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Anthropometric Characteristics, Somatotype, and Body Composition: Differences by Sport Category and Sex in Elite Cuban and Mexican Track and Field Athletes

Características Antropométricas, Somatotipo y Composición Corporal: Diferencias por Categoría Deportiva y Sexo en Atletas de Élite Cubanos y Mexicanos de Pista y Campo

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SUMMARY: The study of the morphofunctional characteristics of high-performance track and field athletes is essential for optimizing training, nutrition, and talent selection. Since physical demands vary by sport specialization, understanding how these attributes affect efficiency and performance is key to maximizing athletes' potential. This study aimed to: i) perform an anthropometric characterization, ii) describe body composition and somatotype, and iii) compare these variables across sports categories and sexes. A total of 131 international athletes from Cuba and Mexico (76 men, 55 women):including 79 Olympic athletes, were evaluated using 43 anthropometric variables according to the ISAK protocol. Body composition was assessed using the Five-Way Fractionation Method by Kerr and Ross, and somatotype was determined using the Heath and Carter method. The results revealed significant differences in muscle mass and body fat between athletes in the Throwing, Sprinting, and Endurance categories. Throwers had an average muscle mass of 50.8 kg, higher than that of sprinters (37.0 kg) and endurance athletes (31.2 kg):with $p \leq 0.05$. Additionally, throwers exhibited a higher body fat percentage (20.3% for men, 26.6% for women) compared to endurance athletes (18.9% for men, 25.9% for women):also with $p \leq 0.05$. Throwers had predominantly mesomorphic somatotypes, while sprinters and endurance athletes were more ectomorphic. These findings suggest that anthropometric characteristics influence performance based on sports specialization.

KEY WORDS: Kinanthropometry; Anthropometry; Body composition; Somatotype; Athletic performance; Track and field.

INTRODUCTION

To achieve excellence in a sport, it is important to consider multiple factors (physiological, psychological, biomechanical, among others) that influence performance. Anthropometric techniques, when administered with the necessary rigor, provide a repetitive, sensitive, and discriminating method for estimating changes in athletes' body composition and are widely used in the field of Sports Medicine (Pons *et al*., 2015). To achieve this scientific

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rigor, the International Society for the Advancement of Kinanthropometry (Norton & Olds, 2006) has developed international standards for anthropometric comparison. Using this technique and reference values, skinfolds, girths, and bone breadths can be measured to obtain analytical elements within Kinanthropometry, such as body composition or somatotype of athletes, from training stages to peak performance. This allows for comparison of each athlete with themselves (their evolution) and with the most successful athletes in their sport.

The study of anthropometry and physiological aspects, although not determining factors of optimal performance, are part of a complex set of qualities that relate to it (Ramos Parrací *et al*., 2023). Anthropometric analyses quantify and provide information about an individual's physical structure at a given moment and the differences caused by growth and training (Iglesias-Sánchez *et al*., 2013). Kinanthropometry allows for the evaluation of body composition, morphology, nutritional status, and proportions of athletes, providing data that guide towards optimal performance parameters when compared to those of elite athletes (Ramos Parrací *et al*., 2023). Furthermore, it becomes a monitoring and control system for the results of diet and training, facilitating the observation of changes in body mass distribution between fat and muscle compartments (Pons *et al*., 2015). It helps guide decision-making regarding procedures to follow, such as when evaluating and controlling an increase in fat tissue or when an athlete loses muscle tissue during a training phase and requires an adjustment in their nutritional intake, facilitating the understanding and relationship between body structure, diet, and physical qualities that can be interpreted as performance indicators (Pons *et al*., 2015).

Therefore, the analysis of body composition has become a fundamental and essential part of its evaluation, as well as the optimization of athletic performance (Toselli, 2021). Unlike most physiological and performance measures, the relevance of body composition for performance is less obvious (Mangine *et al*., 2022). Greater lean mass and higher bone mineral density are characteristics that favor a higher expression of strength and power (Schipilow *et al*., 2013; Stock *et al*., 2017). Conversely, athletes with less fat mass (FM) and a lower percentage of body fat may sustain effort better than individuals with more non-functional mass due to a lower relative workload and, potentially, a more efficient thermoregulatory system (Dervis *et al*., 2016). Still, any advantage gained from superior body composition appears to be modulated by the individual's overall skill in that sport. Greater familiarity with a movement pattern leads to more efficient muscle activation and lower relative workload (Krakauer *et al*., 2019).

