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Anthropometric profile, body composition, and somatotype in stand-up paddle (SUP) boarding international athletes: a cross-sectional study

Perfil antropométrico, composición corporal y somatotipo en atletas internacionales de stand-up paddle *(SUP): un estudio transversal*

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Abstract

Introduction: the anthropometric characteristics of international stand-up paddle (SUP) boarders are relevant aspects when it comes to their performance. However, very little research has been carried out within this sport, almost none regarding the body composition and anthropometric characteristics of SUP practitioners. Therefore, the aim of this research will be to describe the anthropometric profile of international SUP boarders.

Material and methods: a cross-sectional design in thirty-one international SUP boarders (34.2 ± 12.4 years). Height, body mass, 8 skinfolds, 2 bone diameters, and 5 perimeters were measured, and corrected perimeters were calculated by the same two level-2 internationally certified anthropometrists. Anthropometric measurements were taken following the International Society of Advancement of Kinanthropometry (ISAK) protocol. Body fat mass (FM) was calculated using Carter, Faulkner, Yuhasz, and Withers equations, whereas muscle mass (MM) was estimated using the Lee 2000 equation. Somatotype was calculated by applying the Heath and Carter equation. Bioimpedance (BIA) measurements were also recorded.

Results: international SUP athletes had a body mass of 74.6 (6.6) kg, a body fat percentage of 7.6 % (2.1 %) (Carter), 11.3 % (3.5 %) (Faulkner), 7.6 % (2.1 %) (Yuhasz), and 9.0 % (3.6 %) (Whiters), and skinfold sums of 48.2 (20.6) mm for 6, and 57.8 (22.2) mm for 8 skinfolds. Muscle mass was 47.3 % (2.6 %) and somatotype was ecto-mesomorphic with values of 1.9 (0.9) for endomorphy, 5.4 (1.0) for mesomorphy, and 2.4 (0.9) for ectomorphy. BIA results for FM were 11.7 % (4.4 %), and for MM were 50.0 % (2.9 %).

Conclusion: these results suggest that a low body fat percentage and high muscle mass are representative characteristics of international stand-up paddlers, as well as a balanced mesomorphic somatotype. According to these, a low skindfold sum and high arm muscle mass may represent key factors for performance in this sport because of their relation to acceleration and stroke force.

Keywords:

Stand-up paddle boarding. Anthropometry. Body composition. Somatotype. International athletes.

Resumen

Introducción: las características antropométricas de los atletas internacionales de *stand-up paddle* (SUP) son aspectos relevantes para su rendimiento. Sin embargo, se han realizado muy pocas investigaciones dentro de este deporte, y casi ninguna cuando se trata de la composición corporal y las características antropométricas de los palistas de SUP. Por lo tanto, el objetivo de esta investigación será describir el perfil antropométrico de los palistas internacionales de SUP.

Material y métodos: se reunieron treinta y un palistas internacionales de SUP (34,2 ± 12,4 años). Se midieron la altura, la masa corporal, 8 pliegues de piel, 2 diámetros de huesos y 5 perímetros, y se corrigieron otros 2 perímetros, por los mismos dos antropometristas certificados como ISAK 2. Las mediciones antropométricas se realizaron siguiendo el protocolo de la Sociedad Internacional para el Avance de la Cinantropometría (ISAK). La masa grasa (FM) se calculó utilizando las ecuaciones de Carter, Faulkner, Yuhasz y Withers, mientras que la masa muscular (MM) se calculó utilizando la ecuación de Lee 2000. El somatotipo se obtuvo aplicando la ecuación de Heath y Carter. Se registraron también las mediciones mediante bioimpedancia (BIA).

Resultados: los atletas internacionales de SUP tenían una masa corporal de 74,6 (6,6) kg, un porcentaje de grasa corporal de 7,6 % (2,1 %) (Carter), 11,3 % (3,5 %) (Faulkner), 7,6 % (2,1 %) (Yuhasz) y 9,0 % (3,6 %) (Whiters) y sumas de pliegues cutáneos de 48,2 (20,6) mm para 6, y 57,8 (22,2) mm para 8 pliegues cutáneos. La masa muscular era del 47,3 % (2,6 %) y el somatotipo era ectomesomórfico con valores de 1,9 (0,9) para la endomorfia, 5,4 (1,0) para la mesomorfia y 2,4 (0,9) para la ectomorfia. Los resultados de la BIA fueron del 11,7 % (4,4 %) para la FM y del 50,0 % (2,9 %) para la MM.

