

Biomotor Components of Speed, Agility and Strength in Padel Players from The Special Region of Yogyakarta

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ABSTRACT: This study aimed to evaluate linear speed, functional strength, and agility in padel players in Yogyakarta, and to analyze the differences in these parameters based on gender. The study sample involved 20 advanced padel players *aged* 25–30 years, divided proportionally by gender (10 males, 10 females). The measurement instruments used included *a hexagon test* for agility, *10-meter* and *20-meter sprint tests* for linear speed, and *a medicine ball throw test* to measure upper body strength. The analysis results showed that male players performed significantly better than female players in linear speed, upper body muscle strength, and agility (*speed of change of direction*). Furthermore, a significant positive correlation was found between speed and agility. In contrast, functional strength showed a significant negative correlation with speed and agility parameters.

KEYWORDS: Padel, Strength, Speed, Agility, Optimization

INTRODUCTION

Padel is a modern racket sport played on a 10x20 meter court, invented in the 1970s (De Marco, Nicastro, & Patti, 2017; SánchezAlcaraz, 2013). With increasing interest in recent years, it is a cooperative sport, in which two players share the same playing space against another doubles team positioned across the net (Claver, Santandreu, & Martin, 2021). The playing space is surrounded by walls, mostly made of glass with metal mesh on the sides, up to 3 meters high (International Padel Federation, 2017), which gives the sport unique characteristics that allow the ball to bounce off the side and back walls, resulting in a fast-paced game with more frequent action without increasing the physical intensity compared to similar racket sports (Zabala, Badiola, Bidaurrezaga, Vargas, & Granados, 2016).

This sequence of game actions is repeated at high volume in players with longer rally durations. This phenomenon occurs because players are required to maintain optimal physical condition to adapt to the intensity of the competition (Courel-Ibáñez, SánchezAlcaraz, and Cañas, 2015, 2017; Muñoz et al., 2017; Torres-Luque, Ramírez, Cabello-Manrique, Nikolaidis, and Alvero-Cruz, 2015). Several previous studies have shown that technical-tactical actions and temporal aspects of the game can vary significantly based on training background, player generation, and applied training methods. This is due to the differences in physical demands that are directly proportional to the players' practical skill levels (Sánchez-Alcaraz, 2014a; 2014b; Sánchez-Alcaraz, Sánchez-Pay, Gómez-Mármol, Molina-Saorín, and Bazaco-Belmonte, 2017). These findings are very urgent in formulating appropriate and individual short-term planning and competition strategies (Glazier, 2010).

Previous research has analyzed rally duration and offensive dynamics in padel. Specifically, it was noted that 40% of unforced errors occurred within the first 4 seconds of a rally, while more than 50% of points were won between the 5th and 11th seconds. Meanwhile, 30% of forced errors were identified after the 11th second (Sánchez-Alcaraz et al., 2017). These findings suggest that the ability to score points in long rallies (>11 seconds) and minimize unforced errors in the early phase of a rally (≤4 seconds) are important determinants of match success (Sánchez-Alcaraz et al., 2017). Consistent with these findings, Sánchez-Alcaraz et al. (2016) confirmed that advanced players have superior shot accuracy. Furthermore, physiological analysis showed that physical activity during matches, even in long rallies (≥30 seconds), does not induce extreme fatigue that could reduce players' motor performance.

Based on these temporal characteristics, padel requires optimal aerobic capacity integrated with agility, acceleration, deceleration, and *rapid changes of direction to maintain performance throughout the duration of a game of one to two hours* (Amieba & Salinero, 2013). In this context, cardiorespiratory fitness plays a crucial role in the efficiency of players' intermittent

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recovery (Martínez et al., 2017). Superior heart rate reserve capacity has also been identified as a significant physiological differentiating factor between low- and high-level players (Courel -Ibáñez & Herrera- Gálvez , 2020).

In addition to the physical aspects, padel has unique tactical dynamics, where technical, spatial, and stroke effectiveness indicators significantly influence overall performance (Courel -Ibáñez et al., 2019). Based on spatial analysis, there are three main playing styles: (1) net play (*offensive zone*), (2) transition area (*center of court*), and (3) back line (*defensive zone*). In the transition area, the playing pattern is dominated by the use of volleys, *forehands* , and *bandejas*. (Sánchez-Alcaraz et al., 2016). In contrast, the net area is dominated by offensive volley executions, while the backline area is characterized by a high frequency of *lobs* , *forehands* , and *wall shots* (Courel -Ibáñez & Herrera- Gálvez , 2020).

The high frequency of strokes and the limited dimensions of the padel court require players to consistently make short, highintensity movements to reach the ball at the optimal time and position (Courel -Ibáñez, Sánchez-Alcaraz, and Cañas , 2016; 2017). A characteristic of padel is the presence of walls that allow the ball to bounce back, forcing players to rotate their bodies and make circular movements before hitting, especially when anticipating balls in the back corners of the court (Courel -Ibáñez, SánchezAlcaraz, and Muñoz, 2017; Priego et al., 2013). Therefore, adequate speed and agility in changing direction *are* crucial performance determinants.

