



INFLUENCE OF GAME SIDE COURT ON HAEMATOLOGICAL AND URINARY BIOMARKERS IN PROFESSIONAL PADEL PLAYERS

INFLUENCIA DEL LADO DEL JUEGO SOBRE BIOMARCADORES HEMATOLÓGICOS Y URINARIOS EN EL PÁDEL PROFESIONAL

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ABSTRACT

Purpose: to analyze the influence of game side on court in haematological and urinary biomarkers after a simulated padel competition (SC) attending to possible sex differences. **Method:** pre- and post-SC serum creatinine, urea and creatine kinase (CK), and urine specific gravity and erythrocytes of twenty-nine professional padel players (16 female, 13 male) were quantified. A two-way ANOVA was used to show any differences in the studied variables (p values $< .05$). **Results:** significant differences were found before and after the SC for creatinine ($p < .05$) and erythrocytes ($p < .01$). Differences were found for creatinine ($p < .001$), CK ($p < .01$) and specific gravity between sexes ($p < .05$). No game side court effect was found. **Conclusion:** padel SC produced an increase in serum creatinine and hemolysis, probably caused by game dynamics. Sex differences were found in serum creatinine and CK, presumably due to anthropometric gender differences. Both sexes finished the SCs in a dehydrated state, affecting it more to men, something which should be considered to prevent and alleviate its potential negative effects in performance. More studies should be carried out to confirm these data.

Keywords: Racket sports, physiology, hydration, blood, urine.

RESUMEN

Objetivo: analizar la influencia del lado de juego sobre biomarcadores hematológicos y urinarios tras un partido de pádel simulado (SC) atendiendo a posibles diferencias de género. **Método:** se analizaron la creatinina, urea y creatinquinasa (CK) séricas, y la gravedad específica y los eritrocitos en orina antes y después de la SC en veintinueve jugadores profesionales de pádel (16 mujeres, 13 hombres). Se utilizó un ANOVA de dos vías para mostrar cualquier diferencia en las variables estudiadas ($p < .05$). **Resultados:** se encontraron diferencias significativas antes y después de la SC para la creatinina ($p < .05$) y eritrocitos ($p < .01$). Se observaron diferencias significativas entre sexos para creatinina ($p < .001$), CK ($p < .01$) y gravedad específica ($p < .05$). No se encontró ningún efecto del lado de juego sobre los biomarcadores estudiados. **Conclusión:** la SC produjo un aumento de la creatinina sérica y hemólisis, posiblemente provocados por la dinámica de juego. Se observaron diferencias entre sexos en los valores de creatinina sérica y CK, probablemente por las diferencias antropométricas entre géneros. Ambos sexos terminaron la SC en un estado de deshidratación, afectando más a los hombres, algo que se debería tener en cuenta para prevenir y paliar sus posibles efectos negativos sobre el rendimiento. Se deben realizar más estudios para confirmar estos datos.

Palabras clave: Deportes de raqueta, fisiología, hidratación, sangre, orina.

Introduction

Padel is an emerging doubles racquet sport which has become popular around the globe in the last few decades. In recent years, there has been an increase in scientific research into padel to better understand its characteristics and requirements for both professional and non-professional players (García-Giménez et al., 2022). The main topic of study of this sport focuses on aspects of time structure, tactics and strokes, physical fitness and physiology. This sport is played into an enclosed synthetic glass and metal court of 20 m x 10 m (length x width) which is divided by a net in the middle, allowing the ball to bounce on lateral and back walls for rallies (International Padel Federation, 2021). These court measurements and specific game rules makes padel rallies longer in comparison to other racket sports, such as tennis and badminton, with bigger courts and no walls (Torres-Luque et al., 2015).

Padel is characterized by being an intermittent sport which is predominantly aerobic (Carrasco et al., 2011; De Hoyo et al., 2007) where players have to perform rapid movements and changes of direction in very short (.7-1.5 s) and short (9-15 s) periods of time (Sánchez-Muñoz et al., 2020). With regard to cardiorespiratory parameters, oxygen consumption during play is around 40-50% of maximum oxygen consumption, being higher in men. Laboratory tests show that, in padel players, the maximal oxygen consumption is in a range between $38.4 \pm .7$ mL/kg/min and 55.64 ± 8.84 mL/kg/min depending on sex and level. As for heart rate (HR), a mean HR of 151 ± 8 bpm (76 % of maximum HR) has been reported. On the other hand, lactate concentration remains stable (start: 1.83-1.90 mmol/L; end: 2.40-3.38 mmol/L), without gender differences (Carrasco et al., 2011; García-Giménez et al., 2022; Pradas, Cachón, Otín, Quintas, Arracos, et al., 2014; B.J. Sánchez-Alcaraz et al., 2023).

