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Anthropometric Characteristics of Elite and Olympic Mexican Track and Field Athletes: A Retrospective Study

Características Antropométricas de Atletas Mexicanos de Atletismo de Élite y Olímpicos: Un Estudio Retrospectivo

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SUMMARY: Sports specialization requires understanding morphological variability to optimize performance, yet detailed analyses of track and field athletes' anthropometric profiles, especially in Latin America, are sparse. This study addresses this gap by examining the anthropometric characteristics of elite and Olympic Mexican track and field athletes. Seventy-four athletes (49 men, 25 women), aged 22.4 (±4.41) years, representing Mexico at the XXIV Central American and Caribbean Athletics Championship, were evaluated. Using the ISAK protocol, 43 anthropometric variables were assessed to describe their physical morphology, including the Heath-Carter somatotype, body composition, muscle-bone index, muscular-adipose index, sum of skinfold thicknesses, and proportionality. The correspondence among these variables was analyzed across different groups: sprint (n=32), middle-distance (n=6), long-distance (n=11), endurance (n=5), combined events (n=3), jumps (n=11), and throws (n=6). Results revealed sprinters and middle-distance runners were predominantly ectomorphic mesomorphs, while long-distance runners were mesomorph ectomorphs. Sprinters had higher adipose mass compared to endurance runners. Throwers exhibited larger dimensions and greater body mass, muscle, and bone. Additionally, long-distance athletes had higher thoracic index values than sprinters and jumpers, indicating a potential association between thoracic index and athletic specialization. This study highlights the anthropometric diversity among Mexican track and field athletes, providing insights for talent identification and the development of tailored training and nutrition programs specific to each discipline.

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

INTRODUCTION

Research on track and field competitors has been of great interest in sports applied sciences since the early 20th century, particularly from the perspective of Biological Anthropology. James Tanner was a standout in this field for describing the phenotypic variability of many athletes from the 1960 Rome Olympics. Furthermore, he analyzed the secular trend in stature and body mass of sprinters, long-distance runners, jumpers, and throwers in comparison with the competitors from the 1928 Amsterdam Olympic Games (Tanner, 1964).

Other authors have analyzed trends in track and field athletes' body mass and stature, emphasizing the importance of characterizing their anthropometric profile (Borms & Hebbelinck, 1984; Norton & Olds, 2001; Olds, 2009). Environmental and contextual factors, such as

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changes in regulations, technical advancements, training, proper nutrition, growth trends, and professionalization, have influenced the physical evolution of athletes over time (Norton & Olds, 2001; Olds, 2009).

In athletics, although some correlational studies have used anthropometric variables relevant to sports performance, their analysis has been restricted to a limited set of variables (Sedeaud *et al*., 2014; Mangine *et al*., 2021; Zaras *et al*., 2021; Bonato *et al*., 2023). Other studies have referred to the study of adaptive modifications of body composition (Dengel *et al*., 2020; Tsukahara *et al*., 2020; Batra *et al*., 2021; Mangine *et al*., 2021).

Although these athletes have been anthropometrically characterized by describing their general trends (Tanner, 1964; Borms & Hebbelinck, 1984; Norton & Olds, 2001; Olds, 2009), to our knowledge, there are no publications that address the five-way fractionation method of body mass in track and field athletes. Alternatively, there are a few publications applying the method in different sports (Carvajal *et al*., 2009; Holway & Garavaglia, 2009; Carvajal *et al*., 2012; Bernal-Orozco *et al*., 2020; Holway *et al*., 2024; Muñoz *et al*., 2024). Furthermore, reports and publications on the physical particularities of track and field practitioners in Latin America are limited. In classic studies, such as that conducted at the 1960 Rome Olympics (Tanner, 1964), no athletes from this geographic area were included. At the 1976 Montreal Olympics, only 30 subjects from Central America and the Caribbean were studied across 20 sports (Carter, 1982). It is also imperative to highlight the lack of attention paid to the characteristics of female athletes, as another significant limitation.

Given the interest in providing comprehensive information on the morphological variability of humans in athletics worldwide, this study aimed to characterize the anthropometric profile of Olympic and elite track and field athletes, both male and female, representing Mexico in the XXIV Central American and Caribbean Athletics Championship. In particular, considering that event as the base point of Mexico's rise as a sporting power, as observed since the Lima 2019 Pan-American Games (Pulleiro Méndez & Morales Ruvalcaba, 2023). Additionally, this research was intended to contribute data on the five-way fractionation method of body mass (Ross & Kerr, 1991), a widely used methodology scarcely documented in international sports literature. These findings could have significant implications for coaches and sports scientists who could use this information to improve training programs and increase the chances of success for Mexican and Latin American athletes in international competitions.

MATERIAL AND METHOD

Study Design. This research was conducted as a descriptive, cross-sectional, and retrospective analysis. 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 was conducted during the XXIV Central American and Caribbean Athletics Championship in Morelia, Michoacán, Mexico, from July 5 to 7, 2013, at the 'Unidad Deportiva Bicentenario'. It was approved by the Biosafety, Research, and Ethics Committees of the University of Guadalajara (CEI062020-01) and registered at clinicaltrials.gov (NCT 06416124). Participants provided informed consent, with parental consent for those under 18, following the Declaration of Helsinki (World Medical Association, 2013).

Participants. A total of 74 Mexican athletes (men: n = 49; women: n = 25; age: 22.5 ± 4.4 years; stature: 172.1 ± 8.6 cm; body mass: 64.7 ± 12.4 kg; competitive experience: 11.6 ± 4.9 years; weekly training volume: 24.1 ± 4.8 hours) participated in the study. All were actively competing at national or international events, with a record of three Olympic medals and more than 60 medals in international competitions. The athletes were divided into seven groups as follows: Sprint (100 m,110 m hurdles, 200 m, 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 (20k walk and 21k half marathon), Combined events (Heptathlon, Decathlon), Jumps (Pole vault, High jump, Long jump and Triple jump) and Throws (Hammer and Javelin). Inclusion criteria: Mexican athletes selected for the Championship and present at the evaluation area before competition. Exclusion criteria: improper attire or refusal to consent.

Variables. Forty-three anthropometric variables were assessed per the International Society for the Advancement of Kinanthropometry (Stewart *et al*., 2011). 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 (Pederson & Gore, 1996), yielding 4.04% for skinfolds and 0.87% 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 Heath-Carter somatotype, Ross and Kerr's body composition fractionation, Muscle-Bone Index, Muscular-Adipose Index, skinfold sums, corrected girths, and proportionality via Ross's 'Phantom' strategy (Ross & Wilson, 1974; Carter, 1982; Ross & Kerr, 1991; Carter, 2002; Bonilla *et al*., 2022).

Study sample. Non-probabilistic convenience sampling was employed, broadly representing elite Mexican athletes, including 22 Olympic athletes.

Statistical methods. Anthropometric variables were analyzed by group and presented as mean ± standard deviation. Reliability analysis validated the consistency of body composition assessments using Spearman correlation, R-squared, correlation confidence interval (CCI), and intraclass correlation coefficient (ICC). The significance level was $p<0.05$. Somatotype attitudinal distance (SAD) and mean (SAM) were calculated per Carter's equations (Carter, 2002). Data analysis was performed using JAMOVI® version 2.3.21.

RESULTS

The anthropometric characteristics of elite and Olympic Mexican track and field athletes are detailed in Tables I–III. These include absolute measurements, estimates from the five-way fractionation method of body mass, somatotype components, and proportionality, with differentiation by sex and the seven athlete groups established for the study.

The reliability of the five-way fractionation method is evidenced by the comparison of body mass values from a scale (64.6 ± 12.6 kg) and those derived from the sum of the five masses (64.1 ± 12.6 kg). Statistical tests showed a Pearson correlation coefficient of 0.928 ($p<0.001$; 95% CI = 0.888-0.954), an R-squared value of 0.862 ($p<0.001$; 95% CI = 0.808-0.976), and an intraclass correlation coefficient of 0.927 ($p<0.001$; 95% CI = 0.888-0.953), indicating high reliability and agreement of the method used.

Among the athletes, those in the throwing group exhibited the largest average body mass (men: 92.7 ± 6.5 kg; women: 67.6 ± 2.3 kg), stature (men: 180.4 ± 4.2 cm; women: 166.3 ± 2.5 cm), skinfold thickness, and girths (Table I). Long-distance and endurance athletes had lower average values for body mass, stature, and most girths. Combined-events athletes had superior stature values compared to the throwing group. Generally, throwers displayed larger breadths, while long-distance runners had smaller breadths (Table I). Male combined-events athletes had larger proportionate midstylion-dactylion lengths and tibiale lateral heights, whereas middle-distance athletes had larger trochanterion-tibiale lateral lengths.