Conclusión: estos resultados sugieren que un bajo porcentaje de grasa y un elevado porcentaje de masa muscular, junto a un somatotipo mesomórfico equilibrado, son características antropométricas representativas de los atletas internacionales de SUP. Así mismo, y de acuerdo con estos resultados, un bajo sumatorio de pliegues y una elevada masa muscular del brazo pueden ser factores clave en el rendimiento de este deporte, debido a su relación con la aceleración y la fuerza de la palada.

Palabras clave:

Stand-up paddle. Antropometría. Composición corporal. Somatotipo. Atletas internacionales.

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INTRODUCTION

Stand-up paddle boarding (SUP) originated in Hawaii in the 1950s and is a mixture of both surfing and paddling (1). In this new sport, the popularity of which has risen exponentially over the past decade (2), boarding involves a participant getting to their feet on a large board, similar to a surfboard, before using a long paddle for propulsion with strokes on either side of the body (3). However, SUP boards are longer in length (~8-15 ft, 2.4-4.6 m), thicker (4-8 in, 10-20 cm) and wider (26-31 in, 66-78 cm) than traditional surfboards (4). Propulsion of the board is through a long single-bladed paddle in which the athlete alternates sides randomly. The general disciplines of competitive SUP include technical racing, surfing, and marathon racing. Technical SUP racing consists of a 4-8 km sprint in which participants are limited to a maximum board length of 12'6" (3.81 m). Surfing events are held in heats of 20 minutes and 30-minute finals in which the top two scoring waves are counted toward the competitors total (5). Scoring is based upon performing maneuvers, creating power and speed, and getting through closing out sections in a similar manner to traditional surfing. SUP marathon races, normally over a distance of 10 km (6.21miles), allow boards up to 14' in length with a fixed fin, and can be conducted in both open ocean and flat water. The subjects analyzed in our study are participants of an international SUP marathon race.

Taking into account the physical exigency of the tests, a high level of aerobic fitness appears to be required from elite participants (6). Anaerobic fitness is essential for short speed bursts and to catch waves. A high level of dynamic balance and trunk muscle endurance is required by participants, and are both considered important attributes of any SUP participant (4). Isometric contractions of the entire trunk, gluteals, and lower leg musculature are required to counter the rotational forces from the pull phase of each paddling stroke (7).

As SUP increases in popularity and competitiveness, the importance of testing SUP athletes to provide information for both coaches and athletes increases in parallel. Despite this global popularity, there is currently not much scientific literature available on the performance aspect of SUP.

Specific physiological and morphological parameters are important components of performance in many sports. It has been confirmed that certain physical characteristics such as body composition, weight, and height can significantly influence sports outcomes (8). Also, these parameters allow nutritionists and trainers to guide both diet and training so as to achieve the body composition athletes need to attain maximum performance. These parameters have been correlated with performance in elite sport, and have been associated in rowing and surfing with performance outcomes (9-11).

Body composition (BC) and athlete morphological characteristics have been associated with performance in different sports (8), i.e., surfing (12, 13) and different paddling sports like Olympic rowing (14-16), traditional rowing (17) or kayaking (18). Excessive fat mass in a rower, in particular, would act as deadweight, and would have adverse effects on speed, resulting in a diminished ability to accelerate (13). Moreover, it is well established that greater fat-free mass and muscle mass in a high-intensity athlete leads to increased strength and endurance, hence to performance improvement (19). Likewise, in surfers moderate to large significant correlations were obtained between surfer ranking position and some skinfolds, the sum of skinfolds, and vertical jump (9). Finally, in kayaking, important values of body mass and muscle mass have been recorded, even comparable to values obtained in canoeists (20,21). It is not clear whether these high values of lean body mass may benefit or harm kayakers (18).