Proteins, metabolites and electrolytes can serve as biomarkers for athletes. Analysis of biochemical and haematological parameters can be powerful in identifying the balance between training and recovery (Lee et al., 2017). It has been reported that blood biomarkers such as creatinine, urea and creatine kinase (CK) increase after padel practice, probably due to muscular strength requirements, eccentric actions and highly repeated muscle contractions of the game dynamics (Ebbeling & Clarkson, 1989; Pradas et al., 2020).

Various investigations have compared sex differences in padel players (García-Giménez et al., 2022). Male have shown higher values for mass, height and body mass index (BMI) and lower percentage of body fat than female

(Castillo-Rodríguez et al., 2014; Pradas et al., 2019). Regarding endurance, power and strength, it has been observed lower values in female than male in several performance tests (Borges Müller & Boscolo del Vecchio, 2018). From a temporal and technical points of view, longer total time of game, percentage of shots from the midzone and winner shots per game have been reported in the female's matches. On the other side, longer rally durations, games per set and shots at the net have been observed in the male's (A. Escudero-Tena et al., 2021; García-Benítez et al., 2016, 2018; Lupo et al., 2018; Torres-Luque et al., 2015). In the same way, it has been reported gender differences in baseline biochemical and haematological parameters in professional players, with higher values for male, probably due to testosterone levels, muscle mass and fitness level differences (Pradas et al., 2020). Equally, some authors have reported stroke differences according to game side on court (Ramón-Llin et al., 2020, 2021). It has been reported that players on the left side seem to be more effective when using smashes but make more errors when hitting the ball after it bounces off the wall. On the other hand, right-side players made more lobs and made less errors (Ramón-Llin et al., 2020).

Yet, despite the augmented scientific publications about padel, no literature has been found analyzing the influence of the game side on court on haematological and urinary biomarkers in both male and female players. This data could lead to a better understanding of the sport and into a training individualization of padel players. Therefore, the aim of this study was to analyze the influence of game side on court in haematological and urinary biomarkers after a simulated padel competition (SC) attending to possible gender differences.

Material and methods

Participants

Twenty-nine professional padel players (female = 16; male = 13) voluntarily participated in the present study. All of them had participated in the professional World Padel Tour (WPT) circuit in the last 7 years. Due to the difficulty of finding this kind of athletes, participants were selected by convenience. Evaluations were carried out one week after WPT season ended to ensure players' optimal recovery and performance levels to participate in the research. Participants' characteristics are shown per gender in Table 1.

Table 1. Participants' characteristics

Parameters	Female (n = 16)	Male (n = 13)	p
Age (years)	30.1 ± 4.2	27.4 ± 6.8	.198
Weight (kg)	59.9 ± 4.7	78.2 ± 8.5	<.001
Height (m)	1.67 ± 4.8	1.78 ± 4.0	<.001
Fat (%)	20.8 ± 3.0	13.5 ± 4.8	<.001
Experience (years)	10.9 ± 3.5	8.1 ± 3.1	<.05
VO _{2max} (mL/kg/min)	11.2 ± 3.1	8.1 ± 3.0	<.001

VO_{2max}: maximal oxygen consumption

Each participant was informed about the study's objective and gave him/her informed consent. Collecting and processing samples processes were carried out to ensure confidentiality according to the Declaration of Helsinki ethic guidelines, updated at the World Medical Assembly in Fortaleza (Brazil) in 2013 for research with human subjects. The Clinical Research Ethics Committee of the Department of Health and Consumption of the Government of Aragon (Spain) approved the research project (code: 21/2012).

Inclusion criteria of the study were: (i) having played in the WPT in at least the last 5 years, finishing the SC, (ii) not following any special diet, (iii) not being on specific medication or over-the-counter medication, and (iv) not having any injuries or illness during the research or at least 5 months before the beginning of the study.

Procedures

Given the difficulties of analyzing acute physiological parameters during WPT, a SC was designed. SC characteristics appear in Table 2. SC consisted of a padel match reproducing a competitive situation similar to an official one and in line with International Padel Federation game regulations (International Padel Federation, 2021). Matches were played outdoors. Players' training volume and intensity were reduced in the 2 days before SC to reduce fatigue.

