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ORIGINAL

ANTHROPOMETRIC CHARACTERISTICS OF ELITE PADDLE PLAYERS. PILOT STUDY

CARACTERÍSTICAS ANTROPOMÉTRICAS DE JUGADORES DE PÁDEL DE ÉLITE. ESTUDIO PILOTO

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ABSTRACT

Paddle is one of the racket sports that has grown the most in recent years. However, there are few or very limited studies that address the biotype of this discipline, especially in the elite paddle. The aim was to describe the anthropometric characteristics, body composition and somatotype of an international sample of high level paddle players. 29 subjects national top level (15 male and 14 female) participated in this study. 16 anthropometric variables were evaluated. Differences were found between sexes in the variables weight, height and BMI ($p < 0.001$); in triceps, thigh and leg folds ($p < 0.001$); in the arm, thigh ($p < 0.001$) and leg ($p < 0.03$) perimeters; and in all diameters analysed ($p < 0.001$). Differences were also found between men and women in the endomorphic ($p < 0.01$), mesomorphic ($p < 0.001$) and ectomorphic ($p < 0.05$) components of the somatotype. Male players present a mesomorphic-endomorphic somatotype while female players are preferably endo-mesomorphic. This research provides up-to-date reference data for somatotype in elite paddle players.

KEY WORDS: paddle; body composition; anthropometry; somatotype.

RESUMEN

El objetivo de este estudio fue describir las características antropométricas, la composición corporal y el somatotipo de una muestra internacional de jugadores de pádel de alto nivel de ambos sexos. En el estudio participaron 29 jugadores (15 varones y 14 mujeres) de categoría absoluta. Un total de 16 variables antropométricas fueron evaluadas. Se encontraron diferencias entre sexos en las variables masa, talla e IMC ($p<0,001$); en los pliegues tricipital, muslo, pierna ($p<0,001$) y en el sumatorio de 6 pliegues; en los perímetros brazo, muslo ($p<0,001$) y pierna ($p<0,03$); y en todos los diámetros analizados ($p<0,001$). Asimismo se encontraron diferencias en los componentes endomórfico ($p<0,01$), mesomórfico ($p<0,001$) y ectomórfico ($p<0,05$) del somatotipo. Los jugadores presentan un somatotipo mesomórfico-endomórfico y las jugadoras endo-mesomórfico. Esta investigación aporta datos biotipológicos actualizados de referencia para el pádel de élite.

PALABRAS CLAVE: pádel; antropometría; composición corporal; somatotipo.

INTRODUCTION

The effort character occurred during paddle tennis practice is acyclic, where intermittent periods of work and rest continuously take place in a similar manner to other racket modalities (Cabello-Manrique & Gonzalez-Badillo, 2003; Chin, Steininger, So, Clark, & Wong, 1995; Fernández, Mendez-Villanueva, & Pluim, 2006; Pradas, González-Jurado, Molina Sotomayor, & Castellar Otín, 2013). This sport is practiced in pairs and it is developed in a rectangular play area divided into two fields by a central net. The paddle tennis court is characterized by its completely closed girth, combining metallic mesh areas and areas made of materials which allow a regular rebound of the ball (bottom and side walls) against which the game can be played.

Paddle tennis' practice singularity in regard to other racket sports lies in its unique game dynamics, being the only discipline in which it is allowed to return the ball sent by the rival pair in three different ways: a) directly hitting the ball towards the opposing field without letting it drop or after a bounce on the court; b) performing the hit after bouncing the ball on the court and then some wall (lateral, background or both); and c) indirectly, hitting the ball against the side or bottom walls of the playing area where the players are located (Pradas et al., 2014)

From a physiological point of view, paddle tennis has the particularity of bringing together the participation of the different metabolic pathways. Considering the temporal structure of the different gaming actions that occur in this sport, there is visibly an lactic anaerobic metabolic system predominance, although a alactic anaerobic activity also exists to a lesser extent. However, as a consequence of the total duration of the matches, the intervention of aerobic metabolism is also necessary since it is considered the most important energy support system in this sport (Castellar, Pradas, Quintas, Arraco, & Pérez, 2015).