Although research interest in the competitive demands and energy profiles of padel has increased in recent years (Sánchez-Alcaraz et al., 2015; 2018), literature providing a comprehensive evaluation of the physical fitness profiles of padel players remains very limited. Instruments such as the *10-meter/20-meter sprint test* and the *hexagon test* have been extensively validated in similar racket sports, such as tennis (Fernández-Fernández, Ulbricht, and Ferrauti , 2014; Roetert and Ellenbecker , 2007). Furthermore, the *medicine ball throw test* has been shown to be an effective and reliable method for measuring upper body functional strength in this sport (Earp and Kraemer, 2010; Fernández-Fernández et al., 2014). Considering that systematic training periodization should be based on periodic evaluation and structured monitoring (*testing and monitoring*) (Roetert and Ellenbecker , 2008), this study aims to evaluate linear speed, functional strength, and agility in Yogyakarta padel players , while analyzing the differences in these parameters based on gender aspects.

METHOD

The study involved 20 padel players aged 25-30. All players practiced padel regularly more than three times a week for at least a year and participated in more than ten tournaments per year.

Instrument Speed

Linear speed measurements were performed using the 10-meter and 20-meter sprint test instruments, which have been shown to have high reliability ($r = 0.97$) in racquet sports athletes (Sánchez-Pay et al., 2011). In this test procedure, participants took a *standing start position* directly behind the starting line. Immediately after a visual or acoustic signal was given, participants were instructed to run across the 10-meter or 20-meter distance as quickly as possible until their entire body crossed the finish line. Time was recorded in seconds and hundredths of a second, with the best time of two consecutive trials taken for analysis.

Speed of Change of Direction

Dynamic agility or speed of change of direction was evaluated using the *hexagon test* (Reid et al., 2003). In this procedure, participants stood in the center of a hexagon with each side measuring 60 cm. At the start signal, participants had to jump with both feet over one of the boundary lines, then immediately jump back to the center area at maximum speed without changing body direction. This jumping in and out motion was repeated sequentially in a clockwise direction for each side of the hexagon. The test was considered complete after the participant completed three full rotations and landed back at the center point . The best time (in seconds and hundredths of a second) from two trials was used as the final score.

Strength (Upper Body Explosive Strength)

Explosive strength of the upper body muscles was measured using a 3 kg medicine ball horizontally *overhead to achieve maximum distance* (Rivilla -García et al., 2012). During the test, participants stood with their feet shoulder-width apart facing the throwing direction, holding the medicine ball symmetrically under their hips with both hands. The throwing phase began with the ball swung upward and behind the head while straightening the torso *and* flexing the elbows and knees. A dynamic transition movement was then performed through explosive torso flexion and rapid extension of the shoulders, elbows, and knees to throw the ball as far as possible. During the throwing process, the heels were allowed to rise, but both feet had to remain flat on the floor without crossing the throw line. Prior to data collection, a *familiarization trial session* was conducted until participants were able to effectively mobilize the kinetic chain, adapting to the *smash* (spike) mechanics in padel . The longest distance (in centimeters) of the two throws was recorded as a representation of the participants' functional strength.

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Research Procedures All participants were thoroughly explained the study protocol and voluntarily signed an *informed consent form* before the experiment began. To minimize environmental bias, all testing sessions were conducted simultaneously under controlled environmental conditions at 28°C. The procedure began with a *10-minute warm-up session* led by an expert instructor with a background in Sport and Physical Activity Science.

Immediately after the warm-up was completed, participants underwent a series of physical fitness tests arranged in the following order: (1) 10-meter sprint test, (2) 20-meter sprint test, (3) *hexagon test* , and (4) *overhead medicine ball throw test* . All measurement data were systematically recorded on a special assessment sheet during the test.

RESULTS

Results can be presented in graphs, tables, or descriptive form. Tables and figures should only contain essential information from the research. Analysis and interpretation of these results are necessary before discussion.

the mean , standard deviation, minimum and maximum values of each physical condition parameter of all padel players is presented in Table 1.

Padel Player Physical Condition Test Results Table
Table 1. Scores on speed, change of direction and power tests for all padel players .

Variables			M ± SD	Min - Max
10	meter	sprint	2.79 ± 0.33	2.32 – 3.30
(seconds)				
20	meter	sprint	4.17 ± 0.47	3.58 – 4.87
(seconds)				
Change of direction (seconds)			14.95 ± 2.79	11.93 – 21.54
Upper body strength (cm)			526 ± 138	288 – 768

Values are expressed as mean and standard deviation (M ± SD)

Table 2. Scores on speed, change of direction and power tests by gender of padel players .

Variables	Male (n = 10) M ± SD			Female (n = 10) M ± SD			P	Effect Size (EFS)
10 meter sprint (seconds)	0.34	2.64	±	0.16	2.92	±	0.008	0.42
20 meter sprint (seconds)	0.34	3.92	±	0.39	4.33	±	0.021	0.33
Change of direction (seconds)	2.40	14.47	±	3.14	15.47	±	0.606	0.02
Upper body strength (cm)	9.78	633	±	6.78	431	±	<0.001	0.71

Values are expressed as mean and standard deviation (M ± SD).