Table 2. Simulated padel competition characteristics

Parameters		Female (n = 16)	Male (n = 13)	p
Side played (%)	Forehand	40.00	38.50	.933
	Backhand	60.00	61.50	
Total time (min)		59.69 ± 19.38	77.73± 17.30	.079
Real time (min)		25.24 ± 7.75	31.21 ± 7.67	.158
Rest time (min)		33,73 ± 11.51	45.48 ± 10.98	.064
Relative humidity (%)		46.02 ± 3.12	42.17 ± 7.69	.109
Temperature (°C)		24.33 ± 9.24	25.93 ± 5.58	.662
Water intake (mL)		713.41 ± 301.81	795.21 ± 254.12	.211

SC was organized in accordance with the official regulations for professional tournaments, and all the matches were played with the best of three sets (International Padel Federation, 2021). The study was designed to analyze eight SC (four female's and four male's) in a two-week period. Female's matches were carried out in the first week and male's in the second, participating each pair of players in only one SC. During SC period, a maximum of one match was developed and analyzed per day. Matches ended in a tie break if there was a tie after six games. Before starting SC, players did a standard 15-min warm up divided into a 5-min movement and general warm up session and a 10-min specific technical warm up on the court. Players were monitored during SC by pulsometers (Vantage M, Polar, Finland). During matches, what the players drank was controlled. Drinks consisted of bottled mineral water. Players could drink ad libitum during matches.

Total time was the full match time, from the time it began to the time it ended and included game and rest periods. Real time was the time from when a point began (when the serving player hit the ball) until the end. Rest time was from the end of one point to the beginning of the next point (Pradas et al., 2020).

Anthropometric Measurements

Anthropometric measurements were performed by the same experienced operator, who was skilled in kinanthropometric techniques, according to guidelines outlined by the Society for the Advancement of Kinanthropometry (Stewart et al., 2011). Height was measured using a wall-mounted stadiometer (Seca 220, Hamburg, Germany) to the nearest .1 cm. Weight was measured on a calibrated electronic digital scale (Seca 769,

Hamburg, Germany), nude and barefoot, to the nearest .01 kg. A Holtain® 610ND (Holtain, Crymych, UK) skinfold calliper, accurate to $\pm .2$ mm, was employed for the anthropometric assessments. Six skinfolds' thicknesses (abdominal, suprailiac, subscapular, tricipital, thigh, leg) were measured. Fat percentage was calculated using Yuhasz equations (Porta et al., 1993).

Blood Samples and Analyses

Two venous blood samples (antecubital vein) of five milliliters in coded Vacutainer tubes containing ethylenediaminetetraacetic acid (EDTA) as an anticoagulant were taken from each participant both pre- and post-SC. Pre-SC sample was taken 120 min before after a minimum period of 8 h since the last meal. Post-SC sample collected 7-10 min after games ended. After the pre-SC blood sample, participants ingested a predetermined breakfast, which consisted of a bottle of drink with 5% glucose solution.

Once collected, blood samples were coagulated for 25–30 min and then centrifuged at 2500 rpm for 10 min at room temperature to isolate serum. The serum was aliquoted into Eppendorf tubes (Eppendorf AG, Hamburg, Germany), previously washed with diluted nitric acid, and conserved at -80°C until the biochemical analysis. Hematological parameters (creatinine, urea and CK) were determined with an analyzer model Coulter model AcT diff in the laboratory of the San Jorge University Hospital (Huesca, Spain).

Urine Samples and Analyses

All the subjects collected their first urine sample in the morning and the first urine sample after SC. They were collected in polyethylene tubes (previously washed with diluted nitric acid) and frozen at -80°C until analyzed. Containers were measured and codified once they were handed over. Samples were thawed and homogenized (by shaking) prior to analyses.

The quantity of urine used to obtain all the assessed parameters was 10 mL. A refractometer (URC-Ne, Atago, Japan) was pre-calibrated as previously described (Fernández-Elías et al., 2014) to analyze specific gravity in situ.

Biochemical variables (specific gravity and erythrocytes) were measured by placing a reagent strip (Combur Test, Roche, Spain) in a small portion of urine samples. After placing the strip inside an automatic reflection photometer (Urisys 1100, Roche, Spain) during 1 min, parameters were measured.

Statistical Analysis

Data were processed in IBM SPSS 25.0 Statistics for Macintosh (IBM Corp., Armonk, NY, USA). Results are expressed as the mean \pm standard deviation. The normality of the distribution of variables was analyzed by the Shapiro–Wilk test and the homogeneity of variances by the Levene test. A two-way ANOVA was used to show any differences in the studied variables. Effect size was calculated using partial eta squared (η^2), where .01–.06 was a small effect size, .06–.14 was a moderate effect size and $>.14$ was a large effect size (Hopkins et al., 2009). P values $< .05$ were considered to be statistically significant.

