanja posamezne aktivne faze.

Gljučne besede: padel, analiza tekmovalnega nastopa, gibanje, udarci

INTRODUCTION

Performance analysis is a useful tool for improving playing level since it provides objective information on play (feedback) that can be of use in planning strategies and designing training exercises (Courel, 2014; Hizan, Whipp, & Reid, 2011; O'Donoghue, 2010). This form of analysis has been popular in many sports including padel (e.g. Ramón-Llin, Guzmán, Llana, Vučković, & James, 2013). The popularity of padel has greatly increased in recent years and different aspects of performance have been recently investigated (Ruiz, 2014; Sánchez-Alcaraz, Cañas, & Courel-Ibañez, 2015). The main non-physiological parameters analysed to establish the structural aspects of workload and play characteristics are: distance covered by the players (Amieba & Salinero, 2013; Ramón-Llin, 2013), speed of displacement (Amieba & Salinero, 2013; Ramón-Llin, 2013), playing time/rest ratio (Sañudo, de Hoyo, & Carrasco 2008; Amieba & Salinero, 2013; Sánchez-Alcaraz, 2014; Torres-Luque, Ramirez, Cabello-Manrique, Nikolaidis, & Alvero-Cruz, 2015), time spent at different movement intensities (Amieba & Salinero, 2013; Castillo-Rodriguez, Alvero-Cruz, Hernández-Mendo, & Fernández-García, 2014; Ramón-Llin, Guzmán, Llana, Vučković, & James 2016), number and percentage of different shots (Sañudo et al., 2008; Almonacid, 2012; Priego et al., 2013; Torres-Luque et al., 2015) and winner/error analyses (Sánchez-Alcaraz, 2014; Navas & Aparicio, 2016). Knowledge regarding these variables allows coaches a better understanding of training loads to use with players (Andrés, Griego, Selene, & Hernández, 2016; O'Donoghue, 2010; Pereira et al., 2017).

Active playing time (rallies) determines the playing load volume, while its relationship with rest determines the load density (Courel-Ibañez, Sánchez-Alcaraz, & Cañas, 2016). In professional elite players, men's rally durations have averaged between 9.30 s and 15 s (Almonacid, 2012; Sánchez-Alcaraz, 2014, García-Benítez, Pérez-Bilbao, Echegaray, & Felipe, 2016; Torres-Luque et al., 2015). Castillo-Rodríguez et al. (2014) compared three performance levels and found longer match durations as the performance level decreased.

The number of shots per set and per rally is a specific game load parameter that has been analysed. Almonacid (2012) found that men players made an average of 148 shots per set while women averaged 109. Torres-Luque et al. (2015) recorded an average of 9.3 shots per rally for men and 9.5 for women. In a later study García-Benitez et al. (2016) found an average of 7.67 shots per rally for male Padel Pro Tour players compared to 9.7 shots for females.

Distance covered per rally is also an indicator of game load (Pereira et al., 2016). Castillo-Rodriguez et al. (2014) found that lower playing levels covered greater distances (1117 m, 1923 and 2320 m for high, medium and low respectively). Ramon-Llin, Guzmán, Llana, Vučković, & James (2013) found that servers (14.05 to 10.51 m/point) covered more distance than server partners (11.15 to 8.56 m/point).

Intensity load can be described by the rate of play which has been defined as the number of shots per unit of time, i.e. shot frequency (Ramon-Llin, et al., 2016) or the mean displacement speed during passive (0.55 to 0.66 m/s) and active phases (1.15 to 1.22 m/s; Ramón-Llin, 2013). Amieba and Salinero (2013), found an average match speed of 2.59 km/h for eight amateur players. Castillo-Rodriguez et al. (2014) found that as the level of play rose, match speed dropped from 2.18 km/h (low) to 2.13 km/h (medium) and 1.93 km/h for high level players.

Time-motion analysis provides information on the type of effort required (Hughes & Bartlett, 2007), Amieba and Salinero (2013) found that padel players spent 63 % of time at less than 3 km/h,

31% between 3 and 6 km/h, 5% between 6 and 9 km/h and 1% above 9 km/h. Castillo-Rodriguez et al. (2014) classified speed intensities based on Castellano and Casamichana (2010), and found that as levels of play rose players covered shorter distances at higher speeds.