However, there is no study examining the anthropometrical profile of SUP boarders, which should allow coaches and sport scientists to better understand the physical profile of paddlers, and formulate appropriate training strategies (22,23). Therefore, the aims of this study are to describe the anthropometric characteristics (BC, FM, MM, and somatotype) of participants in an international SUP competition, in order to establish reference values within this population of SUP practitioners.

MATERIAL AND METHODS

SAMPLE

"The Europe Tour 2019" is recognized as the World SUP Cup. The Iberdrola Bilbao World SUP Challenge 2019 was part of this circuit and took place on June 7-9 of the same year. In this respect, for the cross-sectional design of this study, data were collected from 31 males (age, 34.2 ± 12.4 years) participating in the race. All participants were international level athletes.

Every participant received both oral and written information regarding the research objectives and methodology, and they signed an informed consent. This study was approved by the University of Deusto Ethics Committee (ETK-13/18-19).

EXPERIMENTAL DESIGN

In order to undergo the anthropometrics and bioimpedance analyses the participants reported to our conditioned area, situated close to the race registration area, on the day before the competition. All anthropometric measurements were performed in compliance with the International Society of Advancement of Kinantrhopometry (ISAK) Level 1 protocol (before last update) (24) by the same two international level-2-certified anthropometrists, respecting the corresponding intrapersonal technical error of measurement (EMT): 5 % for skinfolds and 1 % for other measurements.

Height (cm) was measured using a SECA 220® measuring rod (Hamburg, Germany) with a precision to within 1 mm, and body mass (BM) (kg) was measured using an Inbody 770® (USA) device, with a precision to within 0.1 kg.

Body mass index (BMI) was calculated using both the Inbody and the BM/height (kg/m) equation. For bioimpedance measurements, Inbody instructions and previously validated techniques (25) were followed. Skinfolds (mm) (tricipital, bicipital, abdominal, suprailiac, subscapular, iliac crest, front thigh, and calf) were analyzed using a Holtain® skinfold caliper with a precision to within 0.5 mm. In order to obtain more information about body fat, the sums of 4 (∑4 SF), 6 (∑6 SF) and 8 (∑8 SF) skinfolds (mm) were examined following validated procedures (24). Muscle perimeters (cm) (arm, contracted arm, waist, hip, and calf muscles) were measured using a metal, non-extensible tape (Cercorf®, Brazil) with a precision to within 1 mm. Contracted arm and calf perimeters were corrected via skinfolds by using the following formula: corrected perimeter = perimeter – (∏ x skinfold area) (26). Bone diameters (femoral and humeral) were measured with a Cerscorf® (Brail) pachymeter, accurate to within 1 mm.

FM and body fat percentage (BF%) were calculated using the Carter, Faulkner, Yuhasz, and Withers equations following the recommendations of the International Society for the Advancement of Kinanthropometry (ISAK) and the Spanish Kinanthropometry Group (GREC) for athletes (27,28). Similarly, MM and MM% were calculated using the Lee (2000) equation (29). The Carter and Heath equation (30) was used to obtain somatotype values.

STATISTICAL ANALYSIS

All anthropometric data are presented as mean (standard deviation), and with the minimum and maximum value for each parameter. Body composition and somatotype values were calculated similarly. The statistical data analysis was carried out using the SPSS software package for Windows, version 24.0 (SPSS, Inc., Chicago, IL, USA).

RESULTS

The descriptive data for all studied parameters are displayed in table I and table II. Firstly, table I lists the basic anthropometric values, such as BM (74.6 (6.6) kg; range, 63.7-89.4 kg), height (175.0 (4.2) cm; range, 172.0-178.0 cm), and BMI (23.6 (2.0) kg/m^2; range, 20.5-29.7 kg/m^2). Secondly, all perimeters (cm) and the corrected values of two of them (arm and calf) are displayed. Thirdly, all skinfolds (mm) and the their sum are also included. Thus, ∑4 SF was 34.2 (14.4) mm (range: 18.5-73.0 mm), ∑6 SF was 48.2 (20.6) mm (range: 25.5-105.0 mm), and ∑8 SF was 57.8 (22.2) mm (range: 33.0-125.0 mm). Lastly, bone diameters (cm) are shown, where the humerus was 7.1 (0.4) (range: 6.7-8) and the femur was 9.7 (0.5) (range: 8.8-10.5). BF %, FM, MM%, and MM (kg) as calculated using different specific equations, and somatotypes are expressed in table II. BF% was between 7.6 (2.1) % using the Carter equation, 11.3 (3.5) % using the Faulkner equation, 7.6 (2.1) % using the Yuhasz equation, and 9.0 (3.6) % according to the Withers equation. Table II also shows MM% using the Lee equation (47.3 (2.6) %; range: 42.3-51.6 %), and somatotype values such as endomorphy (1.9 (0.9); range: 1.0-4.0), mesomorphy (5.4 (1.0); range: 3.9-7.7), and ectomorphy 2.4 (0.9); range: 0.2-3.9). These data, represented in figure 1, show that SUP athletes are balanced mesomorphic in somatotype.

