

Anthropometric Characteristics, Body Composition and Somatotype of Elite Pan-American Race Walking 20K

Características Antropométricas, Composición Corporal y Somatotipo de Marchistas Panamericanos de Élite 20k

Espinoza-Navarro, O.¹; Lizana, P. A.²; Gómez-Bruton, A.³; Brito-Hernández, L.⁴ & Lagos-Olivos C.⁵

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SUMMARY: The anthropometric and somatotype evaluation is an essential tool in the selection and control of high-performance athletes. The aim of this study was to describe the somatotype and body composition of male elite race walkers (20 k modality), and its relationship with athletic performance. Twenty-four race walkers participated in this study. The sample was divided into two groups: the race walkers with the best performance (upper 25 percentile; n=7) and the second group (n=17) that corresponds to the rest of the participants. Weight (kg), height (cm), seven skinfolds, two diameters and five perimeters were measured. Body fat percentage (BF%) were estimated with the Yuhasz formula, and the somatotype was used applying the Heath-Carter method. The best performing athletes were taller (178.3 ± 4.4 cm vs. 173.7 ± 5.6 cm, $p < 0.05$) and showed a greater ectomorphic component ($p < 0.05$) than the rest of the participants. The somatotype of the best performance athletes was 2.2-2.8-4.1 against the 2.5-3.8-2.9 of the lowest performing athletes. The average time (hours, minute, seconds) of execution of the race in athletes of better performances was 1:22:40, in comparison with the athletes of lower performances with 1:32:41 ($p < 0.02$). The ectomorphic component and height are morphological characteristics that can determine athletic performance of race walkers. It is suggested to consider these factors in the selection of the race walkers.

KEY WORDS: Race walking; Somatotype; Ectomorphy; Athletics; Anthropometry.

INTRODUCTION

Athletic race walking is an Olympic discipline that is characterized by a technique that subjects the foot to a great effort in its execution, where there is no flight phase, that is, the walker must never lose contact with the ground (IAAF, 2016). This athletic modality is considered a long distance discipline, which requires superior resistance and technical ability (Vernillo, 2013; Hanley *et al.*, 2014; Hanley *et al.*, 2015; Gómez-Ezeiza *et al.*, 2016). The appearance of great world figures in some regions makes it increasingly popular on all continents (Larsen, 2003; Vernillo; Wilber & Pitsiladis, 2012).

Nonetheless, the anthropometric reports of elite race walkers are scarce. Previous studies have reported that female race walkers have a higher percentage of body fat, greater endomorphic component and lower muscle mass than

male athletes (Gamboa *et al.*, 2018; Gómez-Ezeiza *et al.*, 2018). Furthermore, male race walkers have shown low rates of body fat and a predominant ectomorphic component in previous studies (Larsen & Sheel, 2015; Gamboa *et al.*). When comparing distances, a greater mesomorphic component was found in 20k athletes when compared to 50k athletes (Gomez-Ezeiza *et al.*, 2016). However, it remains unknown if there are anthropometric characteristics that are associated with a higher athletic performance among elite 20k race walkers.

One of the best factors to determine adiposity is anthropometry, which has been standardized by the International Society for the Advancement of Kinanthropometry (ISAK, 2001) so that it is reliable, reproducible, valid and accurate (Marfell-Jones *et al.*, 2006).

¹ Laboratory of Reproduction and Development, Department of Biology, Universidad de Tarapacá, Arica, Chile.

² Laboratory of Morphological Sciences, Instituto de Biología, Pontificia Universidad Católica de Valparaíso, Valparaíso, Chile

³ Growth, Exercise, Nutrition and Development (GENUD) Research Group, University of Zaragoza, Zaragoza, Spain.

⁴ Laboratorio Biología de Reproducción y Desarrollo, Programa Magíster Ciencias de la Motricidad Humana, Universidad de Tarapacá, Arica-Chile.

⁵ Departamento de Ciencias de la Actividad Física y del Deporte, Universidad de Tarapacá, Arica-Chile.

