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Original/*Deporte y ejercicio*

Body composition and somatotype of professional and U23 hand Basque pelota players

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Abstract

Introduction: **there is hardly any reference in scientific literature regarding anthropometric characteristics, body composition and somatotype of hand Basque pelota players (*pelotaris*).**

Objectives: **the aim of this research was to analyze and compare the anthropometry features and body composition of professional *pelotaris* and under-23 (U23) *pelotaris*, to create an anthropometric profile of this sport.**

Methods: **the participants were ten U23 *pelotaris*, and eight professional *pelotaris*. Anthropometric measurements were taken following the International Society of Advancement of Kinanthropometry (ISAK) protocol. Fat mass (FM) was calculated using the Yushasz equation modified by Carter and muscle mass (MM) using Lee equation. For the somatotype components, the Carter y Heath equation was applied. The hydration level (kg of body water) of the players was measured with a four-pole kind bioelectrical impedance (BIA) analyzer. Spss was used for the statistical analysis.**

Results: professional *pelotaris* have significantly lower FM ($p < 0.05$) and lower sum of 4, 6 and 8 skinfolds ($p = 0.001$), higher MM ($p = 0.015$), and a less endomorphic somatotype ($p < 0.001$) than U23 *pelotaris*. Professionals have a greater amount of body water ($p = 0.001$) and a larger bistyloid diameter ($p = 0.014$). Professional *pelotaris* have a morphotype characterized by a low FM 8.9 ± 1.1% and medium MM 47 ± 1.7%, height of 183.0 ± 7.1 cm and BM of 85.9 ± 7.6 kg.

Conclusion: **The main results of the present study show that non-modifiable anthropometric features by training (e.g. height, arm span and wrist breadth) are important to become a professional *pelotaris*. Moreover, training and diet related features have been showed to be better in professional *pelotaris* (low FM, higher MM and high body water amount) than U23 *pelotaris*.**

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Key words: *Basque pelota players. Anthropometry. Body composition. Somatotype.*

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COMPOSICIÓN CORPORAL Y SOMATOTIPO DE LA MANO DE LOS JUGADORES DE PELOTA VASCA

Resumen

Introducción: **casi no hay ninguna referencia sobre las características antropométricas, la composición corporal y el somatotipo de la mano de los jugadores de pelota vasca (pelotaris) en la literatura científica.**

Objetivos: **el objetivo de esta investigación fue comparar la composición corporal de pelotaris profesionales y sub-23 para crear el perfil antropométrico de este deporte.**

Métodos: **participaron diez pelotaris sub-23 y ocho pelotaris profesionales. Las medidas antropométricas fueron recogidas siguiendo el protocolo de la Sociedad Internacional de Promoción de Protocolo Cineantropometría (ISAK). La masa grasa (FM) se calculó utilizando la ecuación Yushasz modificada por Carter, y la masa muscular (MM) mediante la ecuación de Lee. Los componentes del somatotipo fueron estimados mediante la ecuación Carter y Heath. El nivel de hidratación de los pelotaris se midió con un analizador tetrapolar de impedancia bioeléctrica (BIA).**

Resultados: **los pelotaris profesionales tienen significativamente menor FM (en % (p = 0,001); en kg (p = 0,025) y en los sumatorios de 4, 6 y 8 pliegues cutáneos (p = 0,001); mayor MM (p = 0,015) y un menor componente endomórfico (p < 0,001) que los pelotaris sub-23. Asimismo, los profesionales tienen una mayor cantidad de agua corporal (p = 0,001) y un diámetro mayor biestiloideo de muñeca (p = 0,014). Los pelotaris profesionales son un morfotipo caracterizado por una baja FM (8,9 ± 1,1%) y una intermedia MM (47 ± 1,7%), además de tener una altura de 183,0 ± 7,1 cm y un peso de 85,9 ± 7,6 kg.**

Conclusión: **los principales resultados de este estudio mostraron que las características antropométricas no modificables por el entrenamiento (por ejemplo, altura, envergadura y diámetro de la muñeca) son componentes importantes para convertirse en un pelotari profesional. Por otra parte, las características relacionadas con el entrenamiento y la dieta han mostrado ser mejores en los pelotaris profesionales (menor FM y mayor MM).**

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Palabras clave: *Pelota vasca. Antropometría. Composición corporal. Somatotipo.*

Abbreviations

∑4P: Four skinfold (Tricipitale + subscapulare + iliac crest + abdominale).