Anthropometric parameters differ by sport and are an important control parameter at the health and optimal performance levels (Mazic *et al*., 2014). The current concept of somatotype does not suggest a permanent physical classification, as it evaluates the phenotype at a specific moment in life and can change during childhood, adolescence, or other stages due to growth, nutrition, training, or illness (Heath & Carter, 1967).

Relevant somatotype properties as important indicators can be associated with body composition characteristics, as well as the metabolic and biomechanical efficiency of athletes in the respective sport (Baranauskas *et al*., 2024). Somatotype is calculated using three basic components: endomorphy (level of body fat): mesomorphy (muscle mass):and ectomorphy (bone structure and leanness). Each sport has a well-defined kinanthropometric pattern. Through this pattern, it is possible to determine the anthropometric characteristics that an athlete must have to achieve sporting success (Navarro, 2020). In many sports, successful athletes tend to have a high proportion of mesomorphy, displaying strong musculoskeletal development (Carter, 1990). However, some anthropometric studies have also found diversity in somatotypes among athletes depending on their participation in different sports (Baranauskas *et al*., 2024). The mesomorphic element was predominant in speed and strength-dependent sports, such as combat sports, weightlifting, rowing, and swimming (Kutseryb *et al*., 2017). Each type has unique characteristics that directly influence athletic capacity, ease of gaining muscle or fat, and physical endurance (González Macías & Flores, 2024). Therefore, each individual has a specific proportion of the three body types related to a mix of endomorphy, mesomorphy, and ectomorphy that is also mediated by genetic traits, as well as environmental factors (Wilber & Pitsiladis, 2012; Marta *et al*., 2013). Finally, several athletes participating in different sports disciplines change their body constitution characteristics, such as body mass and segmental proportions, especially in the lower and upper limbs (Gutnik *et al*., 2015). Therefore, the way a particular body structure develops, based on specific training for each sport, plays a crucial role in elite athletes across various disciplines. In this regard, it is essential to conduct studies on somatotype and perform anthropometric measurements of estimated body segment parameters (Baranauskas *et al*., 2024). Considering these findings, the objective of this study is to compare, by sex and sport category, the anthropometric characteristics, body composition, and somatotype between elite Cuban and Mexican athletes.

MATERIAL AND METHOD

Study Design. This was a descriptive, cross-sectional study. Participants attended the testing location once for data collection. The study followed the Strengthening Reporting of Observational Studies in Epidemiology (STROBE) guidelines (von Elm *et al*., 2007; Vandenbroucke *et al*., 2014).

Setting. The study used two databases. The first was collected prior to the Olympic participation of each of the Cuban athletes, with approval from the Institute of Sports Medicine of Cuba (IMD). The second database was gathered during the XXIV Central American and Caribbean Athletics Championship, held in Morelia, Michoacán, Mexico. This protocol was approved by the Biosecurity, Research, and Ethics Committees of the University of Guadalajara (CEI062020-01) and registered in clinicaltrials.gov (NCT 06416124). All participants provided written informed consent in accordance with the ethical principles outlined in the Declaration of Helsinki (World Medical Association, 2013).

Participants. A total of 131 athletes (Cuban: n = 57; Mexican: n = 74) participated in the study, all actively competing in international events. Of the 57 Cuban athletes, all of whom were Olympic participants, they achieved 6 gold, 4 silver, and 5 bronze in the Olympic Games, 4 gold, 6 silver, and 1 bronze in World Championships (WCH):and 6 gold in the Pan American Games (PG). In total, the Cuban athletes accumulated 32 medals (16 gold, 10 silver and 6 bronze). On the other hand, the 74 Mexican athletes, 22 of whom were Olympic participants, won 1 silver medal in the Olympic Games, 1 gold, 3 silver, and 1 bronze in World Championships (WCH):and 1 gold, 3 silver, and 3 bronze in the Pan American Games (PG). The Mexican athletes earned 13 medals (2 gold, 7 silver, and 4 bronze). In total, the 131 athletes accumulated 45 medals (18 gold, 17 silver, and 10 bronze): with the Cuban athletes earning 32 medals and the Mexican athletes earning 13. The participants were categorized into seven groups: Sprint (100m,110m hurdles, 200m, 400 m and 400 m hurdles):Middle-distance (800 m, 800 m hurdles, 1500 m):Long-distance (3000, 3000 m steeplechase, 5000 m steeplechase, and 10,000 m):Endurance (20 km walk and 21 km half marathon):Combined events (Heptathlon, Decathlon):Jumps (Pole vault, High jump, Long jump and Triple jump) and Throws (Hammer and Javelin). Inclusion criteria: Mexican and Cuban athletes present at the evaluation area. Exclusion criteria: improper attire or refusal to consent.