Sañudo et al. (2008) distinguished drives, backhands, smashes and lobs as direct (taken before the ball hits a wall) or indirect strokes (taken after the ball has hit a wall). Volleys were the most frequent stroke (26%) followed by indirect drives (20%) and direct backhands (16%). Priego et al. (2013) used the same stroke classification and identified volleys (25%), indirect lobs (21%) and direct smash (18%) as the most frequently used. Almonacid (2012) used a more specific classification including: shots off a side wall, off the wire netting, double wall opening and closing, and tray smash. For both men and women he found the predominant defensive strokes were forehands and backhands, followed by off-the-back-wall shots whereas the most popular attacking strokes were volleys and tray smashes.

To provide training guidelines for players of different standard this paper compared differences in movement, rally characteristics and shot distributions between three levels of performer (National, Regional and Recreational). The matches used for each playing level were selected to enable a fair comparison between the playing levels and thus provided directly comparable match statistics. Based on previous research in other racket sports it was hypothesised that higher levels of performer would make less mistakes, play more accurate shots and be more physically able to return shots and hence rally durations, distance covered and number of shots per rally would be expected to be higher.

MATERIAL AND METHODS

Sample

Matches were filmed at two tournaments, both played on a methacrylate covered court with 4 x 3 m side walls and an exterior playing zone, organised by the Valencia Padel Federation and subsequently classified by level of performance by three expert observers (Padel federation coaches with more than 5 years' experience). Ramón-Llin, Guzmán, Vučković, Llana, and James (2011) found that players covered more distance in contested compared to uncontested games due to longer rallies. To control for this, 3 levels of match contest were distinguished; highly contested matches where 20 or more games were played (e.g. 6-4 6-4), medium contested for between 17 and 19 games and uncontested for 16 or less games (e.g. score 6-2 6-2). To enable a fair comparison all three performance levels had to have the same number of matches in each match contest level.

This resulted in 5 matches for each level (1 high, 3 medium and 1 uncontested) all played as best of three sets, involving 725 rallies (19 ± 4 games per match) by National (professional; $n = 20$; $M = 32.8$ years of age; $SD = 7.3$); 727 rallies (19 ± 2.5 games per match) by Regional (amateur; $n = 20$, $M = 35.1$ years of age; $SD = 6.9$) and 841 rallies (18.8 ± 3.6 games per match) by Recreational players (amateur; $n = 20$; $M = 38.4$ years of age; $SD = 7.7$). All participants gave their written consent to take part in the study and the use of the video recordings for scientific purposes. The written consent of the tournament organisers was also obtained to film the matches. This study was approved by the Ethics Committee of University of Valencia (protocol H1494417717437).

Assessments and measures

Two digital Bosch Dinion Model IP 455 video cameras (Bosch, Munich, Germany) were used to film the matches (25 frames per second), sagittally placed over the courts at 6 m from the centre and over the service line (Figure 1).

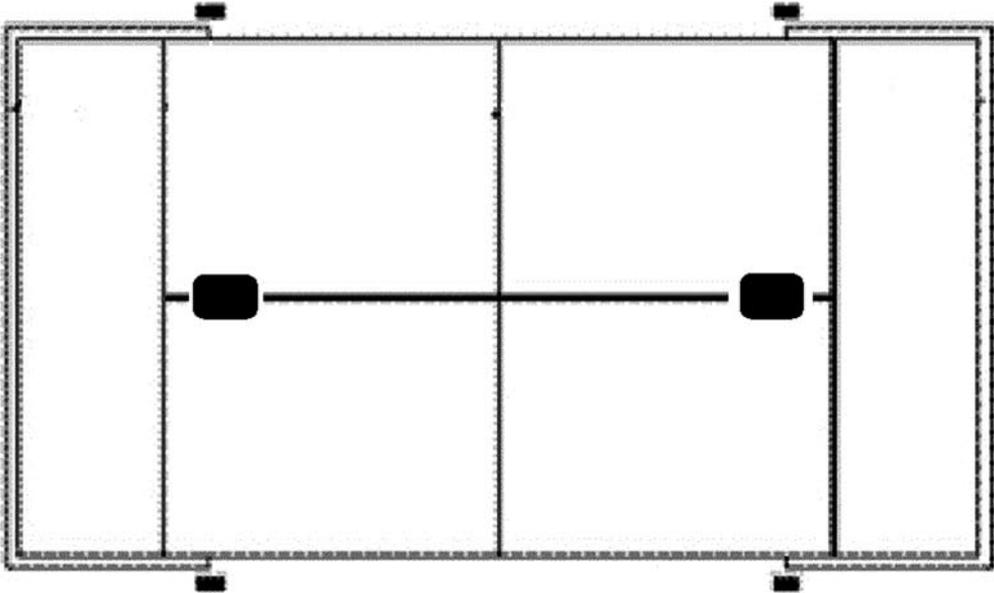


Figure 1.