∑6P: 6 skinfold (Tricipitale + subscapulare + iliac crest + abdominale + thigh+ calf).

∑8P: 8 skinfold (Tricipitale + subscapulare + bicipitale + iliac crest + suprailiace + abdominale + thigh+ calf).

BC: Body composition.

BIA: Bioelectrical impedance.

BM: Body mass.

BMI: Body mass index.

FAPV: Basque Ball Federation of Alava.

ISAK: International Society for the Advancement of Kinanthropometry.

MM: Muscle mass.

FM: Fat mass.

U23: Under 23 age category.

Introduction

Basque pelota is the name for a variety of court sports traditionally practiced in the Basque Country. The most prominent feature of this game is the continuous hitting of the ball against a wall, by the players alternately, using one's hand, a racket, a wooden bat or a basket[1]. Hand Basque pelota (hand-pelota) is an international sport only played by professionals in the north of Spain and the South of France. This professional sport is played in a court with a double wall called "*fronton"* of 36x10x10 m, in single or pair modality. Nowadays, the competition in professional hand-pelota is carried out with faster and heavier balls (102-105 gr) than under-23's (U23) (98-102 gr), which require higher speed and power demand when hitting the ball[2]. This undoubtedly has an effect on the body composition of professional hand-pelota players (*pelotaris*), who are possibly stronger than U23.

Anthropometric features and body composition (BC) of the players, are considered decisive for a high sport performance in many disciplines, especially fat mass (FM) and muscle mass (MM) values[2,3-5]. A high FM percentage increases energy demand and reduces performance in endurance sports[6]. However, MM is a good indicator of sports performance, being used as a control parameter of training, responsible for motor propulsion, energy production during high intensity activities, and provides greater power and resistance strength[7].

Furthermore, bone breadths and lengths could be determinant factors for hand-pelota performance as its contribution in the biomechanics of the hitting movement[8]. Thus, together with the arm span, 1) the biacromial bone breadth, which enables the creation of a stable strength base at the proximal scapular girdle, necessary for the distal explosive strength production (ball hitting). It provides a higher independence to the global kinetic chain of the strike. 2) The transverse diameter of the hand provides a higher possibility to hit the ball. 3) The wrist breadth provides higher stability and less hand vibration when striking, and 4) the length of the fingers are responsible to hit the ball which, if longer, can help players to get a bigger boost when hitting the ball, contrary to shorter fingers, that are more liked to suffer from an injury[2]. Therefore, the length of the fingers can be anthropometric measurements with a great importance. Besides, anthropometric measurements, body mass (BM), FM and MM, can also have an influence on the arm, wrist and hand, as the whole body movement[4]. Hydration state allows muscle and bone to be more flexible and get the power avoiding from injuries, being highly related with all this BC parameters.

To improve the performance in hand-pelota players, and to give an adequate nutritional and sports counseling, it is important to know their BC[3], somatotype[9] and hydration level of the players. Only some references relating to the BC of *pelotaris* have been described, showing few anthropometric parameters, as height, BM, FM and body mass index (BMI) in U23 *pelotaris* from the Spanish National Team[1,10]. However, none references have showed about professional *pelotaris* and their differences with U23 *pelotaris*.

Thus, the aim of this study was: 1) to describe the body composition, anthropometric and somatotype features of professional *pelotaris* and to determine the differences in these variables between professional and U23 *pelotaris*.