The five-way fractionation method revealed that throwing athletes had predominant muscle mass (men: 50.0 ± 2.1 kg; women: 32.6 ± 2.3 kg), bone mass (men: 10.8 ± 0.3 kg; women: 7.3 ± 0.3 kg), and adipose mass (men: 19.6 ± 4.3 kg; women: 17.8 ± 1.3 kg). However, jumping athletes showed higher relative adipose mass compared to other groups (men: 21.6 ± 2.6%; women: 28.0 ± 3.0%). Long-distance athletes had the lowest values for muscle and bone mass. In the somatotype analysis, throwing athletes had the highest adiposity and musculoskeletal development values, while middle-distance and endurance athletes had lower values (Table II). Analysis of somatotype differentiation and dispersion showed SAD values below two units for all groups. The somatotype of long-distance runners was the most dispersed, while throwers had the least dispersion. Middle-distance men and combined events and throwing women had less variation in SAM compared to other groups. Men in long-distance and endurance sports exhibited a broader average somatotype (Table II).

Table III also presents corrected girths and anthropometric indices by group, with throwers showing higher values for corrected girths, BMI, skinfold sums, and muscle-bone ratio (men: 4.6 ± 0.2; women: 4.4 ± 0.1). Notable trends include higher thoracic indices in male middle-distance, long-distance, and endurance athletes compared to those in sprint, combined events, jumps, and throwers groups. For example, male long-distance athletes had a thoracic index of 73.9 ± 14.2, higher than throwers (60.9 ± 2.0). Similarly, female long-distance athletes had a thoracic index of 71.4 ± 3.9, higher than throwers (61.6 ± 0.4). The Height-to-biacromial breadth index (HBBI) was higher in male long-distance runners compared to throwers (4.9 ± 0.6 vs. 4.0 ± 0.1). In female long-distance athletes, the HBBI was also higher (4.1 ± 0.5) compared to the jumps (4.5 ± 0.2) and sprint groups (4.5 ± 0.1). The Height-to-biiliocristal breadth index (HBiiL) also showed differences. Male endurance athletes had an HBiiL of 6.9 ± 0.5, higher than throwers (6.2 ± 0.5). Female long-distance athletes had an HBiiL of 6.8 ± 0.6, compared to throwers (6.0 ± 0.3).

Table I. Anthropometric characteristics of elite and Olympic Mexican track and field athletes. Basics, skinfolds and girths by group.

Variables	Sprint				Middle-distance			Long-distance				Endurance				Combined events			Jumps				Throws			
	Male (*n* = 24)		Female (*n* = 8)		Male (*n* = 5)		Female (*n* = 1)	Male (*n* = 7)		Female (*n* = 4)		Male (*n* = 3)		Female (*n* = 2)		Male (*n* = 1)	Female (*n* = 2)		Male (*n* = 5)		Female (*n* = 6)		Male (*n* = 4)		Female (*n* = 2)	
	Mean	SD	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age (y)	21.0	4.0	21.2	4.1	21.1	1.5	19.5	28.3	5.7	21.8	3.4	26.0	10.7	24.6	0.1	24.0	22.7	2.1	23.1	1.5	22.8	2.3	22.1	4.1	20.6	1.3
Basic																										
Mass (kg)	67.3	7.1	54.4	6.1	69.1	7.1	61.4	64.5	16.6	48.5	8.8	60.9	2.2	46.8	0.6	87.0	51.2	10.5	69.0	7.9	60.7	4.5	92.7	6.5	67.6	2.3
Stature (cm)	175.5	6.2	163.1	3.6	176.9	4.1	173.5	173.1	8.8	157.2	9.1	174.1	6.9	162.8	1.5	187.8	166.7	6.6	178.2	9.1	167.8	2.7	180.4	4.2	166.3	2.5
Sitting height (cm)	91.1	3.3	87.1	2.5	86.5	8.7	93.4	90.4	4.1	84.7	5.6	90.2	6.5	86.7	1.3	96.7	85.3	0.2	96.7	7.2	87.5	3.7	94.1	4.1	91.6	1.9
Arm Span (cm)	178.7	8.3	164.1	8.2	181.5	7.5	176.1	173.7	11.0	158.5	8.1	178.1	9.0	166.0	1.5	193.0	168.4	10.2	184.3	9.9	169.0	6.4	186.9	6.3	161.9	6.3
Skinfolds (mm)																										
Triceps	5.8	1.2	10.2	3.4	5.1	0.9	9.5	4.6	1.1	8.6	1.7	7.1	2.9	7.0	0.0	5.3	8.0	2.8	6.5	1.3	11.6	1.9	10.2	3.4	13.9	1.2
Subscapular	8.1	1.6	8.1	1.5	6.8	0.9	5.5	6.6	1.0	7.9	1.5	8.3	5.8	7.0	0.0	6.3	6.4	0.9	8.4	1.1	8.7	1.7	13.3	5.4	10.8	0.0
Biceps	3.0	0.4	4.0	1.0	2.7	0.2	4.5	2.8	0.3	3.6	0.7	2.5	0.9	2.0	0.0	3.0	3.1	0.2	3.3	0.6	4.5	0.9	5.5	1.9	7.4	0.9
Iliac crest	8.3	2.6	12.8	3.7	6.4	1.1	7.5	7.8	1.7	12.9	3.5	4.4	0.1	9.0	1.4	6.0	11.1	3.4	9.5	3.0	16.6	4.8	18.0	9.3	26.3	1.1
Supraspinal	5.5	1.1	8.7	3.2	4.7	0.7	7.3	5.2	1.1	7.6	1.1	4.7	2.2	5.0	1.4	4.5	7.0	0.7	6.3	1.3	8.5	2.2	11.5	5.7	10.1	0.2
Abdominal	8.5	2.5	12.5	4.9	6.7	1.1	8.8	7.8	2.4	13.8	3.3	8.7	6.7	8.0	0.0	6.0	10.3	4.6	10.1	3.6	14.9	5.8	14.9	7.2	18.6	2.7
Front thigh	6.8	1.5	12.3	3.7	6.6	1.2	14.5	5.6	0.9	9.9	2.2	6.4	4.8	10.0	2.8	6.0	9.6	3.0	8.2	1.7	15.0	3.8	9.2	2.9	14.4	7.2
Medial calf	5.0	1.1	6.6	1.8	4.7	0.7	7.5	4.0	0.7	5.4	1.0	3.4	1.6	5.0	0.0	4.0	5.9	0.9	5.3	0.8	9.4	2.0	7.8	3.2	8.5	3.5

Table I. (Continued)