Table I. Basic anthropometry parameters, perimeters, skinfolds, and bone diameters

	Mean (SD)	Minimum	Maximum
Basic anthropometric parameters			
Body mass (kg)	74.6 (6.6)	63.67	89.4
Height (cm)	175 (4.2)	172.0	178.0
BMI (kg/m^2)	23.6 (2)	20.5	29.7
Skinfold (mm)			
Biceps	2.5 (0.7)	1.5	4.0
Triceps	6.2 (2.5)	3.0	13.0
Subscapular	7.6 (3.3)	5.0	17.5
Abdominal	13.2 (8.2)	5.0	31.5
Suprailiac	7.1 (3.8)	3.5	19.0
Iliac crest	9.5 (4.5)	5.5	22.5
Front thigh	8.7 (4.0)	4.0	21.5
Calf	5.3 (2.5)	2.5	16.0
Sum 4	34.2 (14.4)	18.5	73.0
Sum 6	48.2 (20.6)	25.5	105.0
Sum 8	57.8 (22.2)	33.0	125.0
Perimeters (cm)			
Relaxed arm	31.8 (2.6)	26.6	37.1
Contracted arm	34 (2.5)	28.5	38.6
Waist	80.2 (5.3)	70.0	92.8
Hips	95.1 (4.6)	87.6	106.6
Calf muscle	36.9 (1.9)	31.6	40.6
Corrected arm	31.2 (2.5)	25.9	36.0
Corrected calf	36.3 (1.8)	31.2	39.9
Diameters (cm)			
Humerus	7.1 (0.4)	6.7	8.0
Femur	9.7 (0.5)	8.8	10.5

BMI: body mass index; Sum: skinfold sum.

DISCUSSION

To our knowledge, this is the first study to describe SUP athletes anthropometric and somatotype characteristics. Because of that, we compared our results with data observed in similar sport disciplines such as rowing, surfing, and kayaking, in order to gain a better understanding of this sport (Table III).

Firstly, a mean height of 175.0 cm and BM of 74.6 kg were obtained. These results are similar to those observed in surfers by Sheppard et al. (9,29), who reported a mean height of 177.0 cm and a BM of 72.2 kg, and in accordance with the height data observed, also in surfers, by Fernández Gamboa et al. (10) (mean, 172.2 cm) and Férnandez-López et al. (13) (mean, 174.3 cm).

Table II. Participant body composition with anthropometry and bioimpedance, and somatotype

	Mean (SD)	Minimum	Maximum
Body composition – anthropometry			
Carter body Fat (%)	7.6 (2.1)	5.2	13.6
Carter FM (kg)	5.8 (2)	3.4	11.5
Yuhasz body Fat (%)	7.6 (2.1)	5.3	13.6
Yuhasz FM (kg)	5.8 (2)	3.5	11.5
Whiters body fat (%)	9 (3.6)	4.9	18.9
Whiters FM (kg)	6.8 (3.2)	3.2	16.0
Faulkner body fat (%)	11.3 (3.5)	8.6	24.5
Faulkner FM (kg)	8.3 (2.4)	5.5	14.7
Avg equations (%)	8.9 (2.7)	6.0	15.7
Avg equations (kg)	6.7 (2.4)	4.0	13.4
Lee MM (%)	47.3 (2.6)	42.3	51.6
Lee MM (kg)	35.2 (2.4)	30.5	42.4
Body composition – bioimpedance			
FM (%)	11.7 (4.8)	3.7	24.8
FM (kg)	8.9 (4.2)	2.4	21.0
BIA MM (%)	50.0 (2.9)	42.4	55.9
BIA MM (kg)	37.2 (3.1)	32.3	45.5
Somatotype			
Endomorphy	1.9 (0.9)	1.0	4.4
Mesomorphy	5.4 (1)	3.9	7.7
Ectomorphy	2.4 (0.9)	0.2	3.9

FM: fat mass; MM: muscle mass; BIA: bioimpedance.