The intensity developed during paddle tennis practice is close to that experienced in the individual tennis modality. However, even though the oxygen consumption of paddle tennis players is similar to that achieved by tennis players, both in peak and relative values, the actual requirements of each practice are different (de Hoyo, Sañudo, & Carrasco, 2007).

Biotype analysis that characterizes players is another important issue to consider because of its direct relation with sports performance. If we focus on racket sports, it can be observed that numerous studies are concerned with accurately determining anthropometric characteristics in disciplines such as squash (Mellor et al., 1995), badminton (Vicén, Abián-Vicén, & Sampedro, 2012), tennis (Sánchez-Muñoz, Sanz, & Zabala, 2007) or table tennis (Pradas et al., 2013; Sepúlveda, Barraza, Soto, Báez, & Tuesta, 2015).

However, despite the fact that there are currently interesting studies attempting to describe the anthropometric profile in paddle tennis, it is certainly difficult to standardize the data presented by its heterogeneity, since in some cases the

studies have been performed with university athletes (Martinez-Rodriguez, Collado, & Vicente-Salar, 2015), with very small elite samples (Pradas et al., 2014), and even comparing players of different game levels (Castillo-Rodríguez, Hernández-Mendo, & Alvero-Cruz, 2014).

On the other hand, the important impetus, development and professionalism that paddle tennis has undergone in recent years, have posed a significant reduction in the number of players practicing this discipline coming from other racket sports, especially tennis, increasing gradually the players who have specialized only in this sport.

The incorporation to the elite in recent years of players formed exclusively from an early age in this sport, allows researchers to approach the knowledge of a more specific biotype of reference, closer and according to the sport´s reality of high level paddle practiced currently.

Considering what has been stated so far, determining the anthropometric characteristics and body composition that currently characterizes this discipline could be of interest because of its relevance to obtain an adequate sports performance. In this sense, the objective of this study is to describe and compare the anthropometric profile, the body composition and the somatotype of high-level padel players of both sexes.

MATERIAL AND METHODS

PARTICIPANTS

An international sample of 29 elite paddle tennis players, 15 men (age: 28.2±7.9 years) and 14 women (age: 29.7±3.7 years) voluntarily participated in this study. The selected athletes had an experience of 7.6±3.3 years and trained an average of 10±2.8 hours per week on the court, regularly participating in national top-level competitions, in Paddle Pro Tour tournaments and World Paddle Tour events during the last ten years.

PROCEDURES

The sampling applied in the context of this research was a non probabilistic sampling of convenience. To know the possible differences between sexes, the sample was divided into two groups: men and women. Measurements for anthropometric determinations included: body mass (kg), height (cm), eight skinfolds (biceps, triceps, subscapular, suprailiac, supraspinal, abdominal, thigh and leg (mm)), four girths (relaxed, contracted and flexed arm, thigh and leg (cm)) and three breadths (biepicondylar femur, biepicondylar humerus and bistiloyd wrist (cm)). Protocols proposed by the International Society for the Advancement of Anthropometry (ISAK) and the recommendations of the Spanish Group of Cineanthropometry (GREC) were used to record all measurements and determine the anthropometric profile. All measurements

were performed by an expert accredited by the ISAK, helped by an assistant to record the values obtained.

To ensure the validity and reliability of the measurements during the process, the recommendations were followed to maintain a technical error of inter-evaluating and intra-evaluating measurement below 5% in skinfolds and less than 2% in all other measurements.

For skinfold measurements, a plicometer (Holtain Ltd, Crymych, UK) was used with an accuracy of 0.2 mm. Height and body mass were measured with a Seca 714 scale (Seca Instruments Ltd, Hamburg, Germany). The breadths were determined with a pachymeter and the girths with a flexible metal tape with 1 mm precision (Holtain Ltd, Crymych, UK) using a dermographic pencil.

Based on the evaluations performed, different indices and percentages were calculated in order to determine the body mass index (BMI), body composition and somatotype of the athletes participating in the study. The BMI was calculated using the formula: [mass (kg) x height (m)]^2. Body composition was estimated using a tetra-compartment model, determining the fatty, bone and muscular components. The percentage of body fat was calculated using the formula of Withers, Craig, Bourdon & Norton (Withers, Craig, Bourdon, & Norton, 1987). The somatotype analysis was performed using the method proposed by Heath-Carter (Carter & Heath 1990), obtaining the value of the three components: endomorphic, mesomorphic and ectomorphic.