Variables	Sprint				Middle-distance			Long-distance				Endurance				Combined events			Jumps				Throws			
	Male (*n* = 24)		Female (*n* = 8)		Male (*n* = 5)		Female (*n* = 1)	Male (*n* = 7)		Female (*n* = 4)		Male (*n* = 3)		Female (*n* = 2)		Male (*n* = 1)	Female (*n* = 2)		Male (*n* = 5)		Female (*n* = 6)		Male (*n* = 4)		Female (*n* = 2)	
	Mean	SD	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Girths (cm)																										
Head	55.4	1.5	53.9	1.2	55.2	0.9	57.9	55.0	1.3	53.1	2.1	55.9	0.4	53.6	0.9	58.0	53.0	0.7	56.2	1.6	53.9	2.3	57.1	0.8	53.8	1.3
Neck	36.2	1.5	30.7	1.6	35.6	0.9	31.1	34.9	1.3	29.2	1.5	34.3	1.4	29.8	0.4	39.1	29.3	1.2	36.0	1.3	31.8	0.7	41.7	2.2	33.2	0.7
Arm (relaxed)	28.4	2.7	24.3	2.6	27.5	1.7	25.1	25.6	1.6	22.5	1.5	25.6	1.0	21.1	0.5	33.7	22.4	3.7	28.9	2.2	26.9	2.8	34.6	2.7	30.7	0.4
Arm (flexed and tensed)	31.1	2.9	25.6	2.4	30.5	1.8	25.8	28.5	2.5	23.8	1.4	27.9	0.0	23.0	0.5	38.7	24.2	3.5	31.6	1.9	28.2	2.4	36.8	2.5	32.0	0.1
Forearm (maximum)	25.9	1.7	22.2	1.7	25.2	1.3	23.2	24.5	1.6	20.2	1.6	25.9	1.2	20.8	0.2	30.8	21.8	2.3	26.5	1.2	23.7	0.2	31.2	0.5	25.3	0.4
Wrist (distal styloids)	15.8	1.5	14.5	0.8	16.1	0.5	14.9	15.6	0.9	13.4	0.6	15.4	0.0	13.8	0.4	17.9	14.4	1.0	16.6	0.8	15.0	0.5	18.2	0.8	15.1	0.1
Chest (mesosternale)	92.8	6.3	84.0	4.7	92.0	4.9	85.4	90.1	5.2	81.1	5.4	88.8	2.5	77.8	1.3	102.9	86.9	4.1	94.2	2.5	87.3	3.1	104.4	6.3	92.3	1.0
Waist (minimum)	76.0	4.3	66.5	3.8	74.9	3.4	70.0	72.8	3.1	66.2	2.8	72.6	0.8	64.0	0.3	85.5	64.6	5.4	76.5	4.3	70.2	1.2	88.3	7.8	76.3	0.4
Abdominal (no ISAK)	77.4	3.8	71.7	4.3	76.6	2.2	75.1	73.8	3.3	70.9	6.3	76.4	0.5	67.6	0.7	84.5	67.8	8.0	78.4	4.1	76.5	2.6	90.2	7.6	84.2	2.6
Gluteal (hips)	93.1	4.4	90.8	6.2	88.9	2.8	95.9	87.3	3.6	88.0	7.5	87.5	0.2	86.0	0.2	101.3	88.5	6.5	91.8	3.4	94.4	3.4	104.1	0.4	102.3	0.9
Thigh (1 cm gluteal)	55.0	3.3	53.2	3.4	52.6	3.2	54.2	50.8	2.7	50.2	3.4	51.5	1.0	48.3	0.4	60.0	52.2	4.7	54.7	2.4	56.3	1.3	68.0	1.1	60.0	5.4
Thigh (mid.tro.tib.lat)	50.4	4.9	48.9	3.2	47.7	3.9	49.9	47.3	3.9	44.7	4.0	46.6	1.3	42.6	0.2	57.0	47.2	3.3	49.5	3.6	50.4	1.3	62.3	2.5	54.5	4.3
Calf (maximum)	35.6	2.1	34.4	2.2	35.0	2.7	35.4	36.4	5.9	32.0	2.6	35.8	0.7	32.6	0.5	40.3	32.5	3.1	35.6	1.3	34.7	2.4	41.2	1.5	35.4	2.6
Ankle (minimum)	22.2	1.3	20.9	1.2	22.5	2.8	21.1	21.2	1.5	18.9	1.6	20.5	0.3	20.5	0.0	23.1	21.9	1.2	22.5	1.9	21.3	1.1	25.5	0.8	21.8	0.3

Table 1. (Continued)

Variables	Sprint				Middle-distance			Long-distance				Endurance				Combined events			Jumps				Throws			
	Male (*n* = 24)		Female (*n* = 8)		Male (*n* = 5)		Female (*n* = 1)	Male (*n* = 7)		Female (*n* = 4)		Male (*n* = 3)		Female (*n* = 2)		Male (*n* = 1)	Female (*n* = 2)		Male (*n* = 5)		Female (*n* = 6)		Male (*n* = 4)		Female (*n* = 2)	
	Mean	SD	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Lengths (cm)																										
Acromiale-radiale	33.8	1.6	31.1	1.5	34.7	1.1	33.4	32.5	2.7	29.9	1.6	33.2	1.7	31.1	1.3	35.9	31.9	0.6	34.9	2.1	32.2	1.5	34.9	1.5	30.7	0.4
Radiale-stylion	26.3	2.5	24.3	1.1	26.1	1.6	25.5	25.3	1.4	22.5	1.1	25.2	1.8	24.7	2.1	27.3	24.4	1.2	26.6	1.6	24.7	0.9	26.6	1.0	22.8	0.6
Midstylion-dactylion	19.5	0.8	18.3	0.6	19.6	1.0	19.8	19.0	1.5	17.5	0.7	19.6	0.4	18.4	0.0	21.5	18.5	0.6	20.1	1.5	18.6	0.7	21.1	0.3	22.9	6.8
Iliospinale height	99.0	4.3	89.1	2.7	99.6	3.5	94.4	96.8	5.9	85.6	4.4	98.0	6.7	88.1	2.1	104.9	91.2	0.5	99.9	6.6	92.9	3.2	98.8	2.2	88.0	1.3
Trochanterion height	93.7	10.7	84.4	2.3	95.3	3.2	90.7	90.5	4.0	80.5	4.0	91.0	5.6	84.6	3.6	95.8	88.7	0.1	92.4	6.0	87.1	3.3	91.0	3.5	87.5	0.9
Trochanterion-tibiale laterale	44.5	3.6	41.0	3.3	49.3	4.6	42.8	44.1	3.3	40.2	2.4	42.1	1.8	43.0	3.0	42.6	46.1	1.9	45.1	2.0	42.1	3.2	43.2	1.2	45.6	1.8
Tibiale laterale height	47.5	3.5	44.1	1.6	46.9	2.7	49.0	46.5	3.1	40.9	2.1	48.6	4.2	42.5	0.5	53.2	42.8	2.3	47.9	3.6	45.5	1.7	48.5	1.8	42.7	0.4
Tibiale mediale-sphyrion tibiale	37.5	3.6	34.8	3.2	37.2	2.4	38.9	36.8	2.7	33.5	2.0	38.3	1.9	35.0	0.2	43.6	36.9	1.9	39.7	2.5	37.0	1.6	39.9	1.9	36.1	1.2

Table I. (Continued)

Variables	Sprint				Middle-distance			Long-distance				Endurance				Combined events			Jumps				Throws			
	Male (*n* = 24)		Female (*n* = 8)		Male (*n* = 5)		Female (*n* = 1)	Male (*n* = 7)		Female (*n* = 4)		Male (*n* = 3)		Female (*n* = 2)		Male (*n* = 1)	Female (*n* = 2)		Male (*n* = 5)		Female (*n* = 6)		Male (*n* = 4)		Female (*n* = 2)	
	Mean	SD	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Breadths (cm)																										
Biacromial	40.3	2.1	36.4	1.2	39.8	1.8	38.1	39.4	1.7	35.7	1.1	35.7	5.2	40.0	5.1	43.1	37.8	2.7	41.8	2.1	37.3	1.7	44.8	2.3	37.8	0.8
Biiliocristal	26.6	1.6	24.7	1.5	26.1	1.5	26.6	25.2	1.8	25.2	1.1	27.9	0.5	23.9	1.9	28.1	25.6	3.5	27.4	1.8	26.7	1.4	29.3	1.8	27.7	1.0
Foot length	26.7	1.1	24.1	0.8	26.7	1.0	25.9	26.2	1.5	23.2	1.5	26.0	0.4	26.1	4.1	27.6	24.4	0.9	27.1	1.6	24.7	0.8	27.8	1.3	23.6	0.1
Transverse chest	29.7	2.0	26.1	1.2	29.2	1.7	26.5	29.2	1.8	25.4	0.9	28.6	0.9	24.5	0.6	31.7	26.8	1.9	30.5	1.3	26.9	0.6	33.7	1.7	28.7	0.1
Anterior-Posterior chest depth	18.9	1.3	16.8	1.1	21.5	3.1	16.4	19.1	1.1	15.6	1.5	19.1	0.0	17.5	0.6	19.4	16.3	1.1	18.0	1.6	17.8	2.0	20.5	1.5	17.7	0.0
Humerus	6.9	0.4	6.1	0.3	6.8	0.2	6.2	6.7	0.5	5.5	0.4	6.9	0.4	5.9	0.1	7.9	6.0	0.0	7.1	0.4	6.2	0.2	7.5	0.1	6.4	0.2
Bi-styloid	5.6	0.5	5.1	0.2	5.8	0.2	5.2	5.5	0.4	4.7	0.1	5.6	0.2	5.0	0.1	6.1	5.2	0.3	5.9	0.3	5.1	0.2	6.0	0.3	5.2	0.3
Femur	9.5	0.5	8.5	0.4	9.3	0.3	9.1	9.3	0.6	7.9	0.4	9.3	0.1	8.2	0.0	10.0	8.6	0.6	9.7	0.3	8.7	0.4	10.7	0.2	9.5	0.0
Bimalleolar	7.4	0.5	6.6	0.3	7.3	0.2	7.3	6.9	0.8	6.3	0.6	7.3	0.5	6.5	0.4	8.0	6.6	0.2	7.7	0.3	6.7	0.3	8.4	0.2	7.0	0.0

Table II. Body composition profile and somatotype by group.

