The Journal of Anatomical Sciences
Email: journalofanatomicalsciences@gmail.com

J. Anat Sci 15(2)

Submitted October 2nd, 2023
Accepted August 14th, 2024
Published September 30th, 2024

Sexual Dimorphism in Anthropometric Characteristics of Children from Cross River State, Nigeria

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ABSTRACT

Human sexual dimorphism is an outcome of a survival strategy, a balancing of the need for high degree of biological variation within species with the need for a narrow range of variation in the female, who is physically structured for the perinatal support of infant. This study aimed to evaluate sexual dimorphism in anthropometrics of children from the three senatorial zones of Cross River State, Nigeria, viz: southern senatorial zone (SSZ), central senatorial zone (CSZ) and northern senatorial zone (NSZ). The study sample comprised 300 subjects (150 boys and 150 girls) of Cross River State parentage using systematic random sampling and self-administered proforma. The participants were children, age 5 – 11 years. The results showed that length of mandibular arch, hand length and thigh length of girls from SSZ are significantly higher (P <0.05) than that of boys. In contrast, neck length, foot length and ankle breadth of boys in CSZ are significantly higher (P <0.05) in boys compared to that of their female counterparts whereas, for participants from NSZ, bigonial width and neck length were significantly higher in boys than girls. Comparison of anthropometric dimensions based on senatorial zones and sex revealed that girls from SSZ consistently had significantly higher (P <0.05) anthropometric dimensions compared to their counterparts from the other two zones. In conclusion, the findings of this study demonstrate that moderate differences in altitude does not significantly affect average stature or range in variation.

Keywords: anthropometry, stature, Cross River State

INTRODUCTION

Reproduction across the mammalian order shows similarity with that in other mammals and results in inheritance of characteristics from parents through the shuffling of genetic materials. Within the mechanism through which this inheritance is acquired lies the source of diversity exhibited by organisms. It is essential to have parameters that allow the detection of sexual dimorphism. While humans in general are less sexually dimorphic than other primates, some differences do exist between males and females in almost every population [1,2]. In species where differences in dimorphism between the sexes is not immediately apparent, many studies determine sex based on morphometrics using discriminant function analyses [3-5]. However, the applicability of a discriminant function across a species is not always possible and can depend on the degree of variation in morphometrics between population [6]. Dimorphism is a widespread occurrence across animal taxa, and believed to have evolved in response to selection pressures favouring particular phenotypes. The degree of dimorphism can vary greatly, geographically within and between closely related species [7], such differences in the degree of dimorphism may be due to food availability or inter-population growth patterns [8]. Alternatively, sexual selection may be driving the greater divergence in dimorphism [9].

The human physical form is affected by environmental and genetic factors alike, but expressions of physical diversity such as body size and stature, are interpreted in biological anthropology as adaptations to climate and natural access to resources [10,11]. Humans exhibit biological diversity and since the birth of the discipline of biological anthropology, we have been interested in studying how humans vary biologically and what the sources of this variation are. There are certainly academic reasons for studying human diversity. First, is to consider the evolution of our species and how our biological variation may be similar to (or different from) that of other species of animals. Such investigation can give us clues as to how unique we are as a biological organism in relation to the rest of the animal kingdom. Second, anthropologists' study modern human diversity to understand how different biological traits developed over evolutionary time. If we are able to grasp the evolutionary processes that produce and affect diversity, we can make more accurate inferences about evolution and adaptation among our hominin ancestors, complementing our study of fossil evidence and the archaeological record. Third, it is important to consider that biological variation among humans has biomedical, forensic, and sociopolitical implications [12]. For these reasons, the study of human variation and evolution has formed the basis of anthropological inquiry for centuries and continues to be a major source of plot and inspiration for scientific research. The objective of this research was to determine sexual dimorphism in children from the Southern, Central and Northern senatorial zones of Cross River State.

MATERIALS AND METHODS

This research is a combination of three anthropometric data gathering exercises as mentioned earlier. The study and data gathering were carried out over a period of 36 months. All measurements were taken in the afternoon. A total of 300 convenience sample of participants were measured from the three different senatorial zones of Cross River State. The range included 100 subjects from each senatorial zone, 50 boys and 50 girls. Subjects were selected according to their availability and willingness to participate without payment or any other kind of reward, they were informed with the objectives of the study, anthropometric dimensions, clothing requirements, measurements procedures and freedom to withdraw. Subjects were barefooted, age of the subjects varied between 5 and 11 years old.