Before starting the study, the athletes were verbally informed about the objective, the procedure followed as well as the risks and benefits of their participation. All athletes signed an written informed consent. The research was approved by the Clinical Research Ethics Committee of the Government of Aragon (Spain), following the guidelines of the Declaration of Helsinki.

STATISTICS

SPSS© version 22.0 for Windows (Inc, Chicago, Illinois) was used as statistical software. A descriptive statistic analysis was performed to obtain the measures of central tendency: mean, standard deviation (SD), minimum and maximum. To verify the possible differences between groups, different hypothesis tests were carried out, checking the normality of the sample using the Shapiro-Wilk test and the homoscedasticity of variances through the Levene test. When the samples normality and homoscedasticity conditions were complied, the Student's T-test was used for independent data; when this failed, the non-parametric Mann-Whitney U-test was applied. For all the comparisons, a 95% confidence interval ($p \leq 0.05$) was established.

RESULTS

The overall characteristics of the players who participated in the study were differentially reflected by sex in Table I. The male sample presented significantly

higher values than the female one in the biometric variables of body mass (p <0.001), height (p <0.001) and BMI (p <0.001).

Table 1. Comparison of general characteristics by sex.

	Male		Female		p
Variable	**Mean (±SD)**	**Rank**	**Media (±SD)**	**Rank**	**value**
Age (years)	28.2 (±7.9)	19-46	29.7 (±3.7)	24-37	0.526*
Body weight (kg)	78.2 (±8.5)	68-95	60.3 (±4.4)	49-65	<0.001†
Height (cm)	178.3 (±4.4)	170-189	166.7 (±5.1)	155-173	<0.001*
BFP (%)	10.6 (±2.5)	7-16	17.6 (±2.7)	14-24	<0.001*
IMC (kg/m^2)	24.5 (±1.9)	22-28	21.7 (±1.1)	19-23	<0.001*

*Student's T-test; †Mann-Whitney U-test

The variables associated with the training volume of the sample are summarized by sex in Table II.

Table 2. Experience and training volume characteristics by sex.

	Male		Female	
Variable	**Mean (±SD)**	**Rank**	**Mean (±SD)**	**Rank**
Paddle tennis experience (years)	7.3 (±3.3)	4-12	7.8 (±3.4)	4-14
Court sessions (hours/week)	8.1 (±0.3)	8-9	11.2 (±3.1)	8-15

Skinfold, muscle girth and bone breadth profiles are shown in Table III. The analysis performed on these variables revealed significantly higher values in females than in males in tricipital, thigh and leg skinfolds (p <0.001).

Table 3. Anthropometric variables comparison by sex.

	Male		Female		p
Skinfolds (mm)	**Mean (SD)**	**Rank**	**Mean (SD)**	**Rank**	**value**
Bicipital	4.1 (±1)	2.8-6.2	5.2 (±10)	3.2-8.2	0.782*
Tricipital	9.9 (±3.1)	6.2-16	16 (±4)	10-22	<0.001*
Subscapular	10 (±3.7)	5.8-17.4	9.4 (±2.7)	6.2-16	0.664†
Suprailiac	10 (±4.8)	5.6-21	11.1 (±4)	6.2-22	0.176†
Supraspinal	9.3 (±4.2)	5.6-21	10 (±2.7)	6.2-13.8	0.974*
Abdominal	17.4 (±8.9)	7-38	17.9 (±6.6)	8.2-35	0.873†
Thigh	15.3 (±5.5)	9-26	23 (±4.6)	15.4-29.4	<0.001*
Leg	9.5 (±4.3)	5-19.4	15.1 (±3.9)	9-20	<0.001†
Σ 6 skinfolds	72.4 (±26.9)	41.8-129.6	92.6 (±18.8)	66.8-142.2	<0.02*
Girthss (cm)					
Flexed arm	34.4 (±2.3)	31.1-39.3	28 (±1.2)	25-29.8	<0.001†
Medium thigh	56.8 (±4.1)	51.1-64.5	51.9 (±1.6)	49.1-54.3	<0.001†
Leg	38.4 (±2.8)	35-44.5	35.6 (±1.6)	33.1-38.4	<0.03†
Breadths (cm)					
Biepicondyle	7.1 (±0.3)	6.7-8	6.4 (±1.3)	5.8-6.8	<0.001*
Biepicondylian	9.7 (±0.4)	9.1-10.7	8.8 (±0.4)	8.2-9.4	<0.001*
Bistyloid	5.8 (±0.3)	5.5-6.5	4.9 (±0.2)	4.7-5.5	<0.001*