Variables	Sprint				Middle-distance			Long-distance				Endurance				Combined events			Jumps				Throws			
	Male (*n* = 24)		Female (*n* = 8)		Male (*n* = 5)		Female (*n* = 1)	Male (*n* = 7)		Female (*n* = 4)		Male (*n* = 3)		Female (*n* = 2)		Male (*n* = 1)	Female (*n* = 2)		Male (*n* = 5)		Female (*n* = 6)		Male (*n* = 4)		Female (*n* = 2)	
	Mean	SD	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Body composition																										
Adipose mass (kg)	13.7	1.3	14.3	2.4	13.0	1.3	15.6	12.3	2.1	12.4	2.0	13.0	2.7	11.7	0.9	14.6	13.4	3.3	15.1	1.9	16.8	1.2	19.6	4.3	17.8	1.3
Adipose (%)	20.6	2.9	26.9	3.1	20.3	0.9	26.7	20.4	3.1	26.5	1.4	21.5	4.7	25.9	1.2	16.5	25.4	0.6	21.6	2.6	28.0	3.0	20.2	2.9	25.8	0.4
Muscle mass (kg)	33.5	6.0	24.4	4.6	31.7	5.1	26.0	29.3	0.8	18.9	0.3	30.0	6.0	21.0	4.4	48.3	24.5	5.6	34.1	3.9	27.4	2.9	50.0	2.1	32.6	2.3
Muscle (%)	49.5	3.5	45.6	4.1	49.1	3.0	44.5	48.4	1.0	42.1	2.1	49.0	3.4	44.6	2.4	54.7	46.6	0.1	48.5	2.4	45.2	2.6	52.0	3.2	47.3	0.7
Bone mass (kg)	7.9	1.2	5.8	0.7	7.4	0.8	7.0	7.1	1.4	6.2	0.7	7.0	1.2	5.4	0.7	9.8	6.2	1.6	8.7	1.1	6.4	0.8	10.8	0.3	7.3	0.3
Bone (%)	11.7	1.0	10.9	1.0	11.5	1.0	11.9	11.6	2.3	13.7	1.2	11.6	1.4	11.5	0.7	11.1	11.7	0.4	12.3	0.8	10.6	1.0	11.3	0.6	10.7	0.1
Residual mass (kg)	8.4	1.2	5.5	0.6	8.2	0.6	6.2	7.5	0.8	5.1	0.1	7.7	1.0	5.0	0.5	11.0	5.3	1.1	8.5	1.3	6.2	0.8	11.4	1.6	7.4	0.1
Residual (%)	12.4	0.9	10.3	0.7	12.9	1.6	10.6	12.4	1.2	11.4	0.2	12.8	1.5	10.8	1.0	12.5	10.1	0.2	11.9	0.8	10.3	1.1	11.8	1.0	10.8	0.7
Skin mass (kg)	3.8	0.3	3.2	0.2	3.9	0.2	3.6	3.6	0.2	3.0	0.1	3.7	0.5	3.0	0.4	4.4	3.2	0.4	3.9	0.3	3.5	0.1	4.4	0.1	3.6	0.1
Skin (%)	5.7	0.6	6.2	0.6	6.0	0.7	6.1	5.9	0.2	6.7	0.1	6.1	0.5	6.5	0.4	5.0	6.2	0.7	5.5	0.1	5.7	0.2	4.6	0.2	5.3	0.3

Table II. (Continued)

Variables	Sprint				Middle-distance			Long-distance				Endurance				Combined events			Jumps				Throws			
	Male (*n* = 24)		Female (*n* = 8)		Male (*n* = 5)		Female (*n* = 1)	Male (*n* = 7)		Female (*n* = 4)		Male (*n* = 3)		Female (*n* = 2)		Male (*n* = 1)	Female (*n* = 2)		Male (*n* = 5)		Female (*n* = 6)		Male (*n* = 4)		Female (*n* = 2)	
	Mean	SD	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Somatotype																										
Endomorphy	1.7	0.4	2.8	0.8	1.4	0.3	2.1	1.9	1.3	1.9	0.1	1.4	0.3	2.6	0.4	1.2	2.1	0.4	1.9	0.4	2.9	0.6	3.3	1.4	3.6	0.1
Mesomorphy	4.5	1.0	3.5	1.2	3.9	0.4	2.7	4.0	0.3	2.5	0.4	4.2	1.3	2.7	0.5	6.3	2.5	0.6	4.5	1.0	3.6	0.9	6.9	0.8	5.3	0.1
Ectomorphy	3.1	0.9	3.0	1.1	3.1	1.3	3.7	3.8	0.9	4.5	0.2	3.3	1.1	3.1	0.8	2.4	4.4	0.9	3.2	0.8	2.7	0.9	0.9	0.7	1.4	0.7
X	1.3	1.0	0.2	1.8	1.7	1.4	1.5	2.0	2.2	2.6	0.1	1.8	1.2	0.5	1.0	1.2	2.3	1.3	1.3	0.9	-0.2	0.8	-2.3	2.1	-2.2	0.6
Y	4.2	2.8	1.1	3.3	3.4	0.7	-0.3	2.3	0.1	-1.4	1.1	3.6	3.5	-0.2	1.5	8.8	-1.4	1.7	3.8	2.9	1.5	2.9	9.5	1.0	5.4	2.5
SAD	1.1	0.8	1.5	1.0	1.1	0.1	N	1.6	0.6	1.6	0.7	1.5	0.5	1.6	0.1	N	0.9	0.1	1.1	0.7	1.0	0.9	1.4	0.6	0.8	0.1
SAM	1.3		1.4		0.9		N	1.7		1.3		1.5		1.3		N	0.9		1.2		1.1		1.4		0.8	

Table III. Corrected girths and anthropometric indices by group.