Results

Table 3 shows serum and urinary data obtained according to game side before and after de SC. Significant differences were found before and after the SC for creatinine ($p < .05$) and erythrocytes ($p < .01$).

Table 3. Results from serum and urinary parameters according to game side, before and after SC

		Pre	Post	Side Effect	SC Effect	Side x SC
Creatinine (mg/dL)	Left	.88 \pm .17	1.00 \pm .21	.415	.017 [^]	.991
	Right	.92 \pm .17	1.05 \pm .20			
Urea (mg/dL)	Left	35.38 \pm 9.38	40.00 \pm 10.62	.592	.062 [^]	.960
	Right	36.77 \pm 7.02	41.15 \pm 7.70			
CK (UI/L)	Left	168.19 \pm 157.66	199.50 \pm 163.05	.484	.421	.921
	Right	194.85 \pm 162.86	234.92 \pm 185.07			
Specific gravity (Kg/L)	Left	1.022 \pm .006	1.021 \pm .006	.810	.725	.762
	Right	1.022 \pm .004	1.022 \pm .005			
Erythrocytes (cells/ μ L)	Left	.63 \pm .50	7.81 \pm 9.65	.608	.004 [^]	.816
	Right	.00 \pm .00	6.15 \pm 13.86			

CK: creatine kinase; * large effect size ($>.14$); [^] moderate effect size (.06–.14).

Table 4 presents urinary and serum parameters according to game side and sex. Game side and sex effects, Urinary and serum parameters observed. Differences were found for creatinine ($p < .001$), CK ($p < .01$) and specific gravity between sexes ($p < .05$).

Table 4. Results obtained in serum and urinary parameters according to sex and game side

		Male	Female	Sex Effect	Side Effect	Sex x Side
Creatinine (mg/dL)	Left	1.03 ± .12	.76 ± .09	<.001 [^]	.381	.940
	Right	1.07 ± .12	.79 ± .06			
Urea (mg/dL)	Left	38.86 ± 7.96	32.67 ± 9.92	.088 [^]	.703	.819
	Right	39.33 ± 7.96	34.57 ± 5.79			
CK (UI/L)	Left	255.00 ± 210.88	100.67 ± 39.16	.006 [^]	.665	.908
	Right	284.67 ± 194.36	117.86 ± 81.15			
Specific gravity (Kg/L)	Left	1.023 ± .006	1.021 ± .006	.036 [^]	.992	.374
	Right	1.025 ± .002	1.019 ± .005			
Erythrocytes (cells/μL)	Left	1.43 ± 3.78	.00 ± .00	.314 [^]	.314 [*]	.314
	Right	.00 ± .00	.00 ± .00			

CK: creatine kinase; * large effect size (>.14); ^ moderate effect size (.06–.14).

Discussion

The aim of this study was to analyze the influence of game side on court in haematological and urinary biomarkers after a SC attending to possible gender differences. According to our results, game side on court did not cause any influence in neither the haematological nor the urinary biomarkers analyzed despite the previously reported differences between left- and right-side players in number and distribution of strokes during a padel match

(Ramón-Llin et al., 2020). The differences observed between the sexes could be due to the technical-tactical, anthropometric and physical condition characteristics of the padel players (Adrián Escudero-Tena et al., 2022; Pradas, Sánchez-Pay, et al., 2021).

Padel SC caused a significant increase ($p < .05$) in serum creatinine and urine erythrocyte's concentration in both female and male players regardless of playing side. Creatinine has been described as chronic kidney disease (CKD) marker, negatively affecting to the kidney function over a period of time (Vittori et al., 2021). Its concentration has been reported to be higher in athletes than in sedentary people and it is especially used in sport events where hydroelectrolytic balance is relevant (Banfi et al., 2012). Hence, our results suggest that a simulated padel competition can increase the risk of suffering CKD. This data is according to the observed by Pradas et al. (2020), where a padel game produced a significant serum creatinine augment ($p > .05$) in elite players of both sexes. Instead, heterogeneous results have been reported in other sports, with increases in ultramarathon non-elite runners, cyclists (Hoppel et al., 2019; Neumayr et al., 2005) and weight-trained students after two weeks of strength training (Raastad et al., 2001). Contrary, no modifications in professional Thai boxers (Saengsirisuwan et al., 1998) or even decreases during a season in elite rugby players and skiers (Banfi et al., 2009) have been found.