*Student's T-test; † U of Mann-Whitney test.

The sum of the six skinfolds (Figure 1) is 72.4 mm and 92.6 mm in men and women, respectively (p <0.02). The fat component was distributed in 51.8% for the trunk (37.4 mm) and 48.1% for the limbs (34.7 mm) in males, whereas in females this relation was more pronounced in the limbs with 58.4% (54.1 mm) of the fat component with respect to the trunk values (41.5% and 38.4 mm).

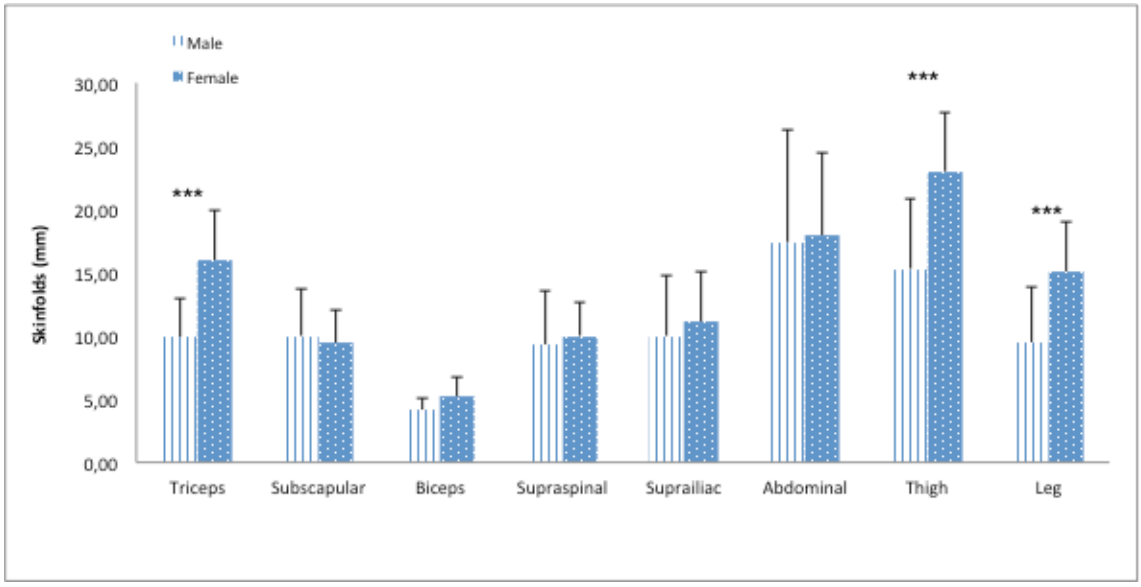

Figure 1. Paddle tennis players' skinfolds comparison by sex (***p<0.001).

The data obtained for the body composition presentation (Table IV) are derived from the categories proposed by Carter & Heath (1990). Muscular weight percentages in males are greater than in females (p <0.001), while the percentages of fat are smaller (p <0.001). Paddle tennis players of both sexes are characterized by having a dominant mesomorphy (5.4±0.9 vs 4.0±0.7) and an endomorphy (2.8±0.9 vs 3.8±0.7) greater than the ectomorphy (2.0±0.7 vs. 2.6±0.6). A statistical significance was found between sexes in the endomorphic (p<0.01), mesomorphic (p<0.001) and ectomorphic (p<0.05) components.

Table 4. Body composition comparison by sex.