Variables	Sprint				Middle-distance			Long-distance				Endurance				Combined events			Jumps				Throws			
	Male		Female		Male		F	Male		Female		Male		Female		M	Female		Male		Female		Male		Female	
	(n=24)		(n=8)		(n=5)		(n=1)	(n=7)		(n=4)		(n=3)		(n=2)		(n=1)	(n=2)		(n=5)		(n=6)		(n=4)		(n=2)	
	Mean	SD	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Corrected girths (cm)																										
Arm	26.6	2.8	21.1	2.2	25.9	1.5	22.0	23.3	0.1	18.9	0.5	24.1	1.4	19.8	1.7	32.0	19.8	2.8	26.8	2.5	23.2	2.7	31.5	1.6	26.3	0.8
Chest	90.3	6.1	81.4	4.7	89.8	4.8	83.6	86.1	0.7	75.7	1.3	88.0	5.1	78.6	5.2	100.9	84.9	3.8	91.6	2.6	84.5	3.1	100.2	5.1	88.9	0.9
Thigh	52.8	3.4	49.3	2.7	50.5	2.9	49.6	49.5	0.5	45.1	1.3	49.0	2.8	47.0	2.8	58.1	49.1	3.7	52.1	2.7	51.6	0.7	65.1	1.0	55.5	3.0
Calf	34.0	2.2	32.4	2.4	33.6	2.5	33.0	34.6	1.1	30.9	0.5	35.2	5.9	30.3	2.3	38.9	30.6	2.8	33.9	1.3	31.7	2.6	38.8	2.5	32.7	1.5
Indexes																										
BMI (kg/m²)	21.8	1.6	20.4	2.1	22.1	2.9	20.4	20.1	0.9	17.6	0.1	21.2	3.2	19.5	1.6	24.7	18.3	2.3	21.7	1.2	21.6	1.6	28.5	2.8	24.5	1.6
WHI	0.4	0.1	0.4	0.1	0.4	0.1	0.4	0.4	0.1	0.3	0.1	0.4	0.1	0.4	0.1	0.4	0.3	0.1	0.4	0.1	0.4	0.1	0.4	0.1	0.4	0.1
HBBI	4.3	0.3	4.5	0.1	4.4	0.1	4.6	4.9	0.6	4.1	0.5	4.4	0.2	4.4	0.1	4.3	4.4	0.1	4.3	0.1	4.5	0.2	4.0	0.1	4.4	0.1
HBiiL	6.6	0.4	6.6	0.4	6.8	0.3	6.5	6.3	0.1	6.8	0.6	6.9	0.5	6.3	0.1	6.7	6.6	0.6	6.5	0.2	6.3	0.3	6.2	0.5	6.0	0.3
BBI	1.5	0.1	1.5	0.1	1.5	0.1	1.4	1.3	0.2	1.7	0.3	1.6	0.1	1.4	0.1	1.5	1.5	0.1	1.5	0.1	1.4	0.1	1.5	0.2	1.4	0.1
MBR	4.3	0.5	4.2	0.6	4.3	0.6	3.7	4.3	0.9	3.0	0.4	4.3	0.7	3.9	0.4	4.9	4.0	0.1	3.9	0.4	4.3	0.5	4.6	0.2	4.4	0.1
AMR	0.4	0.1	0.6	0.1	0.4	0.1	0.6	0.4	0.1	0.6	0.1	0.4	0.1	0.5	0.1	0.3	0.5	0.1	0.4	0.1	0.6	0.1	0.3	0.1	0.5	0.1
Crural index	0.9	0.1	0.9	0.1	1.0	0.2	0.8	0.8	0.1	1.0	0.1	0.9	0.1	0.9	0.1	0.8	1.0	0.1	0.9	0.1	0.9	0.1	0.8	0.1	1.0	0.1
Cormic index	51.9	1.0	53.4	1.2	48.9	5.2	53.8	51.7	1.7	53.2	1.3	52.2	1.3	53.8	0.9	51.4	51.2	2.2	54.3	3.7	52.1	2.0	52.2	2.4	55.0	0.3
RASI	101.8	2.7	100.5	3.2	102.5	2.4	101.5	102.3	1.1	101.9	0.1	100.2	2.1	100.8	0.9	102.7	100.9	2.0	103.4	1.5	100.7	3.0	103.5	1.1	97.3	2.3
Thoracic index	63.7	5.2	64.7	5.8	73.9	14.2	62.0	66.9	2.3	71.4	3.9	65.8	5.5	61.2	5.6	61.0	60.6	0.1	59.4	6.5	66.0	7.4	60.9	2.0	61.6	0.4
Brachial index	77.8	5.8	78.1	3.6	75.3	3.0	76.4	75.8	1.5	79.1	3.3	78.0	3.1	75.2	0.6	76.0	76.3	2.4	76.2	2.4	76.7	2.8	76.1	0.3	74.2	0.9
Other																										
∑6SKF (mm)†	39.6	6.3	58.4	15.0	34.5	5.0	53.0	33.6	24.1	42.0	4.2	33.9	5.5	53.1	7.4	32.0	47.1	12.9	44.6	7.2	68.0	9.9	66.7	27.5	76.3	12.0
∑8SKF (mm)‡	50.9	8.0	75.1	18.5	43.5	6.1	65.0	45.5	25.0	53.0	5.6	44.4	6.8	69.7	11.0	41.0	61.3	16.4	57.3	10.5	89.1	14.9	90.3	37.9	109.8	13.9

BMI, Body mass index; WHR, Waist-to-height index; HBBI, Height-to-biacromial breadth index; HBiI, Height-to-biiliocristal breadth index; BBI, Biacromial-biiliocristal breadth index; MBR, Muscle-bone ratio; AMR, Adipose-muscular ratio; RASI Relative arm span index; ∑6SKF, Sum of 6 skinfolds; ∑8SKF, Sum of 8 skinfolds.
† Sum of triceps, subscapular, supraspinal, abdominal, front thigh, and medial calf skinfold thicknesses. ‡ Sum of triceps, subscapular, biceps, iliac crest, supraspinal, abdominal, front thigh, and medial calf skinfold thicknesses.

Figure 1 displays somatocharts for average somatotypes. Somatochart 1a indicates that male throwers have a predominantly endomorphic mesomorph somatotype (3.3-6.9-0.9) and are more dispersed compared to other groups. The combined events athletes are similar but have an ectomorphic mesomorph somatotype (1.2-6.3-2.4). In contrast, most other groups show an ectomorphic mesomorph somatotype. For female athletes (Fig. 1b), throwers have an endomorphic mesomorph somatotype (3.6-5.3-1.4) with similar dispersion. The predominant somatotypes for other groups were balanced mesomorph (jumps, long distance), mesomorphic ectomorph (middle distance), and balanced ectomorph (endurance, combined events).

Figures 2 (male athletes) and 3 (female athletes) illustrate humanoid models of proportionality using the Phantom strategy (Z-scores), highlighting measures with Z-scores ≤ -2.5 or ≥ 2.5 (yellow and green, respectively). Among males, middle-distance athletes had the highest Z-score in trochanterion-tibiale laterale length (+3.4). Combined events and throwers showed higher Z-scores for stature, midstylion-dactylion length, and various breadths (humerus, femur, bi-styloid, and biacromial), with throwers having the highest Z-score for biacromial breadth (+3.8). Bimalleolar breadth was greater in combined events, throwers, and jumpers. Throwers had larger midstylion-dactylion lengths (+3.0), as did combined events athletes (+3.4). In females (Fig. 3), throwers had a notably larger midstylion-dactylion length (+5.1). Long-distance athletes had narrower humerus (-2.7) and femur (-3.1) breadths, while endurance athletes had proportionally narrower femur and biiliocristal breadths (-2.5 and -2.7, respectively).

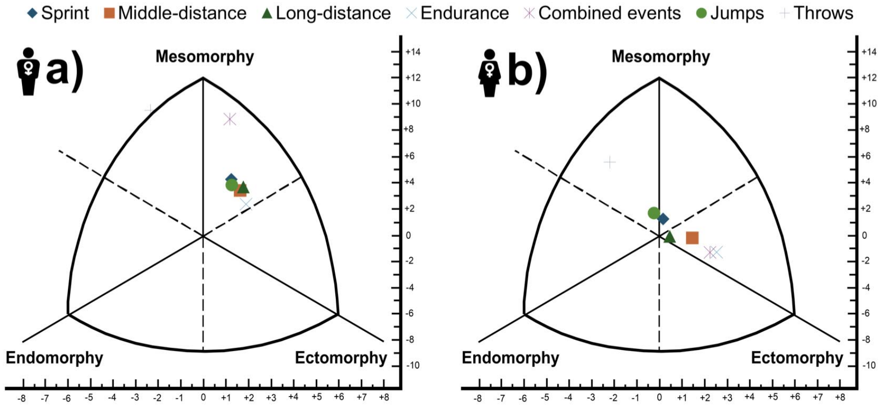

Fig. 1. Somatochart showing the mean somatoplots of elite Mexican athletes in track and field, encompassing both male (a) and female (b) participants by group.

DISCUSSION

The main finding of this study revealed significant morphological differences among elite Mexican track and field athletes. Sprinters and jumpers were predominantly mesomorph-ectomorphic, while long-distance runners were mesomorph-ectomorphs. Throwers exhibited the largest dimensions, higher body mass, and greater adiposity. The reliability of the five-way fractionation method for body mass underscores the need for specialized training to enhance