Variables. Forty-three anthropometric variables were assessed per the International Society for the Advancement of Kinanthropometry (24). Measurements were taken twice or thrice if discrepancies occurred, and the mean or median was used for analysis. Intra-evaluator technical error of measurement (TEM) was calculated (25): yielding 5.04% for skinfolds and 0.93% for other variables.

Data sources and measurements. Participants arrived at the test area after a 7-10 hour fast and 12 hours after their last exercise session.

Anthropometric measurements. Certified level three and level two anthropometrists performed measurements. Body mass was determined using a digital scale (SECA® 874): stature and sitting height with a stadiometer (SECA® 217):skinfolds with a Harpenden caliper, girths with a flexible tape measure, and lengths/breadths with a segmometer and caliper (SmartMet Kinanthropometric Assessment®). Instruments were calibrated before evaluation.

Anthropometric profile. The data were used to create compound variables for the anthropometric profile, including body composition fractionation according to Ross & Kerr (1991) and somatotype according to Carter (2002).

Study sample. Non-probabilistic convenience sampling was employed, broadly representing elite Cuban and Mexican athletes, including 79 Olympic athletes.

Statistical methods. The Kolmogorov-Smirnov test was used to evaluate the normality of the data set. Given non-normality of data distribution, median and interquartile range (IQR) were used as measures of central tendency and dispersion. The Kruskal-Wallis test with a Dunn post hoc analysis were used to evaluate differences between sport events. Differences between sexes were analyzed with the Mann-Whitney U Test. Statistical procedures were performed with IBM SPSS Statistics, version 23.0 (IBM Corp., Armonk, N.Y., USA) using a level of significance ≤ 0.05.

RESULTS

Table I presents the descriptive characteristics of the track and field athletes, grouped by sex and event type. These include age, body mass, height, sitting height, and body mass index (BMI): expressed as the median and interquartile range. The data show differences in anthropometric characteristics between men and women, as well as variations according to event type, reflecting potential influences of specialization in the practiced disciplines.

Table I. Descriptive characteristics of track and field athletes grouped by sex and event.

		Sprint (M=32, F=19)	Middle distance (M=8, F=5)	Long distance (M=7, F=4)	Endurance (M=3, F=2)	Combined events (M=4, F=5)	Jumps (M=17, F=13)	Throws (M=5, F=7)
Age (years)	M	22.9 (18.7-25.0)	21.4 (20.0-24.4)	30.0 (23.0-32.3)	20.1 (19.8-29.2)	23.5 (21.8-24.5)	22.3 (20.0-25.6)	21.8 (19.4-23.0)
	F	20.0 (18.8-26.3)	20.0 (20.0-21.0)	21.4 (19.0-24.3)	24.6 (24.5-24.6)	24.1 (21.2-28.0)	23.7 (22.0-25.0)	22.0 (20.6-23.5)
Body mass (kg)	M	70.2 (64.8-74.7)	72.0 (66.0-73.6)	59.7 (59.3-64.0)	62.2 (60.3-62.2)	86.3 (83.9-88.0)	75.0 (68.7-79.0)	89.9 (89.9-102.5)
	F	55.6 (53.3-60.0)	55.5 (55.0-59.0)	46.7 (42.8-52.3)	46.8 (46.6-47.0)	66.0 (58.6-68.0)	60.9 (57.5-63.6)	78.3 (72.8-89.4)
Height (cm)	M	177.3 (172.2-181.3)	178.2 (174.2-182.8)	172.6 (167.8-175.9)	178.1 (172.1-178.1)	186.2 (183.6-188.8)	182.0 (175.5-185.5)	184.0 (177.1-184.0)
	F	163.6 (161.0-166.8)	167.0 (166.8-172.0)	154.3 (152.3-159.3)	162.8 (162.2-163.3)	172.1 (171.4-178.7)	170.3 (168.9-173.8)	168.0 (166.2-176.3)
Sitting height (cm)	M	91.8 (88.6-93.4)	90.5 (87.3-93.0)	89.5 (89.3-92.6)	94.0 (88.3-94.0)	94.7 (92.4-97.1)	91.1 (90.1-95.1)	94.0 (93.4-99.5)
	F	84.7 (83.8-87.6)	84.1 (82.9-86.1)	83.8 (82.3-86.1)	86.7 (86.2-87.1)	88.3 (85.5-90.8)	88.0 (87.7-89.0)	89.5 (86.5-91.6)
BMI (kg/m)	M	22.5 (21.6-23.4)	21.4 (20.8-22.5)	20.7 (19.6-21.8)	19.6 (19.6-20.4)	24.7 (24.3-25.1)	22.5 (21.8-23.0)	28.4 (26.6-32.7)
	F	20.8 (20.2-21.8)	19.8 (18.8-20.4)	20.0 (18.9-20.6)	17.7 (17.6-17.7)	21.3 (19.9-22.3)	21.7 (18.9-21.9)	27.4 (25.1-29.7)

BMI=body mass index; F=female; M=male Note: data is presented as median (interquartile range).