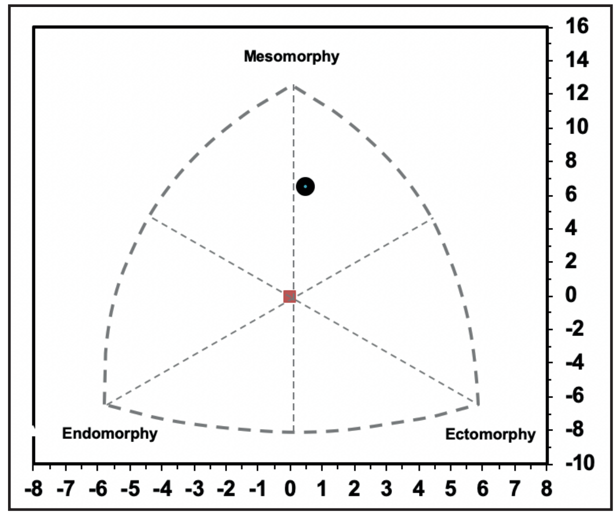

Figure 1.

However, the observed BM is not related to the results obtained in surfers by the same authors: 66.0 kg and 66.7 kg, respectively (30,31). Compared to data observed in rowers by Gutiérrez-Leyton et al. (16) and León-Guereño et al. (17), who reported a mean height of 182.2 cm and 182.5 cm, and a mean BM of 81.5 kg and 80.4 kg, respectively, SUP athletes are less high and heavy than rowers. Similarly, Michael et al. (18) reported a mean height of 184.0 cm and a mean BM of 85.2 kg in male kayakers, almost the same results obtained by Ackland et al. (20) in sprint canoe and kayak paddlers: 184.3 cm and 85.2 kg. These results suggest that SUP athletes have similar anthropometric characteristic with surfers, but different height and BM with rowers and kayakers. Probably, these characteristics are related with the standing position that athletes of both disciplines must maintain in their boards, and with the ability to accelerate in the water.

Table III. Comparison of anthropometric measurements in SUP, rowing, kayaking, and surfing according to the literature

Anthropometric measurement	SUP	Rowing	Kayaking	Surfing
Body mass (kg)	74.6	80.9	85.2	72.2
Height (cm)	175	182.3	184.2	175
Arm perimeter (relaxed)	31.8	30.8-32.5	-	33.3
Arm perimeter (contracted)	34.0	34.5-34.7	37.6	34
Body fat (%)	8.9	9.35	-	11.3-17.1
Sum 6	48.2	51.5	-	57.0-64.3
Sum 8	57.8	67.3	55.4	82.7
Muscle mass (%)	47.3	43.3-52.7	46.9	-
Somatotype	Ecto-mesomorphic	Endo-mesomorphic	Ecto/Endo-mesomorphic	Ecto-mesomorphic

Expressed as mean and/or range. Sum: skinfold sum.

Moreover, since arms represent a main determinant factor in surfing (12), rowing (17), and kayaking (18), assessing both relaxed (and corrected) and contracted arm perimeters could be essential. In this line, we observed a mean relaxed arm value of 31.8 cm and corrected perimeter of 31.2 cm, and a mean contracted arm perimeter of 34.0 cm. In rowing, data show that elite rowers have a mean relaxed arm perimeter within 30.8-32.5 cm, and a mean contracted arm of 34.5-34.7 cm (16,17). In addition, Ackland et al. (20) observed higher mean values of contracted arm (37.6 cm) in kayakers, with no data related to relaxed arm perimeter and corrected value. Similarly, Barlow et al. (12) reported a mean 33.3 cm for relaxed arm and 34.0 cm for contracted arm in 17 professional surfers. Understanding the difference between relaxed and contracted arm as a good indicator of muscle mass, and relating this parameter to power, SUP athletes have similar values than rowers and kayakers, but differences with surfers. This could be explained by the fact that stroke is not the main determinant movement in surfing, but it represents the primary factor in SUP, rowing, and kayaking performance.