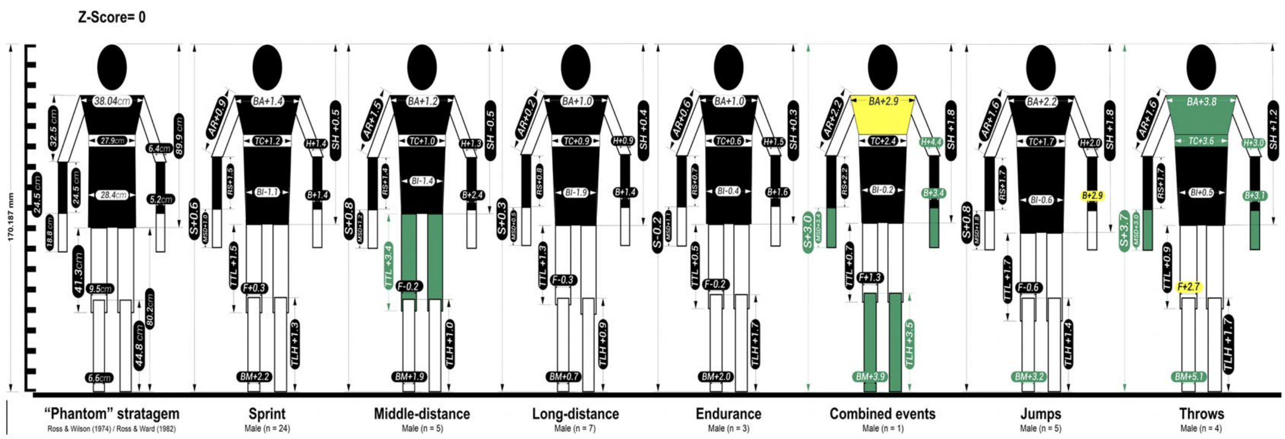

Fig. 2. Unidimensional humanoid models of proportionality of male athletes categorized by group. Values obtained from the means of the Z-Scores derived from basic measurements, lengths, and breadths based on the 'Phamtom' stratagem. S: Stature; SH: Sitting height; TTL: Trochanterion-tibiale laterale length; TLH: Tibiale laterale height; AR: Acromiale-radiale length; RS: Radiale-stylion length; MSD: Midstylion-dactylion length; BA: Biacromial breadth; BI: Biiliocristal breadth; TC: Transverse chest breadth; H: Humerus breadth; B: Bi-styloid breadth; F: Femur breadth; BM: Bimalleolar breadth. n The green color accentuates anthropometric variables with a Z-Score ≤ -3.0 or ≥ 3.0. n The yellow color accentuates anthropometric variables with a Z-Score ≤ -2.5 or ≥ 2.5.

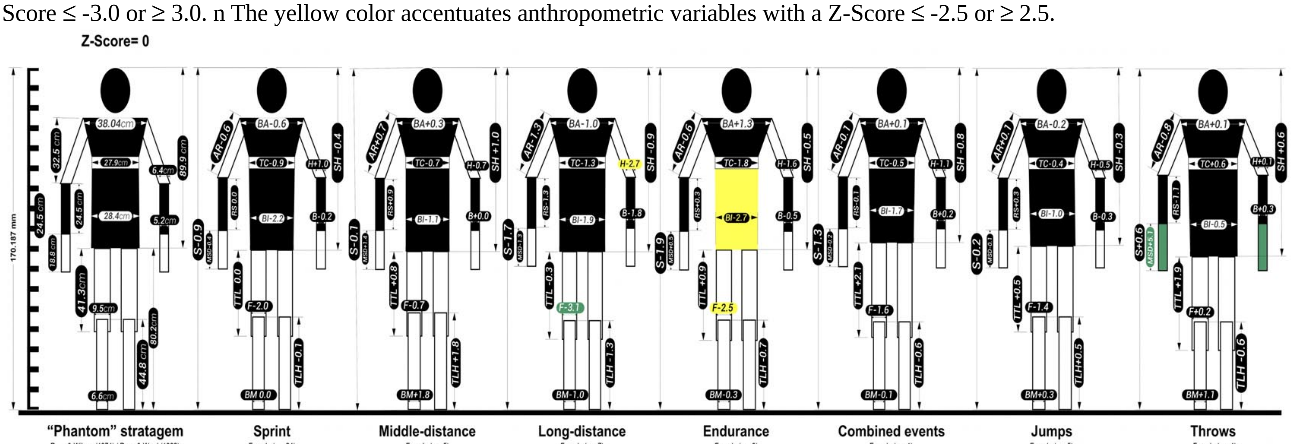

Fig. 3. Unidimensional humanoid models of proportionality of female athletes categorized by group. Values obtained from the means of the Z-Scores derived from basic measurements, lengths, and breadths based on the 'Phamtom' stratagem S: Stature; SH: Sitting height; TTL: Trochanterion-tibiale laterale length; TLH: Tibiale laterale height; AR: Acromiale-radiale length; RS: Radiale-stylion length; MSD: Midstylion-dactylion length; BA: Biacromial breadth; BI: Biiliocristal breadth; TC: Transverse chest breadth; H: Humerus breadth; B: Bi-styloid breadth; F: Femur breadth; BM: Bimalleolar breadth. n The green color accentuates anthropometric variables with a Z-Score ≤ -3.0 or ≥ 3.0. n The yellow color accentuates anthropometric variables with a Z-Score ≤ -2.5 or ≥ 2.5.

performance. These findings offer valuable insights for high performance Mexican athletes.

Anthropometric research in athletics has typically favored athletes from North America and Europe, leading to a gap in understanding the characteristics of athletes from Africa, Latin America, and other regions. This lack of diversity affects the generalization of findings and limits our understanding of the anthropometric traits of populations that have significantly contributed to global athletics (Tanner, 1964; Carter, 1982). For instance, while Jamaican athletes excel in short-distance races, Africans and Mexicans dominate long-distance disciplines and Cubans in events requiring explosive strength (Witard *et al*., 2019).

Our comprehensive anthropometric characterization of elite Mexican track and field athletes highlights the disparities across various groups (sprint, middle and long distance, endurance, combined events, jumps, and throws). This study, which adheres to the ISAK protocol for anthropometric assessment, provides a complete profile of body composition, somatotype, and proportionality. These findings serve as normative data for monitoring sports training, nutritional interventions, and athlete selection (Tanner, 1964; Carter, 1982; Tanner, 1983; Tanner *et al*., 1994, 1997; Witard *et al*., 2019; Fasbender *et al*., 2021; Herrera-Amante *et al*., 2021; Zaras *et al*., 2021; García-Dávila *et al*., 2023; Stone *et al*., 2024).

Notably, our study identified a continuum of anthropometric variability, especially among throwers who showed larger absolute size, higher muscle-bone ratios, and greater adiposity and muscle mass. They also had proportionally larger arm girths and hand lengths. Such traits, not previously highlighted due to the lack of a comprehensive anthropometric profile, could enhance implement release velocity (Fasbender *et al*., 2021).

The role of anthropometry in sports performance is well documented, not only for throwing events but also for long-distance running (Alvero-Cruz *et al*., 2020; Stachon´ *et al*., 2023). Although sprinters' anthropometric characteristics have been less studied, specialists agree on the importance of body configuration and anthropometry in athletic performance (Bezodis *et al*., 2019).

We observed trends in three anthropometric proportionality indices. The thoracic index was higher in middle-distance, long-distance, and endurance athletes, suggesting a benefit from increased cardiorespiratory capacity (Romero Collazos & Marrodán Serrano, 1999). The Height-to-biacromial breadth index (HBBI) was higher in male long-distance runners compared to throwers, and similarly in female long-distance athletes compared to jumpers and sprinters. This suggests that long-distance athletes have narrower shoulders relative to height, while athletes in short duration events have wider shoulders (Stachon´ *et al*., 2023).

The Height-to-biiliocristal breadth index (HBiiL) was higher in endurance athletes compared to throwers, indicating that a narrower hip structure relative to height might enhance movement economy (Stachon´ *et al*., 2023).

Comparing our results with those from other studies, throwers in this study had lower stature and body mass than those from the Beijing 2008 Olympic Games (Pavlovic *et al*., 2013a,b). Similarly, long jump, triple jump, and high jump competitors from the same Olympics were taller than our sample (Pavlovic, 2012). These discrepancies may arise from differences in methods used to assess body composition, as past studies often employed alternative technique (Tanner, 1964; Carter, 1982; Alvero-Cruz *et al*., 2020; Fasbender *et al*., 2021; Stachon *et al*., 2023). Despite this, Fleck's findings align qualitatively with ours, noting that Olympic athletes in explosive or endurance events generally exhibit lower fat percentages and higher fat free mass (Fleck, 1983).

Our study also found differences in skinfold measurements compared to Cuban and Spanish throwers, with Mexican athletes showing lower skinfold sums (Pons *et al*., 2015; Carvajal *et al*., 2018). The reference values obtained using Ross and Kerr's five-way fractionation method are notable for their reliability and relevance, as this method has recently been applied to various sports disciplines (Carvajal *et al*., 2009; Holway & Garavaglia, 2009; Carvajal *et al*., 2012; Bernal-Orozco *et al*., 2020; Dumont Ferro, 2023; Shahidi *et al*., 2023; Holway *et al*., 2024; Muñoz *et al*., 2024).