Table II details the specific anthropometric characteristics of the track and field athletes, grouped by sex and sports category. It includes skinfold measurements (triceps, subscapular, biceps, supraspinal, abdominal, thigh, and calf) and body girths and bone breadths (humerus and femur). The data are presented as the median and interquartile range, allowing for the observation of differences between sexes and disciplines. These variations reflect the influence of sport-specific and biological factors on the athletes' anthropometric measurements, with differentiated values according to the physical effort required by each sports category.

Table III presents the comparison of relative anthropometric measurements in different track and field events, grouped by sex. The table highlights key skinfold, girth, and bone breadth measurements in male and female athletes. The data are presented as the median (interquartile range) for each category, providing information on the differences in body composition between male and female athletes, as well as across different event types.

Highly significant differences were found in body mass between throwing athletes, endurance athletes, long and middle-distance athletes, sprinters, and jumpers ($p \leq 0.001$**). In BMI, differences were observed between throwers and endurance athletes, middle and long-distance athletes, jumpers, and sprinters ($p \leq 0.001$**). Regarding body fat mass, significant differences were recorded between jumpers and long-distance athletes ($p \leq 0.001$**):as well as between throwers and long and middle-distance athletes, endurance athletes, and sprinters ($p \leq 0.001$**). In terms of lean mass, differences were observed between throwers and middle and long-distance athletes, sprinters, and jumpers ($p \leq 0.001$**). Regarding somatotype, in the endomorphic component, differences were found between throwers and endurance athletes, long and middle-distance athletes, jumpers, and combined events ($p \leq 0.001$**). In the mesomorphic component, differences were also presented between throwers and endurance athletes, long and middle-distance athletes, jumpers, and sprinters ($p \leq 0.001$**). Finally, in the ectomorphic component, differences were observed between throwers and endurance athletes, long and middle-distance athletes, jumpers, combined events, and sprinters ($p \leq 0.001$**) (Table IV).

The comparative analysis by sex also showed highly significant differences in the anthropometric variables: body mass, height, sitting height, BMI, body fat mass, and lean mass ($p \leq 0.001$**):as well as in the somatotype components, specifically in endomorphy and mesomorphy ($p \leq 0.001$**) (Table V).

DISCUSSION

The main findings of this study revealed significant differences in body fat and lean mass between athletes in throwing sports and those in endurance, middle and long-distance, and sprint events. In a study by Hirsch *et al.* (2016): body composition and specific muscular characteristics for each event in track and field athletes were evaluated, showing that throwers competing in shot put, discus, and hammer were heavier compared to jumpers, sprinters, middle-distance runners, pole vaulters, and javelin throwers. Similarly, a study on elite male track and field athletes in South Korea showed that throwers had greater body mass and strength compared to sprinters, jumpers, and long-distance runners (Sung & Ko, 2017). These results highlight that the large body structure of throwers is

Table II. Anthropometric characteristics of track and field athletes grouped by sex and event.