Considering BF% as an important measurement to assess performance in any sport (8), previous researches in rowing demonstrated that elite traditional rowers have mean BF% values of 8.0 (Carter), 9.9 (Whiters), 8.6 (Yuhasz), and 10.9 (Faulkner), similar to those obtained by some equations in our study: 7.6 (Carter) and 9.0 (Whiters). In contrast, higher values of BF% (17.1 and 11.3) were reported in surfers by Furness et al. (31) and Barlow et al. (12), respectively. However, understanding the limitations of calculating BF% with body composition equations, primarily due to different arrays of results obtained, and in accordance with other authors (17), the sums of skinfolds are being used in this study to analyze and compare data with other references. Similarly to our observed data, a mean sum of 4 and 6 skinfolds of 33.7 and 51.5 mm, respectively, was observed in traditional elite rowers (17). However, the mean sum of 8 skinfolds (57.8 mm) observed in this study represents a lower value when compared to the 67.3 mm observed by León-Guereño, but a similar value when compared to what Gutiérrez-Leyton et al. (16) and both Michael et al. (18) and Ackland et al. (20) observed in male rowers (54.9 mm) and kayakers (55.4 mm), respectively. With regard to surfers, a range for the 6-skinfold sum within 57.0-64.29 (12,13) and a mean sum of 92.7 mm for 8 skinfolds were observed, which represent higher values as compared to the data observed in SUP athletes. These results could be explained by the fact that surf is not such a physiological demanding sport, but rather a more technical one (11). On the other hand, SUP data are more similar to those seen in sport disciplines like rowing and kayaking, where lower values of BF% and skinfold sum are desirable, primarily because of the negative impact of higher FM on acceleration and propulsion, especially in longer distances (17).

Muscle mass is an indicator of power in any sport, but as it also represents an important part of total BM, adequate values are necessary to optimize performance. There are only few references attending to MM% or MM (kg) in literature. Similar results to those of this study were observed in traditional rowers, representing a mean MM of 43.3 % (17), but higher values were reported also in Chilean rowers (52.7%) (16). Similarly, López-Plaza et al. (21) reported a 46.9 % of MM in young mature elite kayakers. Moreover, somatotype provides information regarding the general shape of subjects, according to their anthropometric characteristics. Rowers are represented by León-Guerrero et al. (17) as endo-mesomorphic athletes, according to their moderate musculoskeletal development and relative adiposity, but like ecto-mesomorphic athletes by Leyton-Gutiérrez et al. (16). These last results are similar to those for kayaker somatotypes as described by Michael et al. (18) and Ackland et al. (20). In surfers, the same somatotype values (ecto-mesomorphic) were observed in one study (13), but different results were also obtained in other reference (12), which described these athletes as endo-mesomorphic. Relatively high musculoskeletal mass seems to be necessary to perform in SUP, as observed in rowers, kayakers, and surfers. Regarding adiposity and its relation with MM and total BM (somatotype), SUP athletes present several similarities with kayakers and professional surfers, but differences with some rowers and amateur surfers, presenting lower values of BF than rowers and surfers, and a little higher values of MM when compared with kayakers and professional surfers. These miscellaneous results could be explained by differences in the recruited sample in each study. Anyway, this information reveals that SUP athletes have a moderate-high musculoskeletal development and low subcutaneous adiposity.

This study has some limitations that are mainly related to the measurements that were not obtained. Firstly, we did not measure the thigh perimeter and corresponding corrected perimeter, which may represent an adequate indicator of leg muscle mass. Secondly, we missed wingspan in our measurement protocol and, considering it is one of the most directly involved anthropometric performance parameters in rowing and kayaking, it could have been interesting to measure. Finally, although our sample is representative of an international-level SUP race, we assume the current lack of professionalization in this sport and, therefore, the heterogeneity of some key measurements like BF% or skinfolds sums.