Ethnicity likely influences somatotypic characteristics, proportionality, and body composition (Tanner, 1964). Our study suggests that Mexican athletes differ from their international counterparts, reflecting regional genetic and climatic factors (Grasgruber *et al*., 2022). Previous research on Mexican athletes, such as race walkers, supports some of our findings but differs in muscle mass estimates (Rivera Sosa *et al*., 2017).

Limitations. This study's sample distribution was imbalanced, with overrepresentation in certain categories (e.g., sprint) compared to others (e.g., combined events). This imbalance limits in depth comparative analyses and may introduce biases in the results.

Interpretation. Results should be interpreted cautiously due to methodological challenges and sample limitations. Despite these, the study provides valuable data on Mexican track and field athletes' anthropometric profiles, offering a reference for future research and training programs.

Generalization. The study's findings are specific to the sample and may not apply to broader or different athlete populations. Caution is advised when generalizing these results to other groups or competitive levels.

Additional Interpretation. Future research should address sample imbalances to build a more comprehensive understanding of athletic success factors. This anthropometric data could help identify key physical attributes related to performance in track and field, particularly in underrepresented populations like Latin American athletes.

CONCLUSION

This study highlights the anthropometric diversity of track and field athletes, providing a framework for exercise science and sports professionals to apply this knowledge in a practical setting. The data reveals significant variations in body composition between the different groups of athletes, underscoring the need for individualized approaches in training and nutrition.

Understanding the specific anthropometric trends of each discipline is a valuable tool for professionals in the physical and technical fields to identify and select sports talent and optimize training plans. For throwers, characteristics such as greater muscle mass, robust bone structure, and larger lengths, such as the midstylion-dactylion length, can influence the technique and power of the throws. Likewise, endurance runners could benefit from having smaller breadths (e.g., a smaller biiliocristal breadth), which could have positive implications for the running economy.

To optimize the body composition of track and field athletes, sports nutritionists can use these anthropometric characteristics to develop personalized diet plans and establish nutritional goals based on muscle, bone, and adipose mass proportions.

This study highlights the need for further research with more balanced samples to validate and expand these findings. The cautious application of these resultscould influence the optimization of strategies for training, performance, and selection of Mexican and Latin American track and field athletes, helping bridge the gap between research and practical application.

Future research should include longitudinal assessments of athletes' anthropometric characteristics and body composition, along with their physiological and functional characteristics, to improve the understanding of the relationship between human structure and sports performance.

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Características antropométricas de atletas mexicanos de atletismo de élite y Olímpicos: Un estudio retrospectivo. *Int. J. Morphol., 44(1)*:79-91, 2026.

RESUMEN: La especialización deportiva requiere comprender la variabilidad morfológica para optimizar el rendimiento; sin embargo, los análisis detallados de los perfiles antropométricos de los atletas de pista y campo, especialmente en América Latina, son escasos. Este estudio aborda este vacío examinando las características antropométricas de atletas mexicanos de atletismo de élite y olímpicos. Se evaluaron 74 atletas (49 hombres, 25 mujeres), de 22,4 (±4,41) años de edad, que representaron a México en el XXIV Campeonato Centroamericano y del Caribe de Atletismo. Utilizando el protocolo ISAK, se evaluaron 43 variables antropométricas para describir su morfología física, incluyendo el somatotipo de Heath-Carter, la composición corporal, el índice músculo-óseo, el índice músculo-adiposo, la suma de los grosores de los pliegues cutáneos y la proporcionalidad. Se analizó la correspondencia entre estas variables en los distintos grupos: velocidad (n=32), medio fondo (n=6), fondo (n=11), resistencia (n=5), pruebas combinadas (n=3), saltos (n=11) y lanzamientos (n=6). Los resultados revelaron que los velocistas y los corredores de medio fondo eran predominantemente mesomorfos ectomorfos, mientras que los corredores de fondo eran ectomorfos mesomorfos. Los velocistas presentaban mayor masa adiposa que los corredores de resistencia. Los lanzadores presentaban mayores dimensiones y mayor masa corporal, muscular y ósea. Además, los atletas de fondo tenían valores de índice torácico más altos que los velocistas y los saltadores, lo que indica una posible asociación entre el índice torácico y la especialización atlética. Este estudio resalta la diversidad antropométrica entre los atletas mexicanos de pista y campo, proporcionando ideas para la identificación de talentos y el desarrollo de programas de entrenamiento y nutrición específicos para cada disciplina.

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

REFERENCES

Alvero-Cruz, J. R.; Carnero, E. A.; García, M. A. G.; Alacid, F.; Correas-Gómez, L.; Rosemann, T.; Nikolaidis, P. T. & Knechtle, B. Predictive performance models in long-distance runners: A narrative review. *Int. J. Environ. Res. Public Health, 17(21)*:8289, 2020.

Batra, A.; Wetmore, A. B.; Hornsby, W. G.; Lipinska, P.; Staniak, Z.; Surala, O. & Stone, M. H. Strength, endocrine and body composition alterations across four blocks of training in an elite 400-m sprinter. *J. Funct. Morphol. Kinesiol., 6(1)*:25, 2021.

Bernal-Orozco, M. F.; Posada-Falomir, M.; Quiñónez-Gastélum, C. M.; Plascencia-Aguilera, L. P.; Arana-Nuño, J. R.; Badillo-Camacho, N.; Márquez-Sandoval, F.; Holway, F. E. & Vizmanos-Lamotte, B. Anthropometric and body composition profile of young professional soccer players. *J. Strength Cond. Res., 34(7)*:1911-23, 2020.

Bezodis, N. E.; Willwacher, S. & Salo, A. I. T. The biomechanics of the track and field sprint start: A narrative review. *Sports Med., 49(9)*:1345-64, 2019.

Bonato, M.; Bizzozero, S. & Filipas, L. The influence of anthropometric parameters in track and field curve sprint. *J. Sports Med. Phys. Fitness, 63(12)*:1254-61, 2023.

Bonilla, D. A.; De León, L. G.; Alexander-Cortez, P.; Odriozola-Martínez, A.; Herrera-Amante, C. A.; Vargas-Molina, S. & Petro, J. L. Simple anthropometry-based calculations to monitor body composition in athletes: Scoping review and reference values. *Nutr. Health, 28(1)*:95-109, 2022.

Borms, J. & Hebbelinck, M. *Review of Studies on Olympic Athletes. In: Carter, J. (Ed.). Physical Structure of Olympic Athletes. Part II: Kinanthropometry of Olympic Athletes*. Vol. 18. Basel, Karger Publishers, 1984. pp.7-27.

Carter, J. *Physical structure of Olympic athletes. Part I: The Montreal Olympic Games Anthropological Project*. Vol. 16. Basel, Karger AG, 1982.

Carter, J. *The Heath–Carter anthropometric somatotype instruction manual*. San Diego, Department of Exercise and Nutritional Sciences, San Diego State University, 2002.

Carvajal, W.; Betancourt, H.; León, S.; Deturnel, Y.; Martínez, M.; Echevarría, I.; Castillo, M. E. & Serviat, N. Kinanthropometric profile of Cuban women Olympic volleyball champions. *MEDICC Rev., 14(2)*:16-22, 2012.

Carvajal, W.; León, S.; González, M. E.; Deturnel, Y. & Echavarría, I. Anthropometrical characteristics of the Cuban sporting population: Reference data from high-performance national teams, 1992–2014. *Apunts Med. Esport, 53(200)*:129-37, 2018.

Carvajal, W.; Ríos, A.; Echevarría, I.; Martínez, M.; Miñoso, J. & Rodríguez, D. Body type and performance of elite Cuban baseball players. M*EDICC Rev., 11(2)*:15-20, 2009.

Dengel, D. R.; Keller, K. A.; Stanforth, P. R.; Oliver, J. M.; Carbuhn, A. & Bosch, T. A. Body composition and bone mineral density of Division I collegiate track and field athletes: A C-CAR study. *J. Clin. Densitom., 23(2)*:303-13, 2020.

Dumont Ferro, M. Perfil antropométrico y rendimiento deportivo de nadadores de pileta durante el Campeonato Argentino de Natación, 2015. *Int. J. Kinanthropometry, 3(2)*:133-49, 2023.

von Elm, E.; Altman, D. G.; Egger, M.; Pocock, S. J.; Gøtzsche, P. C. & Vandenbroucke, J. P. Strengthening the reporting of observational studies in epidemiology (STROBE) statement: Guidelines for reporting observational studies. *BMJ, 335(7624)*:806-8, 2007.