		Sprint (M=32, F=19)	Middle distance (M=8, F=5)	Long distance (M=7, F=4)	Endurance (M=3, F=2)	Combined events (M=4, F=5)	Jumps (M=17, F=13)	Throws (M=5, F=7)
Skinfolds (mm)								
Triceps	M	5.5 (4.7-6.7)	4.9 (4.4-6.0)	4.2 (4.0-4.6)	5.4 (5.4-7.9)	5.2 (4.8-5.3)	5.7 (4.6-6.8)	9.5 (8.0-15.2)
	F	9.2 (7.4-10.0)	5.4 (5.4-7.2)	8.2 (7.4-9.4)	7.0 (7.0-7.0)	8.2 (6.4-9.4)	8.7 (7.0-11.4)	14.7 (12.9-21.6)
Subscapular	M	8.0 (7.5-8.8)	7.1 (6.7-8.3)	6.2 (5.8-7.2)	5.0 (5.0-10.0)	7.6 (6.8-8.2)	8.2 (7.8-10.0)	13.0 (9.5-21.0)
	F	8.8 (6.9-9.3)	7.2 (5.5-8.4)	7.5 (6.9-8.5)	7.0 (7.0-7.0)	8.2 (7.0-9.2)	9.0 (7.4-10.4)	12.8 (11.7-19.7)
Biceps	M	3.0 (2.9-3.5)	2.9 (2.5-3.1)	3.0 (2.5-3.0)	2.0 (2.0-2.7)	3.0 (3.0-3.2)	3.4 (3.0-3.8)	5.0 (4.0-6.5)
	F	3.2 (3.0-4.5)	4.5 (3.6-4.6)	3.5 (3.0-4.1)	2.0 (2.0-2.0)	3.2 (3.0-4.6)	4.0 (3.4-4.5)	7.0 (6.8-8.0)
Supraspinal	M	5.2 (4.7-6.8)	5.0 (4.4-5.4)	4.7 (4.5-5.7)	3.4 (3.4-5.3)	4.7 (4.4-5.3)	5.5 (4.6-6.8)	13.0 (7.0-16.6)
	F	7.2 (5.5-8.5)	6.2 (6.2-7.0)	7.4 (6.9-8.1)	5.0 (4.5-5.5)	7.0 (6.5-7.5)	7.0 (6.0-8.0)	10.2 (10.0-21.5)
Abdominal	M	7.9 (6.6-9.5)	6.4 (5.9-7.8)	6.5 (6.4-8.5)	4.8 (4.8-10.7)	5.7 (5.4-6.0)	6.8 (6.4-8.4)	15.7 (9.5-24.7)
	F	8.7 (6.7-14.4)	8.6 (8.4-8.7)	12.2 (12.0-14.1)	8.0 (8.0-8.0)	10.4 (7.4-10.6)	10.2 (8.2-12.4)	19.0 (17.5-30.7)
Thigh	M	6.3 (5.4-7.5)	6.4 (4.85-7.3)	5.0 (5.0-6.2)	3.6 (3.6-7.8)	5.8 (5.5-6.2)	7.0 (5.4-8.0)	9.7 (7.0-13.0)
	F	11.2 (9.2-15.1)	8.8 (8.0-9.6)	10.2 (8.6-11.4)	10.0 (9.0-11.0)	11.7 (11.0-16.6)	13.7 (10.2-16.0)	15.0 (10.4-21.5)
Calf	M	4.7 (4.0-5.5)	4.6 (3.9-5.1)	4.0 (3.9-4.5)	2.5 (2.5-3.9)	4.3 (4.1-4.7)	5.0 (4.2-5.2)	6.5 (6.0-12.5)
	F	5.8 (5.0-8.4)	6.2 (4.4-6.2)	5.5 (4.8-6.1)	5.0 (5.0-5.0)	6.5 (5.8-8.2)	7.6 (6.7-8.6)	15.4 (11.5-24.4)
Breadths (cm)								
Humerus	M	7.0 (6.7-7.2)	6.9 (6.8-7.0)	6.7 (6.5-7.0)	7.1 (6.8-7.1)	7.5 (7.3-7.8)	7.2 (7.0-7.4)	7.5 (7.4-7.5)
	F	6.1 (6.0-6.3)	6.1 (6.1-6.1)	5.4 (5.2-5.6)	5.8 (5.8-5.9)	6.6 (6.0-6.6)	6.2 (6.1-6.4)	7.0 (6.7-7.3)
Femur	M	9.8 (9.5-10.0)	9.6 (9.2-10.3)	9.3 (9.1-9.5)	9.4 (9.3-9.4)	10.3 (10.2-10.5)	10.2 (9.8-10.4)	10.7 (10.5-10.9)
	F	8.8 (8.6-9.1)	9.2 (9.0-9.3)	7.8 (7.7-8.0)	8.2 (8.2-8.2)	9.5 (9.1-9.5)	9.1 (8.9-9.2)	10.3 (9.7-10.8)
Girths (cm)								
Relaxed arm	M	29.4 (27.5-30.3)	27.7 (27.2-28.2)	26.2 (25.4-26.5)	25.0 (25.0-25.8)	32.4 (30.8-33.5)	28.8 (27.0-30.2)	35.1 (32.6-38.2)
	F	24.6 (23.8-26.2)	24.2 (22.8-25.0)	22.4 (21.6-23.3)	21.1 (20.9-21.3)	26.8 (25.0-27.5)	25.4 (23.3-26.3)	31.8 (31.1-34.4)
Flexed arm	M	32.0 (30.2-34.1)	31.0 (30.5-31.9)	29.2 (28.7-29.2)	27.8 (27.8-27.8)	36.1 (34.8-37.3)	32.5 (30.5-34.0)	36.7 (35.0-40.3)
	F	26.8 (25.8-27.6)	26.4 (25.7-26.8)	23.5 (23.1-24.2)	23.0 (22.8-23.2)	29.6 (26.6-29.9)	28.0 (25.6-29.2)	33.8 (32.3-36.2)
Forearm	M	26.3 (25.7-27.0)	25.4 (25.2-26.0)	25.0 (24.0-25.4)	26.5 (25.5-26.5)	29.6 (29.2-30.0)	26.3 (26.0-28.1)	31.5 (31.4-31.5)
	F	23.2 (22.4-23.4)	22.0 (21.7-23.2)	19.9 (19.3-20.8)	20.8 (20.7-20.9)	23.6 (23.4-24.5)	23.3 (22.6-23.8)	26.8 (26.1-28.6)
Chest	M	94.9 (91.3-97.4)	93.2 (91.9-94.8)	90.5 (88.3-92.2)	87.3 (87.3-89.5)	101.7 (99.6-103.8)	94.3 (92.5-96.6)	106.4 (103.2-111.4)
	F	83.8 (81.3-86.0)	82.0 (80.2-84.6)	80.3 (78.1-83.3)	77.7 (77.3-78.2)	88.1 (86.7-88.2)	84.8 (82.4-87.1)	95.5 (92.3-99.7)
Mid-thigh	M	52.5 (49.5-56.1)	50.5 (46.2-53.3)	48.2 (45.5-49.8)	45.8 (45.8-47.0)	58.6 (56.5-61.0)	55.2 (52.0-56.4)	61.1 (61.0-66.1)
	F	51.5 (48.4-52.7)	49.9 (48.9-50.4)	43.7 (42.1-46.3)	42.6 (42.6-42.7)	55.2 (49.5-55.7)	51.2 (49.4-52.1)	65.6 (61.5-69.0)