Material and methods

Participants

Data collection was conducted in a group of 18 male *pelotaris* who play in individual modality (aged 24.1±4.7, height 180.0±7.1 cm, and BM 82.7±8.2 kg). Data are collected in February at the end of specific period. Participants were assigned to 1 of 2 groups, based on their play level. The groups were allocated: (*i*) Professional *pelotaris*: Eight professional *pelotaris* from a total of the 48 Spanish professional *pelotaris* were recruited from the two professional teams of hand-pelota that exist in Spain and (ii) U23 *pelotaris*: ten U23 *pelotaris* recruited from the Basque Ball Federation of Alava (FAPV) ranked in the top of the category U23. They were designed by FAPV to play several international championships.

All participants had over 5 years of experience in competitions and followed the same training course during 12 weeks highly and professionally supervised, making a total of 3-4 weekly training sessions and 1-2 weekly matches before the study.

Specific criteria such as having a valid federative license and not being injured at the moment of the research were considered eligible for inclusion. All *pelotaris* and entities were provided with oral and written information about the aim and nature of the research, and signed a written consent to participate. The study

followed the criteria of the II Declaration of Helsinki (2008) and was approved by the Ethics Committee of the University of the Basque Country.

Experimental Design

Testing session took place in a *fronton* with standard conditions (temperature: 21ºC and 60% humidity), controlling their hydration level with an bioelectrical impedance (BIA) analyzer. Subsequently, an anthropometric test was carried out on them.

Body composition and anthropometric assessment

Anthropometric measurements were taken following "The International Society for the Advancement of Kinanthropometry" (ISAK) protocol[11]. Additionally, all anthropometric measurements were taken by the same research, who was international certified in anthropometric testing (ISAK level 2). His technical error in the measurement of skinfolds was less to 5% and to 1.5% in the rest of the measurements.

Height (cm) was measured using a SECA® measuring rod (model 704, Seca Corp, Hanover, Maryland), with a precision of 1 mm and a range (130-210 cm), while BM (kg) was assessed by a SECA® calibrated digital model scale (model 704, Seca Corp, Hanover, Maryland), with a precision of 0.1 kg and a range (2 kg - 130kg). BMI was calculated using the formula BM/height^2 (kg/m^2). Eight skinfolds (Tricipitale, subscapulare, bicipitale, iliac crest, suprailiace, abdominale, thigh, calf)[11] were taken (mm) by a Holtain® skinfold caliper (Holtain Ltd, Crymmych, UK), with a precision of 0.2 mm. Four skinfolds (∑4P) (Tricipitale + subscapulare + iliac crest + abdominale), 6 skinfolds (∑6P) (Tricipitale + subscapulare + iliac crest + abdominale + thigh+ calf), and 8 skinfold measurements (∑8P) skinfolds (Tricipitale + subscapulare + bicipitale + iliac crest + suprailiace + abdominale + thigh+ calf) were calculated. Bone breadth (wrist, humerus and femur) were measured with a Holtain® pachymeter (Holtain Ltd, Crymmych, UK), with a precision of 1 mm, and girths (cm) (arm girths (relaxed and flexed), waist girth, hip girth, mid-thigh girth and calf girth) were measured with a narrow, metallic and inextensible Lufkin® model W606PM measuring tape with a precision of 1 mm. Minimum waist to hip ratio was calculated as waist girth (cm)/hip girth (cm). FM was calculated using the Yushasz equation modified by Carter[12] and for the MM by Lee[13] equation. For the somatotype components, the Carter y Heath[14] equation was applied.

Bioelectrical Impedance Analysis (BIA)

The hydration level (kg of body water) was estimated by a four-pole kind, SC-24OMA model Tanita BIA analyzer, following the strict protocol set by Lukaski et al.[15]. This BIA model analyzer estimated hydration level by 2 equations, as specified in the user's manual: one for sportsmen (>10 hours/week of exercise, or resting heart rate ≤ 60 bpm), and another for sedentary people who do not meet the previous requirements. The equation for sportsmen was applied for both groups. The body water percentage was calculated by BIA.