The values reported in this study could be used as normative anthropometry and somatotype values for SUP athletes, representing the first model parameters in this sport discipline. This information is useful to acquire a better understanding of training and nutrition strategies in SUP athletes, and therefore for any trainer or nutritionist aiming to improve anthropometric composition, and to provide nutrition recommendations and training protocols.

CONCLUSION

Low body fat percentage (7-11 %) and high total (47 %) and upper muscle mass are representative anthropometric characteristics of international SUP athletes. As these results constitute reference values obtained from international level paddlers, a low skinfold sum and high arm muscle mass may represent key factors for performance in this sport, suggesting that less opposition to acceleration and high stroke force are two of the most important factors in SUP boarding. Moreover, the somatotype of international

SUP athletes is a balanced mesomorphic one, which represents the importance of an adequate relation between fat and muscle mass, and suggests that training and nutrition programs should be designed according to these characteristics. However, the present results should be interpreted with caution, as further research is needed to determine the relationships between anthropometric outcomes and performance in SUP athletes.

REFERENCES

1. Ruess C, Kristen KH, Eckelt M, Mally F, Litzenberger S, Sabo A. Stand up paddle surfing -- an aerobic workout and balance training. Procedia Eng 2013;60:62-6. DOI: 10.1016
2. Hammer S. Catch the wave of stand up paddling. The Providence Journal 2011;5:3.
3. Walker C, Nichols A, Forman T. A survey of injuries and medical conditions affecting stand-up paddle surfboarding participants. Clin J Sports Med 2010;20:144-5.
4. Schram B, Hing W, and Climstein M. Profiling the sport of stand-up paddle boarding. J Sports Sci 2016;34:937-44. DOI: 10.1080/02640414.2015.1079331
5. http://www.sup-australia.com/events/rules-sup-surfing. [Accessed 26/08/2012]
6. Schram B, Hing W, Climstein M. Laboratory-and field-based assessment of maximal aerobic power of elite stand-up paddle-board athletes. Int J Sports Physiol Perform 2016;11:28-32. DOI: 10.1123/ijspp.2015-0076
7. Schram B. Stand up paddle boarding : an analysis of a new sport and recreational activity. PhD Thesis. Gold Coast: Bond University; 2015.
8. Duquet W, Carter J, In S, Eston R, Reilly T. Somatotyping. In: Eston, R. & Reilly, T. (Eds.). Kinanthropometry and Exercise Physiology Laboratory Manual. Anthropometry. 2nd ed. London, Routledge; 2001. pp. 47-64.
9. Shephard RJ. Science and medicine of rowing: A review. J Sports Sci 1998;16(7):603-20. DOI: 10.1080/026404198366416
10. Fernandez-Gamboa I, Yanci J, Granados C, Camara J. Comparison of Anthropometry and Lower Limb Power Qualities According to Different Levels and Ranking Position of Competitive Surfers. J Strength Cond Res 2017;31(8):2231-7. DOI: 10.1519/JSC.0000000000001565
11. Furness JW, Hing WA, Sheppard JM, Newcomer SC, Schram B, Climstein M. Physiological Profile of Male Competitive and Recreational Surfers. J Strength Cond Res 2018;32(2):372-8. DOI: 10.1519/JSC.0000000000001623
12. Barlow MJ, Findlay M, Gresty K, Cooke C. Anthropometric variables and their relationship to performance and ability in male surfers. Eur J Sport Sci 2014;14(Suppl 1):S171-7. DOI: 10.1080/17461391.2012.666268
13. Fernández-López JR, Cámara J, Maldonado S, Rosique-Gracia J. The effect of morphological and functional variables on ranking position of professional junior Basque surfers. Eur J Sport Sci 2013;13(5):461-7. DOI: 10.1080/17461391.2012.749948
14. Akça F. Prediction of rowing ergometer performance from functional anaerobic power, strength and anthropometric components. J Hum Kinet 2014;41:133-42. DOI: 10.2478/hukin-2014-0041