F=female, M=male Note: data is presented as median (interquartile range).

Table III. Body components.

Body components		Sprint (M=32, F=19)	Middle distance (M=8, F=5)	Long distance (M=7, F=4)	Endurance (M=3, F=2)	Combined events (M=4, F=5)	Jumps (M=17, F=13)	Throws (M=5, F=7)
BF (%)	M	19.9 (18.3-21.4)	20.3 (19.4-21.0)	19.3 (18.1-22.4)	18.9 (18.9-23.0)	16.7 (16.6-17.2)	19.9 (19.4-20.6)	20.3 (18.6-24.5)
	F	24.7 (21.9-28.0)	23.2 (23.0-25.0)	26.7 (25.6-27.7)	25.9 (25.5-26.3)	24.9 (24.7-25.7)	26.4 (24.8-28.0)	26.6 (25.8-35.9)
BF (kg)	M	13.5 (12.9-15.1)	13.4 (12.4-14.8)	11.5 (11.3-12.2)	11.5 (11.5-13.9)	14.7 (14.5-14.8)	14.9 (13.5-16.4)	18.9 (16.8-26.0)
	F	13.9 (11.8-15.5)	12.7 (12.0-13.9)	12.2 (10.8-13.9)	11.7 (11.4-12.1)	16.8 (15.7-17.6)	16.2 (14.6-17.3)	22.7 (17.8-30.7)
MM (%)	M	50.9 (49.5-52.9)	49.3 (48.6-51.6)	51.1 (47.3-51.4)	49.0 (48.2-49.0)	55.8 (54.2-56.8)	51.2 (50.1-53.1)	53.0 (51.8-55.6)
	F	46.6 (45.4-47.9)	44.5 (43.7-45.5)	44.5 (43.1-45.9)	42.0 (41.3-42.8)	46.5 (46.5-46.6)	45.7 (41.3-46.8)	50.7 (48.9-53.8)
MM (kg)	M	37.0 (33.0-38.8)	33.7 (31.4-36.9)	31.2 (27.5-33.8)	29.8 (29.1-29.8)	48.4 (46.6-49.4)	38.4 (34.7-41.0)	50.8 (48.3-52.7)
	F	26.3 (24.5-27.4)	25.0 (23.8-26.1)	20.4 (18.7-22.7)	19.0 (18.9-19.1)	30.7 (28.5-31.9)	27.0 (23.6-28.8)	43.4 (36.2-47.5)
Endomorphy	M	1.8 (1.6-2.0)	1.6 (1.2-1.7)	1.4 (1.3-1.6)	1.1 (1.1-2.3)	1.3 (1.2-1.5)	1.8 (1.5-2.1)	3.5 (2.3-5.3)
	F	2.6 (2.3-3.0)	1.9 (1.9-2.0)	2.7 (2.5-2.8)	1.9 (1.8-2.0)	2.1 (1.9-2.4)	2.6 (2.1-3.0)	4.5 (3.6-5.6)
Mesomorphy	M	4.9 (4.3-5.6)	4.2 (3.9-4.4)	4.5 (3.7-4.9)	3.9 (3.9-4.1)	5.9 (5.5-6.3)	4.8 (4.2-5.4)	7.5 (6.2-7.7)
	F	4.1 (3.5-4.5)	3.2 (3.2-3.6)	2.8 (2.5-3.1)	2.5 (2.3-2.6)	3.3 (3.0-4.3)	3.8 (2.4-4.1)	6.6 (5.5-7.1)
Ectomorphy	M	2.7 (2.2-3.4)	3.7 (3.0-3.8)	3.2 (2.8-4.2)	4.4 (3.6-4.4)	2.5 (2.2-2.7)	2.9 (2.7-3.5)	0.7 (0.5-1.5)
	F	2.7 (2.7-3.2)	3.7 (3.5-4.2)	2.9 (2.5-3.5)	4.5 (4.5-4.6)	3.5 (2.6-3.8)	2.8 (2.7-4.5)	0.7 (0.5-1.4)