Statistical Data Analyses

All data are presented as mean and standard deviation. Values studied between professional and U23 *pelotaris* were compared through the Student's *t* test after checking the normality and homogeneity of variance applying the Saphiro-Wilk and Levene´s tests respectively. The differences were considered statistically significant when $p < 0.05$. The statistical data analysis was made using the SPSS statistical package, version 17.0 (SPSS Inc., Chicago). The size of the effect was estimated by using Cohen's *d*. Cohen's *d* is calculated as the difference between 2 means divided by the pooled standard deviation. A Cohen's *d* of 0.5 indicates that the mean of the intervention group is half a standard deviation larger than the mean of the control group. Cohen's *d* from > 0.80 is a large effect size, 0.51 to 0.80 is moderate, 0.21 to 0.50 is small and 0 to 0.20 is very small[16]. We calculated the effect sizes of each BC, anthropometric and somatotype features separately, between professional and U23 *pelotaris*.

Results

Table I shows the general features of both professional and U23 *pelotaris*. No significant differences were observed between *pelotaris* (professional vs U23) regarding age, height, arm span, BM and BMI. However, were observed large effect size in height (Cohen's d = 0.80) and in arm span (Cohen's d = 0.84) between both groups. Regarding BMI, and bearing in mind data referring to the overall population, our results revealed that both categories and following BMI cut off points, professional and U23 *pelotaris* (25.6 vs 25.4 kg/m^2) are overweighted (BMI ≥ 25 kg/m2).

Table II shows girth, skinfolds and breadths data of the professional and U23 *pelotaris*. No significant differences ($p > 0.05$) were found in any of the girths. However, significant differences were observed ($p < 0.05$) in all the skinfolds, with thinner values obtained in professional *pelotaris* when comparing with U23 *pelotaris*. Similar and significant data were observed for the sum of 4 skindfolds (45.5±5.5 vs. 62.4±10.9 mm), 6 skindfolds (64.3±9.3 vs. 90.4±15.5 mm) and 8 skinfolds (76.2±10.4 vs. 107.3±18.5 mm), showing less adipose tissue professional than U23 *pelotaris,* respectively (all $p < 0.001$).

Table I
General features of professional and U23 pelotaris

	Total (n=18)	*Professional (n=8)*	*U23 (n=10)*	*P*	*Cohen's d*
Age (years)	24.1±4.8	25.3±4.5	22.8±5.0	0.279	0.44
Height (cm)	180.0±7.2	183.0±7.1	177.5±6.6	0.110	**0.80**
Arm span (cm)	185.3±7.2	189.0±6.8	183.0±7.5	0.078	**0.84**
Body mass (kg)	82.7±8.2	85.9±7.6	80.2±8.2	0.149	0.72
BMI	25.5±0.9	25.6±1.0	25.4±0.8	0.597	0.22

Data expressed as mean ± SD. BMI=Body Mass Index.
P: Significance differences between groups.