The images were processed by the SAGIT tracking system (Vučković, Perš, James, & Hughes, 2010), which automatically tracks players' movements, under supervision of an operator who could change any tracking errors and annotate shot types (output to Excel files, Microsoft, Redmond, USA). The reliability of the tracking system has been demonstrated by Vučković et al. (2010) who found player position errors of between 0.09 and 0.5 m in a series of deliberately extreme tests to calculate the maximum error values. These results were sufficient to deem the tracking system as reliable for its purpose. A reliability analysis for the classification of shot types was undertaken using intra-operator tests, a Cohen's Kappa ($k = 0.91$) resulted from a percentage agreement of 0.92) corrected for guessing and considered as a high level of agreement (Altman (1991: 404).

Design and variables

The retrospective group comparison design corresponding to competition levels was analysed per point (Ramón-Llin, 2013; Martínez-Gallego et al., 2013) as variables such as distance covered and time are highly influenced by the number of points played if games or sets are compared. The dependent variables analysed were:

1. Distance covered (by the body's volumetric centre on the horizontal plane) per rally.
2. Point duration time (rally active time of ball in play) from serve until winning shot according to the rules of the Spanish Padel Federation (FEP, 2016).

3. Displacement speed during rallies.
5. Number of shots per rally i.e. total shots by the four players.
6. Rate of play: number of shots per second.
7. Time motion analysis: time spent in each of the following movements: walking (0 to 1.39 m/s), jogging (1.4 to 2.99 m/s), running (3 to 5.19 m/s) and sprinting (> 5.2 m/s), in agreement with Šibila, Vuleta, and Pori (2004).
8. Types of shot: according to the FEP's manual: ground strokes (GS), back wall strokes (BW), side wall strokes (LW), double wall opening (DWO), double wall closing (DWC), volleys (VO), trays (TR), smashes (SM), return against the back wall (CBW) and return against the side wall (CLW) . An independent analysis for the serve (SE) was conducted.

Data analysis

Analyses were performed using SPSS software (IBM, New York, USA). Normality (Kolmogorov-Smirnov) and homogeneity of variance tests (Levene's) indicated the need to perform non-parametric tests. Kruskal-Wallis H tests compared variables for playing level with follow up Mann-Whitney U-tests for paired samples analyses, readjusting the significance in accordance with Bonferroni at $p < .017$ (O'Donogue, 2010). Chi-square tests, and follow up Z-tests, determined between playing level differences in frequencies of time motion and shot variables.

RESULTS

Analysis of rally variables

Higher performance levels tended to have longer rallies, with more shots, more distance covered, the players were faster and had a higher rate of play (Table 1).

Table 1. Descriptive statistics (percentiles) per point of padel play variables according to performance level.

Variables per rally	National					Regional					Recreational				
	25%	Median	75%	95%	Max	25%	Median	75%	95%	Max	25%	Median	75%	95%	Max
Distance (m)	2.73	7.21	13.97	30.14	56.99	2.52	6.59	12.92	27.38	68.04	1.18	4.07	8.18	18.62	50.34
Time (s)	2.88	6.44	11.84	25.03	48.28	2.84	6.20	11.80	24.94	67.12	1.96	4.84	9.36	18.24	53.64
Speed (m/s)	0.93	1.08	1.21	1.37	1.70	0.86	1.02	1.14	1.33	1.75	0.62	0.81	0.97	1.21	1.49
N° shots (*)	3	5	9	19	36	2	5	9	18	46	1	3	6	12	38
Rate of play (shots/s)	0.71	0.81	0.95	1.19	1.82	0.69	0.78	0.93	1.19	1.78	0.63	0.72	0.88	1.09	1.35

Significant differences ($p < .05$) were found between performance levels with follow up tests finding that only speed, and rate of play were different between National and Regional players but Recreational players differed from the other two levels on all variables (Table 2).

Table 2. Inferential analysis according to performance level.