	Male		Female		p*
Variable	**Mean (SD)**	**Rank**	**Mean (SD)**	**Rank**	**value**
% Fat mass	10.6 (±2.5)	7.7-16.2	17.6 (±2.7)	14.1-24.9	<0.001
% Muscle mass	43.4 (±2.4)	39.4-48.7	36.6 (±2.8)	32.7-42.5	<0.001
% Bone mass	15.8 (±0.8)	14.4-17.4	15.5 (±0.6)	14.5-16.4	0.328
Endomorphy	2.86 (±0.9)	1.6-5.2	3.8 (±0.7)	2.7-5.9	<0.01
Mesomorphy	5.47 (±0.9)	3.2-7.6	4.0 (±0.7)	2.8-5.3	<0.001
Ectomorphy	2.02 (±0.7)	1.0-3.1	2.6 (±0.6)	1.6-3.5	<0.05

*Student's T-test

Statistically significant differences were found in the percentage of fat and muscle weight (p<0.001) when comparing players by sex. There was a remarkable increase in fat percentage from 10.6 to 17.6% and a decrease from 43.4 to 36.6% in the muscle component between men and women, respectively. The mean somatotype obtained by the male players was 2.8-5.4-2.0 (Figure 2) while that of the female players was 3.8-4.0-2.6 (Figure 3).

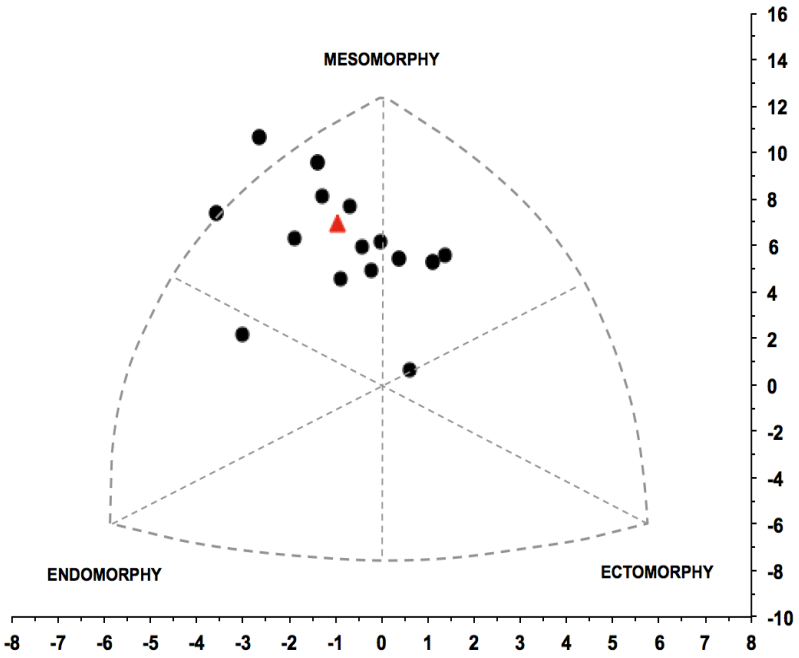

Figure 2. Somatochart's male somatotype distribution.