Table II
Anthropometric measurements of professional and U23 pelotaris

	Total (n=18)	*Professional (n=8)*	*U23 (n=10)*	*p*	*Cohen's d*
		Girths (cm)			
Arm Girth (relaxed)	33.7±2.0	34.1±1.6	33.5±1.8	0.484	0.35
Arm Girth (flexed and tensed)	34.6±1.8	35.1±1.7	34.2±1.8	0.288	0.51
Waist Girth	84.1±4.0	84.3±3.9	84.0±4.3	0.900	0.07
Hip Girth	100.3±4.2	99.9±4.5	100.5±4.2	0.768	-0.134
Waist to Hip Ratio	0.84±0.04	0.85±0.03	0.84±0.05	0.689	0.24
Calf Girth	40.4±2.2	41.0±2.0	39.9±2.2	0.269	0.52
Mid-thigh Girth	61.2±2.7	60.8±2.5	61.4±2.9	0.671	-0.22
		Skinfolds (mm)			
Bicipitale	4.7±1.5	3.9±0.7	5.4±1.6	**0.014**	-1.22
Tricipitale	1.1±2.8	9.3±2.3	12.6±2.4	**0.010**	-1.40
Subscapulare	10.7±1.9	9.8±0.9	11.3±2.3	0.095	-0.856
Abdominale	19.0±6.4	14.4±3.8	22.7±5.8	**0.003**	-1.69
Supracrestale	14.1±3.4	11.9±1.2	15.8±3.7	**0.009**	-1.42
Suprailiac	9.9±2.6	8.0±1.1	11.4±2.5	**0.003**	-1.76
Thigh (front)	14.9±5.7	11.7±3.1	17.4±6.1	**0.028**	-1.18
Calf	9.0±3.5	7.2±2.4	10.5±3.6	**0.038**	-1.08
Sum of 4 skinfolds	54.9±12.3	45.5±5.5	62.4±10.9	**0.001**	-1.96
Sum of 6 skinfolds	78.8±18.5	64.3±9.3	90.4±15.5	**0.001**	-2.04
Sum of 8 skinfolds	93.5±21.8	76.2±10.4	107.3±18.5	**<0.001**	-2.07
		Bone breadth (cm)			
Humerus	7.1±0.4	7.1±0.5	7.1±0.3	0.724	0
Femur	10.3±0.5	10.4±0.3	10.2±0.6	0.555	0.42
Wrist	5.9±0.3	6.1±0.2	5.8±0.3	**0.014**	**1.18**

Data expressed as mean ± SD. BMI: Body Mass Index; Sum of 4 skinfolds: Tricipitale + subscapulare + iliac crest + abdominale skinfolds; Sum of 6 skinfolds: Tricipitale + subscapulare + iliac crest + abdominale + thigh+ calf skinfolds; Sum of 8 skinfolds: Tricipitale + subscapulare + bicipitale + iliac crest + suprailiace + abdominale + thigh+ calf skinfolds.
P: Significance differences between groups.

Regarding breadths, similar humerus and femur breadths were obtained in both groups. However, professional *pelotaris* had a statistically greater wrist breadth than U23 *pelotaris* (6.1±0.2 vs. 5.8±0.3 mm) ($p = 0.014$), besides a large size effect (Cohen's de = 1.18).

Table III shows the BC of the professional and U23 *pelotaris*. FM was significantly lower in professional than U23 *pelotaris*; (7.7 kg vs 9.3 kg); (8.9% vs. 11.6%) respectively ($p < 0.05$). Moreover professional had higher absolute MM mass than U23 *pelotaris* (39.7 kg vs 36.1 kg) ($p = 0.015$). A large effect size both in MM and bone mass were observed (Cohen's de > 0.80).

Table IV shows the body water percentage for both professional and U23 *pelotaris* measured through BIA. Professional players had significantly higher absolute body water mass (50.9 kg) than U23 (47.6 kg) *pelotaris* ($p < 0.001$). Furthermore a large effect size was observed in kg of body water (Cohen's de > 1.84).

Regarding somatotype, professional *pelotaris* showed values of 3.9-5.5-1.8 (endomorphy-mesomorphy-ectomorphy), while the values of U23 *pelotaris* were 4.9-5.8-1.6. Likewise, it was observed that the endomorphic component in professional was statistically lower ($p < 0.001$) than U23 *pelotaris* (Table V).

Figure 1 shows a somatochart of each of the players. It was noted that the professional *pelotaris* tended to be placed in an ecto-mesomorph zone, while the U23 *pelotaris* tended to be in an endomorphic zone.

Discussion

To author's knowledge the present study was the first study describing the anthropometric and somato-

Table III
Body composition of the professional and U23 pelotaris

	Total (n=18)	*Professional (n=8)*	*U23 (n=10)*	*P*	*Cohen's d*
Fat (Carter, %)	10.4±1.9	8.9±1.1	11.6±1.6	**0.001**	-1.97
Fat (Carter, Kg)	8.6±1.6	7.7±1.2	9.3±1.6	**0.025**	-1.13
Muscle (Lee, %)	45.6±1.8	47.3±1.7	45.1±1.8	0.090	**1.26**
Muscle (Lee, Kg)	37.7±3.6	40.7±3.3	36.1±3.1	**0.015**	**1.44**
Bone (Rocha, %)	11.0±2.3	12.0±2.0	10.3±2.2	0.111	**0.81**
Bone (Rocha, Kg)	13.2±1.5	13.9±1.2	12.7±1.5	0.085	**0.88**

Data expressed as mean ± SD.
P: Significance differences between groups.