Rally variables	Kruskal-Wallis		Mann Whitney U-Test*					
			National vs Regional		National vs Amateur		Regional vs Amateur	
	χ^2	<i>p</i>	<i>Z</i>	<i>p</i>	<i>Z</i>	<i>p</i>	<i>Z</i>	<i>p</i>
Distance (m)	110.2	< .001	-1.5	.131	-9.6	< .001	-8.2	< .001
Time (s)	36.2	< .001	-0.65	.518	-5.4	< .001	-4.8	< .001
Speed (m/s)	453.2	< .001	-5.74	< .001	-19.6	< .001	-15.8	< .001
N° shots (*)	86.6	< .001	-1.22	.221	-8.5	< .001	-7.3	< .001
Rate of play (shots/s)	93.9	< .001	-2.56	<.05	-9.2	< .001	-6.9	< .001

(*) Significance adjusted according to Bonferroni for $p = .017$.

Time motion analysis

Time motion analysis showed that as the performance level increased the percentage of time spent in the slower intensity (walking) decreased as the percentage of time in the faster intensities increased ($\chi^2 = 34.7$; $df = 4$; $p < .001$; Table 3). Paired contrast Z tests showed significant differences between Recreational and both National and Regional with the exception of running. No differences were found between National and Regional levels.

Table 3. Analysis in percentages of time motion

Motion intensity	Performance levels		
	% National	% Regional	% Amateur
Walking	70a	72.7a	80.4b
Jogging	26.3a	24.7a	18.3b
Running	3.7a	2.6ab	1.3b
Sprinting	0	*	0
Total	100	100	100

This category was not used in the comparisons since its column proportion is equal to 0 or 1.

Using the Bonferroni correction the tests were adjusted for all the paired comparisons within a row for each innermost sub-table.

Types of shots.

Increased performance level was associated with less ground shots and lobs, more wall shots (back walls, double wall closing, double wall opening and side wall shots) and more net shots (volleys, smash and tray) ($\chi^2 = 173.4$ $gl = 20$; $p < .001$; Table 4). However Regional players used more trays shots than National with both playing more than Recreational players.

Table 4. Analysis of time motion analysis and type of shot (excluding serves).

Type of Shot	Performance levels		
	% National	% Regional	% Amateur
Back wall	15.4	13.6	12
Double wall closing	2.5	2.5	0.8
Double wall opening	2.7	2.2	1.4
Ground shots	17.6	18.2	36.5
Lobs	10.7	13.5	14.6
Side wall	6.7	5.3	4.9
Smash	5	4.1	2.9
Return against the back wall	2.2	2.6	2.6
Return against a side wall*	0	0	0.1
Trays	8.9	11.8	7.4
Volleys	28.3	26.2	16.7
TOTAL	100	100	100

*This category was not used in the comparisons since its column proportion is equal to 0 or 1.

The serve accounted for 23.5% of all shots for the Recreational players compared to 15% for the other two performance levels ($\chi^2 = 30.8$ $gl = 2$; $p < .001$; Table 5). National and Regional players had similar serve profiles which were better than Recreational players for both first serves ($\chi^2 = 70.3$ $gl = 2$; $p < .001$) and double faults ($\chi^2 = 42.3$ $gl = 2$; $p < .001$).

Table 5. Analysis of performance at serve shot according to performance level.

Serve variables (%)	National	Regional	Amateur
Serves /All Shots	15	15.5	23.5
1st serve	83.3	82.2	69.3
2nd serve	16.4	17.8	28.1
Double faults	0.3	0	2.6

DISCUSSION

It was hypothesised that performance improvements associated with different playing levels would result in longer rallies, shots per point etc. in the rallies played by National players compared to Regional players and further reductions in performance for Recreational players. However, performance at National and Regional levels tended to be quite similar and significantly different to Recreational level. Rally time was higher for National ($Mn = 6.4$ s) and Regional ($Mn = 6.2$ s) levels compared to Recreational ($Mn = 4.8$ s). However, the National level rally times seemed shorted than expected since Carrasco, Romero, Sañudo, and de Hoyo (2011) had found a mean value of 7.4 s for elite juniors while Sánchez–Alcaraz (2014) obtained higher values for elite players ($M = 11.62$ s). However, the sampling method used in this study i.e. 1 highly contested to 3 medium to 1 uncontested match, may not have been the same as in the Sánchez–Alcaraz

(2014) study. Also the use of the median lowers the average value in comparison to the mean as the distribution of rally times was positively skewed.