BF = body fat; F=female; M=male; MM = muscle mass. Note: data is presented as median (interquartile range).

Table IV. Differences between events.

	H	df	*p*-value	Post Hoc Comparisons
Age	4.85	6	0.563	
Body mass	33.27	6	<.001**	e-h, d-h, a-h, b-h, g-h
Height	14.27	6	0.027*	
Sitting height	6.27	6	0.393	
BMI	42.04	6	<.001**	e-h, d-h, b-h, g-h, a-h
Body fat	43.77	6	<.001**	d-g, d-h, e-h, b-h, a-h
Muscle mass	30.52	6	<.001**	e-h, d-h, b-h, a-h, g-h
Endomorphy	28.52	6	<.001**	b-h, e-h, d-h, f-h, g-h, a-h
Mesomorphy	32.93	6	<.001**	e-h, d-h, b-h, g-h, a-h
Ectomorphy	40.12	6	<.001**	h-a, h-f, h-g, h-d, h-b, h-e

BMI = body mass index, df = degrees of freedom. a=sprints; b=middle distance; d=long distance; e=endurance; f=combined events; g=jumps; h=throws. * significant at the ≤0.05 level. ** significant at the <0.001 level

Table V. Differences between sexes.

	U	*p*-value
Age	2002.5	0.685
Body mass	775.0	<.001
Height	545.0	<.001
Sitting height	721.5	<.001
BMI	1374.0	<.001
Body fat	505.0	<.001
Muscle mass	737.0	<.001
Endomorphy	800.0	<.001
Mesomorphy	1131.0	<.001
Ectomorphy	2086.5	0.989

associated with high body mass. Data from elite throwers show that, in general, they have body masses over 100 kg, except for javelin throwers, who weigh less (Zaras *et al*., 2021). In our study, throwers had an average body mass of 89.9 kg, with ranges near these reference values (89.9-102.5 kg). Moreover, contemporary data show that elite throwers have become heavier, with shot putters reaching 130 kg and discus throwers around 117 kg in body mass (Zaras *et al*., 2021). Additionally, throwers regularly perform resistance training to increase their strength and muscle power, leading to a significant increase in lean mass, particularly in the muscle groups directly involved in their specific throwing event (Zaras *et al*., 2021). Therefore, throwers possess greater lean mass compared to athletes in other disciplines. In our study, throwers had greater muscle mass (50.8 kg) than sprinters (37.0 kg):long-distance runners (31.2 kg):middle and long-distance runners (33.7 kg–29.8 kg).

Regarding somatotype components in our study, throwers showed differences compared to endurance, middle and long-distance, sprint, and combined sports athletes. In sex comparisons, there were differences in all body composition and somatotype variables across the studied sports categories. In throwers specializing in events like the hammer throw, Singh *et al*. (2011): determined that the somatotype of male throwers was endomorphic mesomorph (Endo: 4.61; Meso: 5.04; Ecto: 0.75): similar to results in our study (Endo: 3.5; Meso: 7.5; Ecto: 0.7): with a greater predominance of the mesomorphic component.