The presence of erythrocytes in urine, denominated hematuria, after the SC ($p < .05$) could be a consequence of athlete's repeated changes of direction and landings during the game. As pointed by Urakami et al. (2019) these impacts can produce bladder contusions caused by the repeated the contact of its posterior wall with the fixed bladder neck. Other contributors to the observed acute hematuria could have been footstrike hemolysis, an increase glomerular permeability, renal ischemia, or a combination of all (Shephard, 2016). Similar results were found in national level badminton players after a real game ($p < .05$) (Abián-Vicén et al., 2012) and after successive games ($p < .05$) (Abián-Vicén et al., 2014), suggesting high intensity as a possible trigger for hematuria.

Further, the SC held in the present study led into different gender responses with statistically higher values for male than female players in creatinine ($p < .001$), CK ($p < .01$) and specific gravity ($p < .05$). Creatinine is mainly stored in muscle tissue and therefore influenced by anthropometric characteristics and specially by athletes' body and muscle mass (Banfi et al., 2009, 2012; Perrone et al., 1992). Consequently, creatinine sex differences

could be due to the higher male's sample body mass ($p < .001$), who typically are heavier, taller and have greater muscle mass than female players as reported in previous studies (Castillo-Rodríguez et al., 2014; Muñoz et al., 2021; Pradas, Cachón, Otín, Quintas, Arraco, et al., 2014). CK release in the bloodstream is considered as a marker of skeletal muscle microtrauma (Clarkson & Hubal, 2002) and elevated CK values are typical of eccentric exercise (Banfi et al., 2012). Recently, various studies have informed of CK increases in other racket sports involving these eccentric actions, such as Hacker et al. (2021), who observed augmented levels of CK ($p < .0001$) in male elite badminton players after a loading training microcycle of four days. Equally, Gescheit et al. (2015), reported everyday increments in CK and muscle-soreness ratings over four consecutive days of prolonged competitive tennis match plays in well-trained male tennis players. In our study, higher values in male could be explained, on the one hand, because of their above-described higher muscle mass compared to female, being able to release considerable amounts of CK as it is produced from skeletal muscle. On the other hand, male's SC total and real time were 30.22% and 23.65% respectively greater compared to female's, with a major possibility of eccentric actions, such as changes of directions, jumps, landings and sprints characteristics of the game dynamics, taking place. Specific gravity values reveal that the whole male sample and females playing in the left side of the court finished the SC in a dehydrated state, considering 1020 g/mL as the upper limit threshold of euhydration (Casa et al., 2000), with a more pronounced dehydration in the first ones. This data could be associated to lower female's metabolic rates and body size, which could imply less sweating, and hence dehydration, than male (Sawka et al., 1983). Similar results were found in preceding studies with elite padel players (Pradas, García-Giménez, et al., 2021) and well-trained tennis players (Gescheit et al., 2015), where players commenced their matches in a dehydrated state and it was accentuated after them. Opposite, Abián-Vicén et al. (2012), only reported a pre-match hypohydration in 9,1% of elite badminton players and no dehydration after competitions. These differences among racket sports could be explained by different temporal characteristics and opportunities to rehydrate during competitions.

The present study has some limitations. Firstly, the match was not a real match, which could affect the results as the motivations of the players could be different. The analyzed markers could be altered by the "keys moment" (Adrián Escudero-Tena et al., 2022; B.J. Sánchez-Alcaraz et al., 2019). Secondly, we did not include plasma changes after the match, which could alter the serum results. Thirdly, the sample size was small.

Conclusions

Padel SC produced an increase in serum creatinine, which could affect to kidney function over a period of time, and hemolysis, probably caused by game dynamics. Sex differences were found in serum creatinine and CK, presumably due to anthropometric gender differences, with higher muscle mass for male, and longer SC total time in the male sample compared to the female. Both sexes finished the SCs in a dehydrated state, affecting it more to male, something which should be considered to prevent and alleviate its potential negative effects in performance. More studies should be carried out to confirm these data.

Practical applications

As padel is an intermittent sport involving explosive and eccentric actions which could result in muscular damage, special attention should be paid to strength training in various forms such as plyometrics, maximal, isometric and isoinertial strength among others, in an attempt to alleviate this consequence and even enhance players' performance. Furthermore, players should be advised about the importance of hydration and electrolyte supplementation, both pre- and during competitions, to prevent possible negative consequences in their performance caused by hyponatremia and dehydration. Last but not least, recovery between matches becomes important according to the present results, where an adequate protein ingestion, liquid and electrolyte replacement could counteract the effects of a padel match over muscle damage and dehydration to ensure an optimal recuperation to face with future efforts.

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Ethics

The study was approved by the Ethics Committee of the Department of Health and Consumption of the Government of Aragón, Spain (code: 21/2012).

Disclosure statement

The authors report no conflict of interest.

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