Table IV
Hydration levels of the professional and U23 pelotaris

	Total (n=18)	*Professional (n=8)*	*U23 (n=10)*	*p*	*Cohen's d*
BIA Water (Kg)	47.6±4.4	50.9±2.3	45.0±3.9	**0.001**	**1.84**
BIA Water (%)	58.5±1.2	58.4±1.3	58.7±1.2	0.597	-0.24

Data expressed as mean ± SD.
p: Significance differences between groups.

Table V
Somatotype of professional and U23 pelotaris obtained from anthropometric data

	Total (n=18)	*Professional (n=8)*	*U23 (n=10)*	*p*	*Cohen's d*
Endomorphy	4.5±0.6	4.0±0.3	4.9±0.5	**<0.001**	-2.18
Mesomorphy	5.7±0.6	5.6±0.7	5.8±0.6	0.352	-0.31
Ectomorphy	1.7±0.4	1.8±0.5	1.6±0.3	0.241	0.49

Data expressed as mean ± SD.
P: Significance differences between groups.

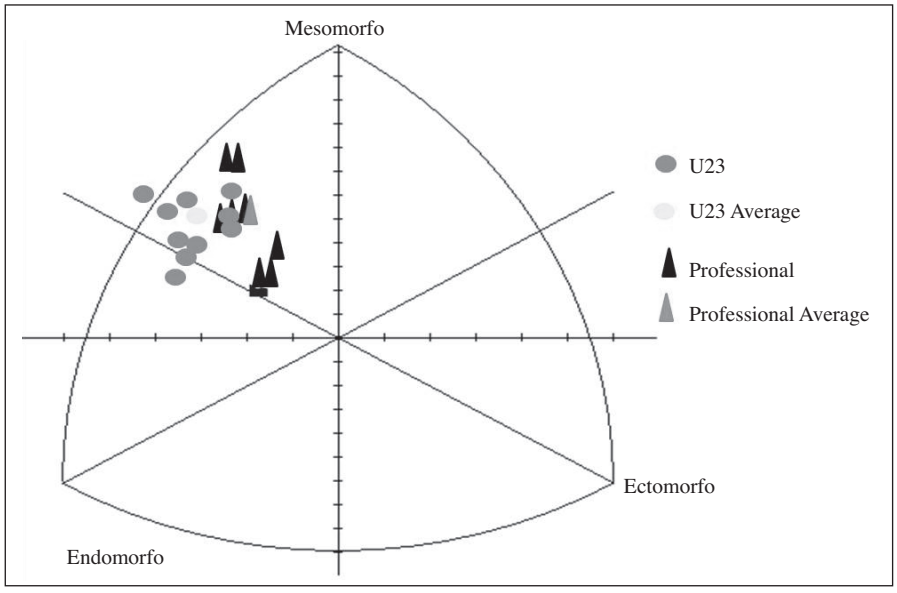

Fig. 1.—Somatochart of each professional and U23 pelotaris and average measurements.

type features of *pelotaris* and analizing the differences between professional and U23. The main results of the present study showed that non-modifiable anthropometric features by training (e.g. height, arm span and wrist breadth) are important to become a professional *pelotaris*. Moreover, training and diet related features (FM and MM) seem to be better in professional *pelotaris* that had lower FM and higher MM than U23 *pelotaris*.