Table 3. Correlation between physical condition variables in padel players .

Variables			10 meter s	20 meters	PA	KTBA
10 meter sprint (10m)	Correlation			0.836	0.585	-0.836
	Meaning		*	<0.001*	0.014*	<0.001*
20 meter sprint (20m)	Correlation				0.667	-0.766
	Meaning			*	0.003*	0.000**
Change of direction (PA)	Correlation					-0.567
	Meaning					0.018*
Upper body strength (UPB)	Correlation					
	Meaning					

* $p < 0.005$;

** $p < 0.001$.

Abbreviations: PA = Change of Direction (*Cambio de Dirección*); KTBA = Upper Body Strength.

Table 2 presents the results of a comparative analysis of physical performance by gender. Male players performed significantly better than female players in upper-body explosive strength ($p < 0.01$) and linear speed over the 10-meter and 20-meter distances ($p < 0.05$). Conversely, no statistically significant differences were found in agility or *change-of-direction speed* between the two gender groups.

The results of the correlation analysis between the tested variables are summarized in Table 3. All evaluated physical variables showed significant correlations with each other. Specifically, the 10-meter and 20-meter sprint variables had significant positive correlations with change-of-direction speed; this indicates that higher linear speed capacity is linearly related to faster agility capacity. Conversely, upper body explosive strength showed significant negative correlations with both linear speed and change-of-direction speed. These findings suggest that participants with higher levels of upper body strength tended to have slower running times on the speed and agility tests.

DISCUSSION

This study aimed to evaluate linear speed, agility, and functional strength in Yogyakarta padel players . In general, in the 10-meter and 20-meter linear speed tests, Yogyakarta padel players showed times of 0.5 to 0.7 seconds. Compared to tennis athletes, padel players in this study also showed slower speed performance, with a difference of 0.4–0.5 seconds in the male group and 0.7–0.8 seconds in the female group (Fernández-Fernández et al., 2014). Regarding *change of direction speed* (CODS), padel players

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showed slightly longer travel times (0.1–0.2 seconds) than high-achieving tennis players of the same age (Roetert & Ellenbecker , 2007).

This is likely influenced by the more limited dimensions of the padel court and the high frequency of strokes, which mechanically limit long-distance movements (Priego et al., 2013). Nevertheless, players in this phase are required to develop optimal tactical skills, such as efficient positional distribution on the court and accuracy in reading the direction of the ball's trajectory (Courel -Ibáñez et al., 2017).

Gender comparisons showed that male players had significantly faster times in sprint and change of direction tests than female players. This finding contradicts some previous studies and tennis athletes (Sánchez-Alcaraz et al., 2016), although classical literature suggests that gender differences in motor development begin to appear during childhood physical maturation (Raudsepp & Paasuke , 1995).

From a tactical perspective, differences in playing style between male and female players contribute to these physical demands. Despite relatively similar points in duration, male players execute a significantly higher volume of shots (Courel -Ibáñez & Sánchez-Alcaraz, 2017 ; Sánchez-Alcaraz, 2014b), while female players predominantly use defensive shots such as *lobs* (Muñoz-Marín et al., 2017 ; Torres- Luque et al., 2015). These characteristics increase the tempo of play in the men's division, requiring greater speed and agility to match the intensity of the competition.

Correlation analysis results indicate a strong positive relationship between linear sprint speed and CODS in Yogyakarta padel players . The relationship between these two variables has been widely explored in various sports with varying and contradictory results (Buttifant et al., 2001). Young et al. (2001) reported a low and insignificant correlation. Similarly, Buttifant et al. (2002) found a low coefficient of determination between the 20-meter sprint and *the zigzag agility test in soccer players*, while Little and Williams (2005) confirmed a weak relationship between the 20-meter flying sprint and a similar agility test in professional soccer players. In contrast, a recent study by Vescovi and McGuigan (2008) showed moderate to strong correlations between several sprint testing methods (from a standing position and a *flying start*) and *the Illinois Agility Test* in female athletes. These discrepancies in findings are likely due to methodological variability, differences in speed and CODS testing instruments used, and the diversity of age and sport specificity of the study samples.

On the other hand, functional strength showed a significant negative correlation with linear speed and agility. These results suggest that subjects with greater upper-body strength capacity tend to have slower running times and lower agility. This finding is inconsistent with research by Hernández (2003) on the relationship between speed, strength, and explosive power, which found no significant correlation between these variables.

CONCLUSION

This study has several limitations that need to be considered in interpreting the data. First, the relatively small sample size limits the generalizability of the results regarding differences in physical fitness profiles across a wide variety of players. Therefore, future research is recommended to expand the sample size and integrate other moderating variables, such as *playing level* . Furthermore, exploration of other field testing instruments to measure agility, such as *the T-test* , as well as specific measurements such as ball speed *in the medicine ball throw test* is highly recommended (Earp & Kraemer, 2010). In conclusion, this study is a pioneering study evaluating physical fitness parameters in a population of padel players in Yogyakarta. The results are expected to serve as important reference data in the design and periodization of specific physical training programs for padel .

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