In line with the longer rallies for the higher performance levels so too did the number of strokes per rally (5 for National and Regional and 3 for Recreational). Almonacid (2012) found an average of 563 shots per set, with an average of 64 points played per set, giving an average of 8.64 shots per point. Torres-Luque et al. (2015) also found an average of 9.3 shots per point for top elite male players. Again the higher values are likely due to the longer points in both the Almonacid (2012) and Torres-Luque et al. (2015) studies, due to the different sampling of matches in this study.

As the time played per rally rises there is an increased probability of the players having to cover longer distances (Ramón-Llin, 2013). In this study, distance covered per rally, rally duration time and number of shots played all increased with performance level with the longest distance covered at National level ($Mn = 7.2$ m), then Regional ($Mn = 6.6$ m) and finally Recreational ($Mn = 4.1$ m) levels. This contrasts with Castillo-Rodriguez et al. (2014) who found that higher performance levels covered less distance per rally. However, the players who covered the longest distances were also the ones who had the longest match times, as per this study.

The rate of play increased significantly with each performance level to a median of 0.81 shots per second at National level. Torres-Luque et al. (2015) found an average of 9.3 shots per point in men's matches, where rallies lasted an average of 9.3 s i.e. 1 shot per second; but these were top-class players, which tends to confirm the premise that the rate of play increases with an increase in playing level. In this study, displacement speeds also rose significantly with increased performance levels. This contradicts what Castillo-Rodriguez et al. (2014) and Fernández-Fernández et al. (2009) found, that as performance level rises, average speed declines. However, both of these studies did not distinguish between active (ball-in-play) and passive time whereas this study only considered ball-in-play time.

The time-motion analysis revealed that sprinting did not occur in these padel matches, but the activity levels did relate to healthy activity, as Teresa et al. (2017) defined physical intensity. The Recreational players spent significantly more time at lowest intensities (walking and jogging) compared to the other two levels which corresponded well with the results from Ramón-Llin et al. (2016).

Higher performance level players tended to play more shots at the net (attacking play) which supports the finding of Courel, Sanchez-Alcaraz, and Cañas (2015) who reported that winners were more efficient at volley shots. The increased use of wall shots (back, side and doubles) as the performance level increased may be indicative of the ability to return more shots due to increased skill levels. The fact that matches were played indoors (7 metre ceiling height) probably affected the type of lob played (Muñoz et al., 2017) as the ball touching the ceiling loses the point. Consequently, shot types are likely to be affected by court dimensions meaning that between study differences should be treated with caution. The importance of the serve was evident at the Recreational level as the shorter rally durations meant that a good or bad serve tended to play a role in determining the rally outcome. The higher rally durations for the higher-level performers meant that this effect was less for these players. As Almonacid (2012) found, double faults were very rare for all levels, because the serve shot in padel is relatively easy to learn.

In summary, the results of this study suggest the following guidelines for training to increase the level of performance:

- Defensive aspects of play (back, side wall and double wall shots) tend to discriminate the best players from lesser ones more than offensive shots and result in increased rally lengths.
- The serve and return of serve play a large part in determining the outcome of lower level performance. Therefore, improving these two facets of the game is especially important for recreational players
- Offensive shots (volleys, trays and smashes) are most prevalent at higher performance levels.
- Conditioned games that aim to improve tactical performance should include combinations of trays and volleys involving movement to and from the net where movement speed is emphasised.

This study provided a fair comparison of play between performance levels by using the same mixture of matches, in terms of how contested the matches were, for each performance level. However, the relatively small sample sizes meant that whilst this sampling technique avoided clearly biased results there remained the possibility that some of the performance differences could have been due to sampling effects. This could never be completely eradicated however since every match has rallies of different duration and intensity, This was clearly shown in this study by using percentiles rather than the more familiar mean and standard deviation (or more accurately for skewed data the median and interquartile range) used in many other studies.

CONCLUSIONS

The rate of play and displacement speed were found to be the highest at the highest player performance level (professional) with increased performance indicated by longer rally durations, distance covered, more net (volley, tray and smash) and wall shots (back, side and doubles) while a higher proportion of ground shots and lobs found at amateur levels. Future studies need to consider how tactics impact on performance, for example players may change the way they play as a result of losing the first set; in particular the variation in match characteristics (throughout a match and within sets or games) depending on rally duration (differences between very short, short, medium and long).

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