15. Penichet-Tomás A, Pueo B. Performance conditional factors in rowing. Retos 2017;32:238-40.
16. Gutiérrez-Leyton L, Zavala-Crichton J, Fuentes-Toledo C, Yáñez-Sepúlveda R. Características Antropométricas y Somatotipo en Seleccionados Chilenos de Remo. International Journal of Morphology 2020;38(1):114-9. DOI: 10.4067/S0717-95022020000100114
17. León-Guereño P, Urdampilleta A, Zourdos MC, Mielgo-Ayuso J. Anthropometric profile, body composition and somatotype in elite traditional rowers: A cross-sectional study. Revista española de nutrición humana y dietética 2018;22(4):279-86. DOI: 10.14306/renhyd.22.4.605
18. Michael JS, Rooney KB, Smith R. The metabolic demands of kayaking: a review. J Sports Sci Med 2008;7(1):1-7.
19. Mielgo-Ayuso J, Zourdos MC, Calleja-González J, Urdampilleta A, Ostojic SM. Dietary intake habits and controlled training on body composition and strength in elite female volleyball players during the season. Appl Physiol Nutr Metab 2015;40(8):827-34. DOI: 10.1139/apnm-2015-0100
20. Ackland TR, Ong KB, Kerr DA, Ridge B. Morphological characteristics of Olympic sprint canoe and kayak paddlers. J Sci Med Sport 2003;6(3):285-94. DOI: 10.1016/s1440-2440(03)80022-1
21. López-Plaza D, Alacid F, Muyor JM, López-Miñarro PÁ. Differences in Anthropometry, Biological Age and Physical Fitness Between Young Elite Kayakers and Canoeists. Journal of human kinetics 2017;57:181-90. DOI: 10.1515/hukin-2017-0059
22. Adhikari A, McNeely E. Anthropometric Characteristic, Somatotype and Body Composition of Canadian Female Rowers. Am J Sports Sci 2015;3(3):61. DOI: 10.11648/j.ajss.20150303.15
23. Slater G, Rice A, Jenkins D, Hahn A. Body mass management of lightweight rowers: nutritional strategies and performance implications. Br J Sports Med 2014;48(21):1529-33. DOI: 10.1136/bjsports-2014-093918
24. International Society for the Advancement of Kinanthropometry, editor. International Standards for Anthropometric Assessment. Glasgow: ISAK; 2016.
25. Moon JR. Body composition in athletes and sports nutrition: an examination of the bioimpedance analysis technique. Eur J Clin Nutr 2013;67(Suppl 1):S54-9. DOI: 10.1038/ejcn.2012.165
26. Pons V, Riera J, Galilea PA, Drobnic F, Banquells M, Ruiz O. Características antropométricas, composición corporal y somatotipo por deportes. Datos de referencia del CAR de San Cugat, 1989-2013. Apunts Med Esport 2015;50(186):65-72. DOI: 10.1016/j.apunts.2015.01.002
27. Alvero Cruz JR, Cabañas MD, Herrero de Lucas A, Martínez Ria za L, Moreno Pascual C, Porta Manzanillo J, et al. Protocolo de valoración de la composición corporal para el reconocimiento médico-deportivo. Documento de consenso del grupo español de cineantropometría de la federación española de medicina del deporte. Arch Med Deporte 2009;XXVI(131):166-79.
28. Stewart A, Marfell-Jones M, Olds T, Riidder H. International Standards for Anthropometric Assessment. Lower Hutt, New Zealand: ISAK; 2011.
29. Lee RC, Wang Z, Heo M, Ross R, Janssen I, Heymsfield SB. Total-body skeletal muscle mass: Development and cross-validation of anthropometric prediction models. Am J Clin Nutr 2000;72:796-803. DOI: 10.1093/ajcn/72.3.796
30. Carter JEL, Heath BH. Somatotyping-development and applications. Cambridge (England); New York: Cambridge University Press; 1990.
31. Sheppard JM, McNamara P, Osborne M, Andrews M, Oliveira Borges T, Walshe P, et al. Association between anthropometry and upper-body strength qualities with sprint paddling performance in competitive wave surfers. J Strength Cond Res 2012;26(12):3345-8. DOI: 10.1519/JSC.0b013e31824b4d78
32. Furness JW, Hing WA, Sheppard JM, Newcomer SC, Schram BL, Climstein M. Physiological Profile of Male Competitive and Recreational Surfers. J Strength Cond Res 2018;32(2):372-8. DOI: 10.1519/JSC.0000000000001623