The Heath-Carter method which is performed with the aforementioned anthropometric measurements, classifies individuals by its three essential elements, endomorphy or first component (relative adiposity), mesomorphy or second component (tendency to relative musculoskeletal development) and ectomorphy or third component (tendency to relative linearity) which results in the somatotype or biotype of a person. This is an anthropometric method that has had an essential relevance in the classification of athletes and non-athletes (Olguín *et al.*, 2013; Busko *et al.*, 2013; Lizana *et al.*, 2015; Gamboa *et al.*; Gomez-Ezeiza *et al.*; Lizana *et al.*, 2018a; Lizana *et al.*, 2018b).

In this sense, the aim of the present investigation was to determine the differences in somatotype and adiposity in elite 20k race walkers according to sports performance.

MATERIAL AND METHOD

This was a cross-sectional study in which anthropometric characteristics were compared between upper and lower performance race walkers. The participants comprised male athletes who competed in the Pan-American race walking cup in the 20k event (XVII Pan-American March Cup, Arica-Chile, 2015).

For this study, all athletes were invited to participate before the competition. Those athletes who agreed to participate and who completed the whole evaluation (n=24) were included in the study. One athlete was excluded for not presenting complete data. Athletes from 10 different nationalities were included in the present study.

The athletes were evaluated two days before the competition, during the morning session. Weight and height were measured with Detecto model 2391 (Detecto, Webb City, NY, USA) of 0.1 kg and 0.1 cm of precision respectively. With the variables of weight and height, the body mass index (weight in kilograms divided by the square of height in meters) was determined. The percentage of body fat (BF %) for males was recorded through the Yuhasz equation: $BF \% = (\sum 6 \text{ skinfolds} \times 0.1051) + 2.58$ (Yuhasz, 1974), which incorporates six skinfolds (triceps, subscapular, supraspinal, abdominal, anterior thigh and medial calf), the Yuhasz equation was chosen because it was used with and for athletes (Carter, 1982). The skinfolds, perimeters, and diameters were determined with the Rosscraft anthropometric set (Rosscraft, Surrey, Canada). All the variables were measured on the right side of the body of the athletes.

For the evaluation of the anthropometric somatotype the Heath-Carter method was used, which comprises two primary measures: weight and height, four skinfolds (triceps, subscapular, supraspinal, and medial calf), two bone diameters (bicipondylar humeral and femoral) and two perimeters (arm flexed and in maximum tension and maximum leg perimeter). From the measurements, the three components of the somatotype (endomorphy, mesomorphy, and ectomorphy) were determined. To calculate the difference between two somatotypes, the somatotype dispersion distance (SDD) was used, using the equation $SDD = \sqrt{3(X1-X2)^2 + (Y1-Y2)^2}$, this is a measure of dispersion; this distance is statistically significant at $p < 0.05$, when SDD is equal to or greater than 2 (Hebbelinck *et al.*, 1975). The sample was also represented through a somatochart and to describe the categories of the somatotype the thirteen categories proposed by Carter were defined (Carter & Heath, 1990).

Evaluations were performed with the athletes standing in bare feet and wearing light clothes. Anthropometric measurements were taken at the right hemibody. The measurements were made following the standardized protocols of the International Society for Advancement of Kineanthropometry (Marfell-Jones *et al.*, 2006). The technical error of measurement of the evaluator (ENO) was less than 3 % for skinfolds and less than 1 % for other anthropometrics measurements. The Ethics Committee of the Universidad de Tarapacá, Chile, approved the work protocols following the Helsinki Declaration.

Statistical analysis. All the obtained data were processed with the statistical package STATA 12 (Stata, College Station, TX) software. The inspection of normality before the analyzes was performed with the Shapiro Wilk test. The results were expressed in frequency, average, and standard deviation. The sample was separated into two groups: the p25 with the best performances (n = 7) and the rest of the athletes (n = 17). The Mann-Whitney test was performed to compare both groups. The level of significance used was $p < 0.05$.

RESULTS

Table I describes the characteristics of the sample, according to age, height and weight, as well as skinfolds, diameters and body perimeters. Athletes with better performance were taller ($p < 0.05$). Moreover, high performance athletes presented lower triceps skinfolds and a smaller femoral diameter ($p < 0.05$). A tendency to lower BMI was also observed in high-performance athletes ($p = 0.06$).