Several research described hand-pelota training, its general features, technical and tactical aspects, or the players' medical problems due to the continuous impacts they suffer from hitting the ball[2], but none of them describes the anthropometric features of the players[1]. BC could have a great relevance, since it can help to perform quick movements. Another important factor, bone length, demonstrated in some studies[17], as having longer limbs it is possible to increase the throwing power or the ball hitting power, improving performance and prevent from injuries[18].

Other sports such as handball, volleyball or basketball, which also require the use of hands, have a clearly defined anthropometric profile (especially with height between 180-190cm and body mass above 80-90 kg, important features to kick or hit the ball more powerful)[19-22]. Due to the lack of studies analyzing *pelotary* antropometric features, it allows us to compare our players regarding international elite sportsmen, since, supposedly, they are the best sportsmen and have "the perfect" physiological[18] and anthropometric[23] profile.

Among the few existing references in scientific literature regarding hand-pelota anthropometric features, Córdova et al.[2] and Izquierdo et al.[1,10] presented an average height and BM of 181.3 cm and 82.9 kg in professional *pelotaris* and an average height and BM of 180.5 cm and 80.5 kg respectively in U23 *pelotaris*. These data were similar to those obtained in our study, for both professionals (height: 183.0 cm and BM: 85.9 kg) and U23 (height: 177.5 cm and BM: 80.2 kg) *pelotaris*.

Hand-pelota has been described as a mixture of volleyball, football, basketball and tennis[22]. In this connection, all *pelotaris* have a similar height to handball wingers (184 cm)[22] and tennis players (170-195 cm), but they are smaller than basketball (185.7-203.9 cm)[20] and volleyball players (193.9 cm)[19] in any play position. The reason for this is that in hand-pelota, as in tennis or handball, the height is not the most important parameter, being the arm span essential in the performance of the upper body[24].

Regarding BM, all *pelotaris* were similar to any handball player (81-88 kg)[22], heavier than football players (74.0-83.8 kg)[21] and point guards in basketball (82 kg), and lighter than center players (103.9 kg), forwards (89.4 kg)[20]; and than volleyball players (88.4 kg)[19].

Regarding BMI, our results revealed that both categories a professional and *pelotaris* () are overweighted (professional: 25.6 kg/m^2; U23: 25.4 kg/). However, it is important to point out that when talking about sportsmen the interpretation must be done in a different way, since a high BMI as a resulting of a high weight, indicates higher MM instead of higher FM[25]. Therefore BMI cannot be used to make a diagnosis of the BC or any kind of classification in active people.

Regarding the breadths, we have observed that the wrist breadth was statistically higher in professional (6.1±0.3 cm) than in U23 (5.8±0.2 cm) *pelotaris*, with a large effect size between groups (Cohen's d = 1.18). This, together with having long limbs, is an important fact which allows players to hit the ball more powerfully. The humerus (7.1 cm) and femur (10.4 cm) breadths were same to volleyball and handball players[19, 22].

Professional *pelotaris* had significantly lower skinfolds ($p < 0.05$) than U23, which results in a lower quantity of FM and the endomorphic component of the

somatotype ($p < 0.05$). Some authors state that tricipitale, suprailiac, abdominale and front thigh skinfolds have a greater connection with FM[26-28]. In our study, significant results were obtained when comparing skinfold values between professional and U23 *pelotaris*. The existing literature confirm our results[1,29]. Nevertheless, we have to be careful when comparing data regarding the fat component, since there is no consensus on the equations used, and that is why it is common to use the sum of skinfolds or data from international reference[11, 28]. In our case, professional *pelotaris* had a result of 64.3 mm in the sum of 6 skinfolds, lower than U23 (90.4 mm). According to Cajasús el al., in most intermittent and team sports, the sum of 6 skinfolds of the players should be close to 60 mm during tapering, and lower in endurance sports, in order to compete in the best conditions[30]. It is appropriate to present data of skinfolds from several sites to obtain the fat subcutaneous accumulation of different parts of the body (upper, lower or central) in order to plan nutritional strategies and specific physical training.