Traditional anthropometric tools were used including manual anthropometer, weighing scale, meter scales, pachymeter, measuring tape, calliper and small adjustable chair. They are simple, portable, inexpensive, accurate and reliable. All the equipment used were calibrated against standard protocol and instrument. In managing the data collection in the three senatorial zones, two female and two male research assistants received prior training to become familiar with the equipment, body landmarks and measurement techniques. In addition, some pilot tests were conducted. Inherently, the research assistants had an experience to be a subject of the same measurement in the previous anthropometric experiment. At the start of each data collection session, the subjects were informed of the purpose of the study, equipment, measurement procedure and possible application of the data to be collected. The male research assistants measured the boys, whereas the female research assistants measured the girls. All anthropometric measurements were taken following procedures described elsewhere [13-15].

Sexual size dimorphism (SSD) and size dimorphism index

Sexual size dimorphism is the morphological difference between males and females of the same species [16]. While, size dimorphism index (SDI) indicates percentage of difference between sexes. Following the methods of Lovich and Gibbons, a size dimorphism index (SDI) was calculated from the mean measurements of boys and girls, where the extent of dimorphism (percent difference) was calculated as [8]:

$$SDI = |-\left(\frac{Mean\ male}{Mean\ female}\right) + 1| \times 100$$

Alternatively, SDI formulation is based on the simple ratio of size of the larger sex divided by size of the smaller sex, with the result arbitrarily defined as positive when females are larger than males and negative in the converse situation [16]. One approach for the identification of the general phylogenetic patterns of SSD within a group of individuals is to establish which sex is larger among a large number of taxa [17]. The procedure of rating species on the basis of the direction of SSD has the advantage of permitting broad phylogenetic comparisons but the disadvantage of not permitting the ranking of species on the basis of degree of dimorphism. Also, it does not allow quantitative comparison of populations that can demonstrate levels of variability within a species. Hence, the use of a size dimorphism index (SDI) has been proposed by numerous authors to quantify the degree of SSD exhibited by a species or population. However, the variation in methods of calculating the SDI has been extensive, and the diversity of methods has, in some instances, hampered comparisons among phylogenetic groups. Methods for calculating an SDI are roughly divisible into two broad classes: those based on a ratio, and those based on a difference.

Statistical analysis

Descriptive statistics were presented as mean ± standard deviations and ranges. Sexual dimorphism across anthropometric dimensions were assessed with unpaired sample *t*-test for each senatorial zone. To test for significant difference in anthropometric variables for each sex across the three senatorial zones, analysis of variance (one-way) was conducted followed by John Tukey's Honest Significant Difference for multiple comparisons. Data management and analyses were conducted using Statistical Package for Statistical Product and Service Solutions (IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp). All tests were two-tailed with a *P-value* <0.05 set as the limit of statistical significance.

RESULTS

In the Southern Senatorial Zone, the mean height for boys to girls were 128.84 ± 10.93 cm and 131.98 ± 10.07 cm respectively (Table 1), indicating that the girls were insignificantly taller in stature when compared with the boys ($t = -1.49$, $P = 0.138$). The mean anthropometric parameters were insignificantly higher in girls when compared with the boys, $P < 0.05$, except for BMI, bigonial width (BGW) and neck length (NL) which were insignificantly higher in the boys when compared with the girls. More so, thigh length (ThL) was significantly higher in girls ($t = -3.87$, $P < 0.001$). However, there was no significant difference in foot breadth (FB) in both boys and girls ($t = 0.00$, $P = 1.000$).

Table 1: Descriptive statistics and sexual dimorphism in anthropometric parameters of children (5-11 years) in SSZ