Table I. Descriptive anthropometric characteristics of elite race walkers (20 kilometers). Arica, Chile. May 2015 (n=24)

Variable	Total sample		Best performance		Low performance		p-value ^a
	Mean	SD	Mean	SD	Mean	SD	
Age (years)	23.30	4.60	23.29	3.35	23.24	5.12	0.823
Height (cm)	175.04	5.58	178.29	4.42	173.71	5.55	0.033
Weight (kg)	65.48	5.93	63.99	5.34	66.09	6.21	0.341
Personal best (h.min.s)	1.29.46	0.06.37	1.22.40	0.01.13	1.32.41	0.05.35	0.002
Skinfolds (mm)							
Biceps	4.18	1.01	3.71	0.76	4.36	1.05	0.147
Triceps	7.7	3.81	5.43	1.99	8.64	4.03	0.021
Subscapular	8.52	2.29	8.71	3.04	8.44	2.01	0.725
Abdominal	11.60	4.77	9.86	5.76	12.27	4.30	0.127
Supraspinal	9.2	4.22	9.71	5.28	8.99	3.88	0.873
Front thigh	9.11	4.28	7.71	2.29	9.68	4.82	0.278
Medial calf	6.83	3.73	5.43	2.37	7.40	4.09	0.209
Breadths (cm)							
Humeral	7.12	0.75	7.27	1.37	7.06	0.29	0.370
Femur	9.68	0.63	9.14	0.93	9.90	0.27	0.004
Perimeters (cm)							
Upper arm	25.44	1.96	25.36	2.63	25.48	1.71	0.873
Upper arm tensed	28.43	2.01	28.46	1.95	28.42	2.10	0.900
Waist	74.71	5.08	74.16	5.63	74.94	5.01	0.373
Hip	88	4.52	86.57	4.04	88.59	4.69	0.265
Calf (maximum)	33.70	2.15	33.11	3.13	33.87	1.67	0.179
Body composition							
Body mass index	21.40	2.02	20.15	1.74	21.91	1.93	0.061
Percentage of BF ^a	8.15	1.81	7.54	2.01	8.40	1.71	0.153
∑ of six skinfolds	52.92	16.99	46.86	18.34	55.41	16.31	0.162
Somatotype^b							
Endomorphy	2.45	0.83	2.22	1.01	2.54	0.76	0.153
Mesomorphy	3.51	1.22	2.82	1.63	3.79	0.92	0.136
Ectomorphy	3.26	1.17	4.09	1.04	2.92	1.07	0.028

SD, Standard deviation. *Mann-Whitney test for comparison of all variables were used.

aPercentage fat was estimated according to Yuhasz's equation.

bThe Heath-Carter anthropometric method was used for somatotyping.

Concerning somatotype, high performance athletes showed significant higher values for the ectomorphic component versus their lower performance peers (p<0.05). In addition, the SDD shows differences between the p25 (best performance) and the rest of the subjects (SDD = 3.80)

Table II shows the distribution of the somatotype categories according to those proposed by Carter & Heath. It is reported that the balanced ectomorph category predominates in the high performance athletes (43 %) and the categories mesomorph-ectomorph (23.53 %) and ectomorphic mesomorph (23.53 %) predominate in athletes with the lowest performance.

Figure 1 shows the distribution of the somatotypes of elite race walkers 20K. Gray circles represent the best performance athletes (p25). Black circles represent the rest of the athletes. White circle indicates the average somatotype of the sample: 2.5- 3.5- 3.3. White square suggests the group of athletes with the best performance 2.2-2.8-4.1 and black square indicates the rest of group 2.5-3.8-2.9. Black triangle represents the average somatotype of race walking according to Canda and black square represents the average somatotype of race walkers according Gomez-Ezeiza *et al.*