Regarding FM, significant lower values were observed in professional *pelotaris* (8.9±1.1%) when comparing with U23 (11.6±1.6%). Izquierdo et al.[1, 10] showed that U23 *pelotaris* who played in world championships had a range of FM of 11-13%, not specifying the method they used to obtain these data, but observing a similarity with our data obtained in U23 *pelotaris*. On the other hand, there is a great variability in the quantity of FM in players of team sports such as volleyball[19], handball (11.5-14%)[29] or football (8.2-8.6%)[30, 31], which makes us think that the position of the players could be a key factor. Besides, in sports which a high performance demand with a high number of jumps, such as volleyball[19], or even in multi-disciplinary sports with high aerobic intensity, such as football or tennis. To have less FM is beneficial, since BM can be a limiting factor[24].

Regarding body girths, professional *pelotaris* have a relaxed arm girth (34.1 cm) similar to handball wingers (34.7 cm)[22] and volleyball players (33.6 cm)[19], while the calf girth (41.0 cm) is similar to handball pivot players (41.03 cm) and larger than volleyball players (38.9 cm). These data show that in sports in which arms are essential, players have a similar arm girth, while the calf girth is more important in those sports or positions in which players have to keep ground contact[32]. At the same time, *pelotaris* had a larger waist girth than football players (84.23 cm vs. 80.0 cm)[30].

The MM difference is 2.2% higher ($p < 0.05$) in professional than U23 *pelotaris* (47.3% and 40.7 kg, respectably). These values in absolute percentages are higher than other sports, as basketball[20]. These data could be due to the played role of throwing-hitting motion biomechanics (upper body) and the speed of the movements (lower body). Thus, these features can also be found in handball players (MM = 48.0%)[22] and tennis players (MM = 46.7%)[18], who need high MM values of arm, thigh and calf girths.

Regarding the breadths, we have observed that the wrist breadth was statistically higher in professional (6.1±0.3 cm) than in U23 (5.8±0.2 cm) *pelotaris*, with a large effect size between groups (Cohen's d = 1.18). This, together with having long limbs, is an important fact which allows players to hit the ball more powerfully. The humerus (7.1 cm) and femur (10.4 cm) breadths were same to volleyball and handball players[19, 22].

In reference with hydration state, while normal adults have a 50-55% of total body water, in sportsmen the level increases up to 55-60%, due to a high lean BM, a low FM and a great quantity of muscle glycogen[33]. The quantity of total body water is related to the MM proportion, and a muscle can contain up to 70% of it. An individual of 70 kg can hold approximately 42 kg of body water, a similar quantity to U23 *pelotaris* (45.0 kg). Professional *pelotaris* had higher MM and lower body fat (40.7 and 7.7 kg, respectively) than U23 pelotaris (36.1 kg and 9.3 kg respectively). These differences confirm that there is a higher proportion of body water ($p = 0.001$) in professional *pelotaris*. To assess and monitor body water is very important, since a decrease in BM of more than 2% can have a negative effect on the forearm maximum strength[34,35].

Regarding all the data obtained in this study, *pelotaris*' coaches could use this information to determine the type of physical profile that is needed for professional *pelotaris* and also to design specific training and nutritional programs.

A major limitation of the study is the small size of the sample, but not too many hand-pelota players were available. However, we have presented the data of top professional and U23 *pelotaris* of Spain. Future research is necessary to identify the physical changes during the whole seasons.

In conclusion, professional *pelotaris* have significantly lower fat mass (FM), higher muscle mass (MM) ($p = 0.015$), less endomorphic ($p < 0.001$) and higher body water amount than U23 *pelotaris*. Moreover, professionals have a larger bistyloid diameter ($p = 0.014$), which is a very important feature that enables players to hit the ball harder.

Professional *pelotaris* are a morphotype characterized by a low fat percentage and medium muscle mass, together with a body mass slightly higher. It allows players to hit the ball with great stability (strength in the legs and waist) with great power and speed in the upper body. Furthermore, non-modifiable anthropometric features by training (e.g. height, arm span and wrist breadth) are necessary to become a professional *pelotari* especially in hitting.

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