Fasbender, P.; Korff, T. J.; Baltzopoulos, V. B. & Linthorne, N. P. Optimal mass of the arm segments in throwing: A two-dimensional computer simulation study. *Eur. J. Sport Sci., 21(1)*:45-52, 2021.

Fleck, S. J. Body composition of elite American athletes. *Am. J. Sports Med., 11(6)*:398-403, 1983.

García-Dávila, M. Z.; Ramírez-Siqueiros, M. G.; Bauer, P.; Makivic, B.; Hernández-Cruz, G.; Rangel-Colmenero, B. R.; Valencia-Falcón, T.; Yáñez-Sepúlveda, R. & Martínez-Rodríguez, A. Analysis of dietary intake and body composition of collegiate runners. *Int. J. Morphol., 41(3)*:845-50, 2023.

Grasgruber, P.; Cacek, Z.; Hlavonova, T.; Kralova, L.; Svobodova, S.; Hrebickova, J. & Ondracek, J. The physique of Olympic athletes as a reflection of human physical variation: Implications for adaptive evolution and mapping global sports potential. *Res. Sq*., 2022.

Herrera-Amante, C. A.; Ramos-García, C. O.; Alacid, F.; Quiroga-Morales, L. A.; Martínez-Rubio, A. J. & Bonilla, D. A. Development of alternatives to estimate resting metabolic rate from anthropometric variables in Paralympic swimmers. *J. Sports Sci., 39(18)*:2133-43, 2021.

Holway, F.; Campa, F.; Petri, C.; Pincella, M.; Gallo, P. O.; Forchino, F. & Kirkendall, D. Kinanthropometry and anatomical body composition of elite soccer players in Argentina: The FUTREF project. *Int. J. Kinanthropometry, 4(1)*:62-71, 2024.

Holway, F. E. & Garavaglia, R. Kinanthropometry of Group I rugby players in Buenos Aires, Argentina. *J. Sports Sci., 27(11)*:1211-20, 2009.

Mangine, G. T.; Eggerth, A.; Gough, J.; Stratton, M. T.; Feito, Y. & VanDusseldorp, T. A. Endocrine and body composition changes across a competitive season in collegiate speed-power track and field athletes. *J. Strength Cond. Res., 35(8)*:2067-74, 2021.

Muñoz, O. M.; Franco, K. & Martínez, D. Caracterización antropométrica en deportistas de artes marciales mixtas por métodos de fraccionamiento de masa corporal en dos y cinco componentes y el somatotipo. *Int. J. Kinanthropometry, 4(1)*:32-43, 2024.

Norton, K. & Olds, T. Morphological evolution of athletes over the 20th century: Causes and consequences. *Sports Med., 31(11)*:763-83, 2001.

Olds, T. *Body Composition and Sports Performance*. In: Olympic Textbook of Science in Sport. Vol. XV. Chichester, John Wiley & Sons, 2009. pp.131-49.

Pavlovic, R. The morphological status of the finalists in jumping disciplines at the Beijing Olympics. *Sport Sci., 5(2)*:43-8, 2012.

Pavlovic, R.; Mihajlovic, I.; Idrizovic, K.; Pupis, M.; Rakovic, A. & Bosnjak, G. Differences in morphological space of thrower finalists of the Beijing Olympics. *Acta Kinesiologica, 2*:52-7, 2013a.

Pavlovic, R.; Rakovic, A.; Radic, Z.; Simeonov, A. & Pirsl, D. Morphological status of female athletes in throwing disciplines at the Beijing Olympic Games. *Res. Phys. Educ. Sport Health, 2(2)*:113-9, 2013b.

Pederson, D. & Gore, C. *Anthropometry Measurement Error*. In: Norton, K. & Olds, T. (Eds.). Anthropometrica. Sydney, UNSW Press, 1996. pp.77-96.

Pons, V.; Riera, J.; Galilea, P. A.; Drobnic, F.; Banquells, M. & Ruiz, O. Características antropométricas, composición corporal y somatotipo por deportes: Datos de referencia del CAR de Sant Cugat, 1989–2013. *Apunts Med. Esport, 50(186)*:65-72, 2015.

Pulleiro Méndez, C. & Morales Ruvalcaba, D. Latin American structure and Pan-American Games: Analysing the medal table from international relations. *Third World Q., 44(9)*:2115-35, 2023.

Rivera Sosa, J. M.; Muñoz-Daw, M. J.; Cervantes Borunda, M. S.; Romero Martínez, C. P.; De la Torre, M. L. & Álvarez Mendoza, G. Evaluación cineantropométrica en deportistas de marcha atlética varonil: Mexicanos vs. internacionales. *Rev. Mex. Invest. Cult. Fís. Deporte, 6(8)*:145-61, 2017.

Romero Collazos, J. F. & Marrodán Serrano, M. D. Proporcionalidad torácica y capacidad vital en ciclistas españoles de alta competición. *Estud. Antropol. Biol., 9*:505-19, 1999.

Ross, W. & Kerr, D. Fractionation of body mass: A new method for use in clinical nutrition and sports medicine. *Apunts Med. Esport, 28*:175-87, 1991.

Ross, W. & Wilson, N. A stratagem for proportional growth assessment. *Acta Paediatr. Belg., 28*:169-82, 1974.

Sedeaud, A.; Marc, A.; Marck, A.; Dor, F.; Schipman, J.; Dorsey, M.; Haida, A.; Berthelot, G. & Toussaint, J.-F. BMI, a performance parameter for speed improvement. *PLoS One, 9(2)*:e90183, 2014.

Shahidi, S. H.; Al-Gburi, A. H.; Karakas, S. & Tas¸kıran, M. Y. Anthropometric and physical performance characteristics of swimmers. *Int. J. Kinanthropometry, 3(1)*:1-9, 2023.

Stachon, A.; Pietraszewska, J. & Burdukiewicz, A. Anthropometric profiles and body composition of male runners at different distances. *Sci. Rep., 13(1)*:18222, 2023.

Stewart, A.; Marfell-Jones, M.; Olds, T. & De Ridder, H. *International standards for anthropometric assessment.* Lower Hutt, International Society for the Advancement of Kinanthropometry (ISAK), 2011.

Stone, W. J.; Garver, M. J.; Wakeman, A.; Tolusso, D.; Nelson, H.; Hair, J. & Nehlsen, E. More than body composition: A Darwinian theory of somatotype applied to a Division II track and field outdoor season. *Int. J. Exerc. Sci., 17(4)*:1-12, 2024.

Tanner, J. M. *The physique of Olympic athletes.* London, George Allen & Unwin Ltd., 1964.

Tanner, J. M. *Assessment of Skeletal Maturity and Prediction of Adult Height (TW2 Method). Prediction of Adult Height*. London, Academic Press, 1983. pp.22-37.

Tanner, J.; Oshman, D.; Bahhage, F. & Healy, M. Tanner–Whitehouse bone age reference values for North American children. *J. Pediatr., 131(1)*:34-40, 1997.

Tanner, J. M.; Oshman, D.; Lindgren, G.; Grunbaum, J. A.; Elsouki, R. & Labarthe, D. Reliability and validity of computer-assisted estimates of Tanner–Whitehouse skeletal maturity (CASAS): Comparison with the manual method. *Horm. Res., 42(6)*:288-94, 1994.

Tsukahara, Y.; Torii, S.; Yamasawa, F.; Iwamoto, J.; Otsuka, T.; Goto, H.; Kusakabe, T.; Matsumoto, H. & Akama, T. Changes in body composition and its relationship to performance in elite female track and field athletes transitioning to the senior division. *Sports, 8(9)*:115, 2020.

Vandenbroucke, J. P.; von Elm, E.; Altman, D. G.; Gøtzsche, P. C.; Mulrow, C. D.; Pocock, S. J.; Poole, C.; Schlesselman, J. J. & Egger, M. Strengthening the reporting of observational studies in epidemiology (STROBE): Explanation and elaboration. *Int. J. Surg., 12(12)*:1500-24, 2014.

Witard, O. C.; Garthe, I. & Phillips, S. M. Dietary protein for training adaptation and body composition manipulation in track and field athletes. *Int. J. Sport Nutr. Exerc. Metab., 29(2)*:165-74, 2019.

World Medical Association. World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. *JAMA, 310(20)*:2191-4, 2013.

Zaras, N.; Stasinaki, A. N. & Terzis, G. Biological determinants of track and field throwing performance. *J. Funct. Morphol. Kinesiol., 6(2)*:40, 2021.

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