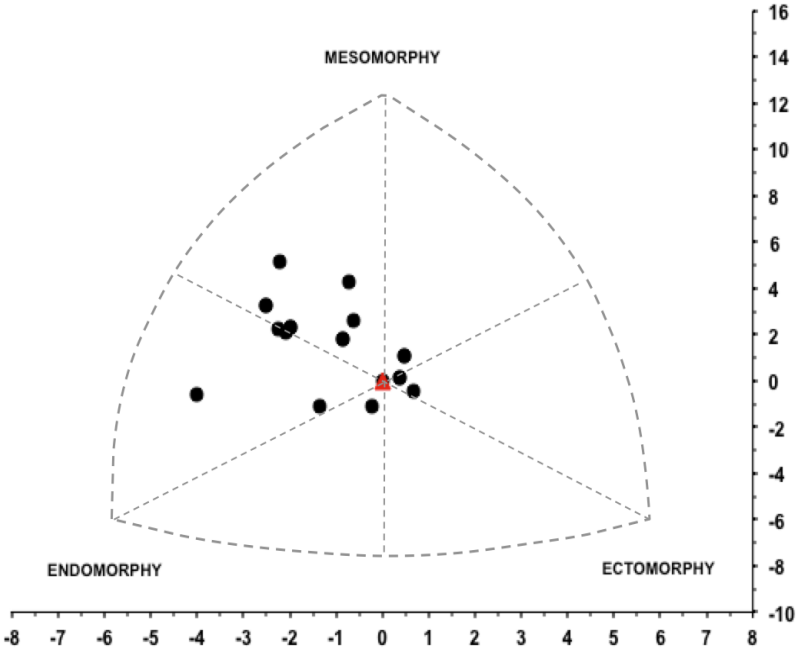

Figure 3. Somatochart's female somatotype distribution.

DISCUSSION

At present, paddle tennis is a sport discipline in a full expansion, evolution and development period, thus it continues to be a rather unknown sport, especially regarding the biotypological indicators that characterize it. This study aims to

improve the knowledge about the anthropometric and somatotype characteristics of elite paddle tennis players of both sexes.

The anthropometric characteristics analysed in this research revealed differences between sexes. Men presented higher values than women in body mass (78.2 vs. 60.3 kg), height (178.3 vs. 166.7 cm) and BMI (24.5 vs. 21.7). The data obtained in this study by the players for these three variables are very similar to those found by Castillo-Rodríguez et al. (2014) in national level paddle tennis players and slightly higher than those recorded by Martinez-Rodriguez et al. (2015) in university athletes.

If we compare the data obtained by the male sample with that of other athletes in different racket sports disciplines, it can be seen that paddle tennis players present slightly higher values than those found in table tennis (178.3±4.4 vs. 177±0.06) (Pradas et al., 2013), but lower than those found in badminton (181±5.7) (Faccini & Dal Monte, 1996) and professional tennis (184±7.1) (Hornery, Farrow, Mújika, & Young, 2007). The high level players analyzed in squash presented different heights (172.6±4.3 cm, 174.5±0.7 cm and 182±7 cm) (Chin et al., 1995; Johansen & Jensen, 1999), which could be related to the phenotype of the populations studied in each case.

The values found for the anthropometric variables (mass, height and BMI) in females are similar to those obtained by Castillo-Rodríguez et al. (2014) in Spanish national level paddle tennis players. As there are not enough studies on this sport, it is necessary to compare these results with other racket sports. It is noted that female paddle tennis players' height is slightly higher than in table tennis (Pradas et al., 2013), and lower than tennis players (Hornery et al., 2007), but it is contained within the height range described in female badminton players (Vicén et al., 2012).

The values presented by paddle tennis players of both sexes lead to think that the height variable may not be as important in this sport as in other disciplines such as tennis or badminton. Probably, one of the possible explanations related to height can have a direct relation with the game's dynamics developed in this sport. In paddle tennis it is possible to let the ball pass to hit it after its bounce, impact and later rebound on the bottom enclosure, which is why it is not essential to carry out hits on high balls, being skills more important than power play in this sport, especially for the most produced game actions, which are those that are developed close to the net, with these being considered as the most relevant and transcendent ones in paddle tennis (Courel-Ibáñez, Sánchez-Alcaraz, & Cañas, 2015).

Female players recorded a body mass very similar to that obtained by Castillo-Rodríguez et al.(2014) but higher than that found in sports such as table tennis (Pradas et al., 2013), although very close to that recorded in badminton (Vicén et al., 2012), but lower than that found in tennis (Hornery et al., 2007).

The male sample had a body mass similar to that found by Castillo-Rodríguez et al. (2014) in national level paddle tennis players, and slightly higher (78.2±8.5 vs. 74.3±8.6) than university players (Martinez-Rodriguez et al., 2015). In comparison to other racket sports, the players analyzed have shown greater body mass. In table tennis, values of 73.6±5.6 and 71.9±9.1 were found in elite players of the Chilean and Spanish teams, respectively (Pradas et al., 2013; Sepúlveda et al., 2015). They are also heavier than the squash players analyzed by Chin et al. (1995), with values of 67.7±6.9 kg. In comparison to the tennis players investigated by Ooi et al. (2009), the sample analyzed also showed higher values, although with a smaller weight difference.