A systematic review by Zaras *et al*. (2021): suggests that the main biological determinants of performance in track and field throwing events are lean body mass size, neural activation of muscles involved in the throw, and the cross-sectional area of type II muscle fibers.

Regarding anthropometric assessments in endurance athletes, Sánchez-Muñoz *et al*. (2020): described the anthropometric characteristics, body composition, and somatotype of elite male youth runners, comparing these variables by specialty (middle-distance vs. long-distance). They found a predominantly ectomorphic mesomorphic somatotype, similar to previous studies. Carter (1990) found that Olympic male runners were classified as mesomorph-ectomorph (1.5-4.3-3.6 for middle-distance; 1.4-4.2-3.7 for long-distance; and 1.4-4.4-3.4 for marathon runners):with no significant differences between Olympic runners participating in different events. In our study, the somatotype of male runners presented endomorphy, mesomorphy, and ectomorphy values of (1.6-4.2-3.7 for middle-distance, 1.4-4.5-3.2 for long-distance, and endurance sports 1.1-3.9-4.4):while female runners in our study showed (1.9-3.2-3.7 for middle-distance, 2.7-3.2-3.7 for long-distance, and endurance sports 1.9-2.5-4.5). Performance in longer distances is also more dependent on efficiency than effectiveness, with lower muscle mass, especially in the upper limbs, being key for this purpose. This makes sense since training is focused on achieving performance results during competition. Long-distance events require athletes to be lighter and more efficient, which is achieved through a combination of genetics and training and nutrition strategies (Sánchez-Muñoz *et al*., 2020).

On the other hand, body fat can negatively contribute to the development of power. In fact, excess body fat can reduce movement speed due to the additional body mass that needs to be carried by the muscular system. In this regard, the less body fat, the better for a thrower. Previous studies showed diverse results regarding body fat percentage in throwers, possibly due to varying eating habits among athletes. Male throwers had an average body fat percentage of < 15-18%, while female throwers' body fat could reach 25-28% (Kyriazis *et al*., 2010). In our study, male throwers had a body fat percentage of 20.3% (18.6-24.5):and female throwers had 26.6% (25.8-35.9). Endurance male athletes had 18.9% (18.9-23.0):and female endurance athletes had 25.9% (25.5-26.3).

CONCLUSION

The results of this study highlight the morphofunctional characteristics and variability among sports categories in high-performance track and field athletes. The sample, which included over 70 Olympic athletes, provides a unique insight into the anthropometric profiles of world-class athletes. The observed differences in muscle mass, body fat percentage, and somatotypes across sports disciplines emphasize the importance of considering the specific physical demands of each specialty when designing training and nutrition programs.

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RESUMEN: El estudio de las características morfofuncionales de los atletas de pista y campo de alto rendimiento es esencial para optimizar el entrenamiento, la nutrición y la selección de talento. Dado que las demandas físicas varían según la especialidad deportiva, entender cómo estos atributos afectan la eficiencia y el rendimiento es clave para maximizar el potencial de los atletas. Este estudio tuvo como objetivos: i) realizar una caracterización antropométrica, ii) describir la composición corporal y somatotipo, y iii) comparar estas variables entre categorías deportivas y sexos. Se evaluaron 131 deportistas internacionales de Cuba y México (76 hombres, 55 mujeres):incluidos 79 atletas olímpicos, utilizando 43 variables antropométricas según el protocolo ISAK. La composición corporal se determinó a través del fraccionamiento de cinco vías de Kerr y Ross y el somatotipo de Heath y Carter. Los resultados mostraron diferencias significativas en masa muscular y grasa corporal entre los atletas de lanzamiento, velocidad y endurance. Los lanzadores presentaron una masa muscular promedio de 50.8 kg, superior a la de los de velocidad (37.0 kg) y endurance (31.2 kg):con $p \leq 0.05$. Además, los lanzadores mostraron un mayor porcentaje de grasa corporal (20.3% hombres, 26.6% mujeres) en comparación con los de endurance (18.9% hombres, 25.9% mujeres):también con $p \leq 0.05$. Los lanzadores presentaron somatotipos predominantemente mesomorfos, mientras que los de velocidad y endurance fueron más ectomorfos. Estos hallazgos sugieren que las características antropométricas influyen en el rendimiento según la especialidad deportiva.

PALABRAS CLAVE: Cineantropometría; Antropometría; Composición corporal; Somatotipo; Rendimiento atlético; Atletismo.

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