Somatotype categories	Male (n 24)	Best performance	Low performance
1. Balanced endomorph	0 (0)	0 (0)	0 (0)
2. Mesomorphic endomorph	0 (0)	0 (0)	0 (0)
3. Mesomorph-endomorph	12.50 (3)	14.29 (1)	11.76 (2)
4. Endomorphic mesomorph	12.50 (3)	0 (0)	17.65 (3)
5. Balanced mesomorph	4.17 (1)	0 (0)	5.88 (1)
6. Ectomorphic mesomorph	20.83 (5)	14.29 (1)	23.53 (4)
7. Mesomorph-ectomorph	20.83 (5)	14.29 (1)	23.53 (4)
8. Mesomorphic ectomorph	4.17 (1)	0 (0)	5.88 (1)
9. Balanced ectomorph	16.67 (4)	42.86 (3)	5.88 (1)
10. Endomorphic ectomorph	4.17 (1)	14.29 (1)	0 (0)
11. Endomorph-ectomorph	0 (0)	0 (0)	0 (0)
12. Ectomorphic endomorph	0 (0)	0 (0)	0 (0)
13. Central	4.17 (1)	0 (0)	5.88 (1)

Table II. Distribution of 13 somatotype categories among race walkers (20 kilometers). Arica, Chile. May 2015 (n=24).

Values are expressed as percentage and frequency (). Bold values indicate high prevalences.

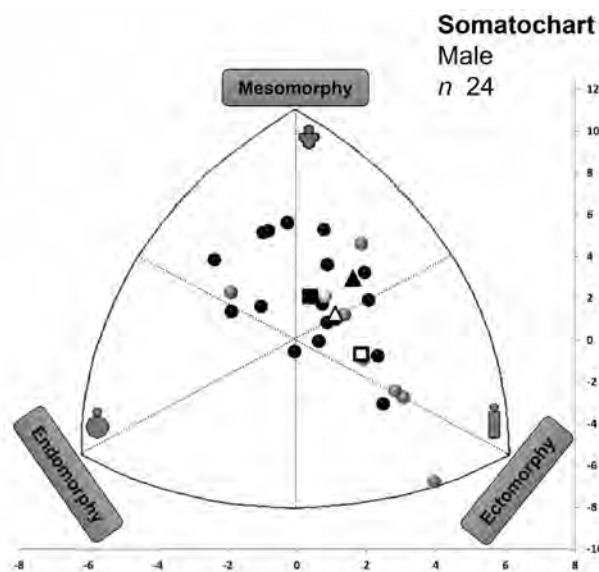


Fig. 1. Distribution of individual somatopoints of the male elite race walkers. Gray circles represent the best performance athletes (p25). Black circles represent the rest of the athletes. White circle somatotype of the sample: 2.5- 3.5- 3.3. White square best performance 2.2-2.8-4.1. Black triangle somatotype of race walkers according to Canda (2012). Black square represents the average somatotype of race walkers 20k according to Gomez-Ezeiza at al. (2018).

DISCUSSION

The search for athletes who have the right anthropometric characteristics to compete successfully at the highest level is increasingly difficult. Anthropometry and somatotype are methods that report on the most predominant physical characteristics of athletes (Rodríguez Quijada, 2016; Giannopoulos *et al.*, 2017). Several authors using these methods have previously noticed the importance of height and adiposity levels in sports performance (Carter; Carter and Heath; Knechtle *et al.*, 2010). However different athletic disciplines have distinct morphological characteristics, such as long upperlimbs in rowing, greater endomorphy in throwing sports and higher ectomorphy in long-distance races (Kerr *et al.*; Yáñez-Sepúlveda *et al.*, 2018). When analyzing the anthropometric characteristics of the studied sample, it was observed that high performance athletes were taller, which could give them an advantage in the length of the step that they execute during the race. In this regard, Hanley *et al.*, (2011), reported differences in walking speed between males and females, in the 10k and 20k modalities, for the range of the step at the same rate indicating that the initial cause of deceleration was the reduction in the length of the step (Hanley *et al.*, 2011;

Hanley *et al.*, 2014), aspect that was also observed in 50k race walkers (Hanley *et al.*, 2013). It has also been reported that Kenyan distance athletes have 5 % longer lower limbs when compared to elite Scandinavian distance runners (Wilber & Pitsiladis), so a higher height could be an advantage in long distance running/walking events.