This greater weight recorded in paddle tennis players compared to other racket sports could be closely related to the intensity to which this sport is developed, being inferior to disciplines like badminton, tennis, squash or table tennis, where the game actions occurred are performed at a high speed (Cabello-Manrique & Gonzalez-Badillo, 2003; Chin et al., 1995; Fernández et al., 2006; Pradas et al., 2013). In this sense, an excessive body weight in a paddle player, in particular of the adipose component, can generate a clear disadvantage against the adversary, producing a negative effect on the performance, fundamentally to carry out specific movements, like those that take place close to the net, or to return balls very close to the side and bottom walls, by the greater displacement of non-propulsive tissue, considering the performance of more severe muscular efforts by the degree of acceleration and deceleration that they require (Chin et al., 1995; Pradas et al., 2013).

Within the skinfolds analyzed, and despite the fact that women presented higher values in seven of the eight skinfolds measured, significant differences have been found in only three of them, corresponding to the extremities.

The differences found among sexes in the anthropometric variables of mass, height and BMI, as well as in the different girths and breadths evaluated, are the consequence of a marked sexual dimorphism between men and women (Cox & Calsbeek, 2010).

The body fat percentage (BFP) obtained was lower in men than in women, which is consistent with what is described in the literature for different racket sports (Pradas et al., 2013). Martinez-Rodriguez et al., (2015) describe BFP values in university paddle tennis players far above those found in the elite players analyzed in the present study. These results show that the percentages of BFP are inversely proportional to the players' level of performance.

When comparing the BFP of the male sample with the existing studies on racket sports, it is observed that paddle tennis players present the lowest BFP. Pradas et al. (2013) found BFP values in high level table tennis male players of 12±2.7%. In badminton Majumdar (1997) and Ooi et al. (2009) obtained values slightly above 12%. In squash, BFP values below 12% have been found in high level players (Chin et al., 1995).

Data relating to the BFP of female paddle tennis players were not found among the literature consulted. The values obtained in this study (17.6±2.7%) are higher than those found by (Pradas et al., 2013) in elite table tennis players (14.7±1.5%), but slightly lower than those found in badminton and tennis players with values of 23.6±3.3% and 18.1±2.3%, respectively (Hughes, Reilly, Hughes, & Lees, 1995; Pyke, Elliott, & Pyke, 1974). BFP may be considered as a factor that may limit paddle tennis players´ performance. Moreover, as pointed out by Chin et al. (1995), an excess of body fat could increase the energy expenditure required during a competition, causing a negative impact on physical and technical-tactical performance, which is accentuated as the game goes by.

The somatotype analysis of high level paddle tennis players reveals a mesomorphic-endomorphic type in men, very similar to that found in other similar investigations (Castillo-Rodríguez et al., 2014; Martinez-Rodriguez et al., 2015), where the mesomorphic component is the predominant one, but with important differences in values referring to the endomorphic component, which is probably related to the higher technical and physical level of the high level sample analyzed.

The somatotype analysis reveals a wide distribution of the players throughout the somatochart and specifically the mesomorphic zone. However, women are located closer to the central zone and in the endo-mesomorphic sector, similarly to female tennis players (Solanellas, Tuda, & Rodríguez, 1996).

Even though mesomorphy is the major component in both sexes, body composition results show a higher percentage of BFP in women and a higher body muscular and bone mass percentage in men, with these sexual differences being common among men and women (Cox & Calsbeek, 2010).

It was not possible to make a comparison of the somatotypes obtained since there is currently no data on a reference somatotype in the sport of paddle tennis.

CONCLUSION

Height does not seem to be such an important variable in this sport compared to other racket sports.

Triceps, thigh and leg skinfolds are significantly lower in men.

The adipose component, expressed both in percentages and in the sum of six skinfolds, presents significantly higher values in women.

Body composition in this sport presents a dominant mesomorphy and a greater endomorphy than ectomorphy in both sexes.

The somatotype obtained by men is mesomorph-endomorphic while that of women is endomorph-mesomorphic.

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