Concerning the somatotype of our sample, it is observed that the athletes have a predominantly mesomorph-ectomorph somatotype, which corresponds to similar mesomorph and ectomorph components with the endomorph being less predominant. Eiin *et al.* (2007), describe the somatotype of young Malaysian distance athletes, finding in men an average somatotype similar to our results from the total sample with greater mesomorph and ectomorph components, also reported by Canda in Spanish race walkers. However, when dividing the groups, the high performance group shifts towards the balanced ectomorphism and the low performance towards a balanced mesomorphism. Additionally, these results are consistent with the significant differences in SDD among the groups studied. Kandel *et al.*, evaluated the performance of Ironman athletes, observing that a low endomorphic component combined with a high ectomorphic component result in a significantly better performance. Besides the authors emphasize that the somatotype had a larger impact on the running discipline and these results were those of men since the same findings were not found in females. These results are similar to those found in our study due to lower values associated with adiposity (BF %, Σ of six skinfolds, and endomorphy, not significant) and a greater ectomorph component. In this sense, a marked ectomorph component is observed in marathon athletes over mesomorphism and endomorphism (Vernillo, 2013). Furthermore, a characteristic element of Kenyan distance runners is their ectomorphic somatotype, which have been highlighted by essential sporting achievements in recent decades (Larsen & Sheel).

Additionally, some authors report an important relationship between the thickness of the skinfolds of the thigh and leg and the performance in long distance events (Arrese & Ostariz, 2006), in our study we observed smaller skinfolds in athletes of better performance. However, these differences between groups were not significant. Although, we found a trend that is relevant to continue studying in elite race walkers. Another component frequently mentioned in sports practice is the BF% that has been related to performance (Knechtle *et al.*). Our group presented 8.2 % BF, while the high performance showed a 7.5 % BF, similar of that reported by Gomez-Ezeiza *et al.* with a 6.8 % BF. Employing the same formulas for BF % as our study, Gamboa *et al.*, reported a 7.64 BF % in 10K race walkers, a value that was similar to that of the highest performing 20K athletes.

Limitations. On the one hand the sample of athletes is small, but they are elite race walking of a Pan-American championship and therefore the whole sample that could be measured was also small. Another limitation was that the sample studied is very heterogeneous (ten different nationalities) with different ethnic groups that could influence the biotype of the subjects. On the other hand, because it is a cross-sectional study by its nature, it is not possible to determine cause-effect, so future studies are needed to corroborate the findings.

CONCLUSIONS

The ectomorph component and height are morphological characteristics that could be associated with athletic performance of 20k elite race walkers. It is suggested to consider these factors in the selection of high-performance race walkers.

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RESUMEN: La evaluación antropométrica y del somatotipo es una importante herramienta en la selección y control de los atletas de alto rendimiento. El objetivo de este estudio fue describir el somatotipo y composición corporal de hombres marchistas olímpicos, modalidad 20 k, y su relación con el rendimiento atlético. Veinticuatro atletas de marcha participaron en este estudio. La muestra fue dividida en dos grupos: los marchistas de mejores rendimientos p25 superior (n=7) y el segundo grupo (n=17) que corresponde al resto de los participantes. Se registró el peso (kg), talla (cm), siete pliegues cutáneos, dos diámetros y cinco perímetros. Se estimó el porcentaje de grasa corporal (%GC) con la fórmula de Yuhasz y se describió el somatotipo utilizando el método de Heath-Carter. Se reporta una mayor altura en los atletas de mejor rendimiento (178,3±4,4 cm vs. 173,7±5,6 cm; p<0,05) y mayor componente ectomorfo (p<0,05) que el resto de los participantes. El somatotipo de los atletas de mejor rendimiento fue de 2.2-2.8-4.1 frente a 2.5-3.8-2.9 de los atletas de menor rendimiento. El tiempo promedio (hora, minuto, segundo) de ejecución de la carrera en atletas de mejores rendimientos fue de 1:22:40, en comparación con los atletas de menores rendimientos con 1:32:41 (p <0,02). El componente ectomorfo y altura serían características morfológicas que pueden determinar el rendimiento deportivo de atletas de marcha. Se sugiere considerar estos factores en la selección de los marchistas olímpicos.

PALABRAS CLAVE: Marchistas; Somatotipo; Ectomorfismo; Atletas; Antropometría.

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Corresponding author:

Prof. Dr. Omar Espinoza Navarro
Facultad de Ciencias Departamento de Biología
Universidad de Tarapacá
Avenida. General Velásquez N 1775
Arica
CHILE

Email: omarespinoza091@gmail.com

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