Variable	Boys + Girls (n = 100) Mean ± SD	Min - Max	Boys (n = 50) Mean ± SD	Min - Max	Girls (n = 50) Mean ± SD	Min - Max	t	*P*	SDI
Age (years)	8.97 ± 1.62	5.00 – 11.00	8.84 ± 1.66	5.00 – 11.00	9.10 ± 1.58	5.00 – 11.00	-0.80	0.424	2.86
Height (cm)	130.41 ± 10.57	101.00 – 154.00	128.84 ± 10.93	101.00 – 152.00	131.98 ± 10.07	110.00 – 154.00	-1.49	0.138	2.38
Weight (kg)	27.41 ± 5.48	15.00 – 42.00	27.32 ± 5.45	19.00 – 40.00	27.50 ± 5.56	15.00 – 42.00	-0.16	0.870	0.65
BMI (kg/m^2)	16.02 ± 1.90	10.96 – 21.70	16.36 ± 1.82	11.25 – 21.70	15.69 ± 1.94	10.96 – 20.11	1.77	0.081	-4.27
SHt (cm)	65.05 ± 5.98	53.00 – 87.00	64.76 ± 6.06	53.00 – 87.00	65.34 ± 5.95	53.00 – 79.00	-0.48	0.630	0.89
BGW (cm)	9.99 ± 1.01	7.50 – 12.00	10.09 ± 0.10	7.50 – 12.00	9.89 ± 1.02	7.60 – 12.00	0.98	0.329	-2.02
LOMA (cm)	17.62 ± 1.52	14.00 – 22.00	17.20 ± 1.49	14.00 – 20.00	18.04 ± 1.46	15.00 – 22.00	-2.86	**<0.005**	4.66
NL (cm)	10.58 ± 1.42	8.00 – 16.00	10.70 ± 1.33	8.00 – 14.00	10.46 ± 1.50	8.00 – 16.00	0.85	0.399	-2.29
BALt (cm)	27.29 ± 2.70	21.00 – 34.00	27.22 ± 2.91	21.00 – 34.00	27.36 ± 2.50	22.00 – 32.00	-0.26	0.797	0.51
DSLt (cm)	68.41 ± 5.92	53.00 – 83.00	67.34 ± 5.94	53.00 – 83.00	69.48 ± 5.75	59.00 – 82.00	-1.83	0.070	3.08
HL (cm)	15.61 ± 1.36	13.00 – 19.00	15.34 ± 1.32	13.00 – 18.00	15.88 ± 1.36	13.00 – 19.00	-2.03	**0.046**	3.40
HB (cm)	8.65 ± 0.87	6.50 – 11.00	8.64 ± 0.92	7.00 – 11.00	8.65 ± 0.82	6.50 – 10.00	-0.06	0.954	0.12
WRB (cm)	7.11 ± 0.82	5.00 – 9.00	7.06 ± 0.87	5.00 – 9.00	7.16 ± 0.77	6.00 – 9.00	-0.61	0.542	1.40
ThL (cm)	41.91 ± 4.56	34.00 – 60.00	40.26 ± 3.84	34.00 – 50.00	43.56 ± 4.66	36.00 – 60.00	-3.87	**<0.001**	7.58
LL (cm)	32.92 ± 4.27	23.00 – 42.00	32.18 ± 4.33	23.00 – 40.00	33.66 ± 4.12	25.00 – 42.00	-1.75	0.083	4.40
FL (cm)	21.20 ± 2.09	17.00 – 27.00	20.87 ± 2.28	17.00 – 27.00	21.53 ± 1.84	18.00 – 27.00	-1.60	0.114	3.07
FB (cm)	11.64 ± 1.04	9.00 – 14.00	11.64 ± 1.06	9.00 – 14.00	11.64 ± 1.03	9.00 – 13.00	0.00	1.000	0.00
AKB (cm)	11.69 ± 1.06	9.00 – 13.00	11.70 ± 1.07	9.00 – 13.00	11.68 ± 1.06	9.00 – 13.00	0.09	0.925	-0.17

BMI = Body Mass Index; SHt = Sitting Height; BGW = Bigonial Width; LOMA = Length of Mandibular Arch; NL = Neck Length; BALt = Biaxillary Length; DSLt = Demispan Length; HL = Hand Length; HB = Hand Breadth; WRB = Wrist Breadth; ThL = Thigh Length; LL = Leg Length; FL = Foot Length; FB = Foot Breadth; AKB = Ankle Breadth; SDI = Sexual Dimorphism Index; SSZ = Southern Senatorial Zone

Statistical significance is expressed in bold fonts

In the Central Senatorial Zone, the mean height of boys to girls were 129.04 ± 10.36 cm and 129.74 ± 11.23 cm respectively (Table 2), indicating that the girls were slightly and insignificantly taller in stature when compared with the boys (t = -0.32, $P = 0.747$). The mean anthropometric parameters were insignificantly higher in boys when compared with the girls, $P < 0.05$, except for weight (WT), BMI, sitting height (SHt), bigonial width (BGW), biaxillary length (BALt), hand length (HL), thigh length (ThL) and leg length (LL) which were insignificantly higher in the girls when compared with the boys. More so, neck length (NL), foot breadth (FB) and ankle breadth (AKB) were significantly higher in boys (t = 2.41, $P = 0.018$; t = 3.67, $P <$ 0.001 and t = 2.35, $P = 0.021$) respectively.

Table 2: Descriptive statistics and sexual dimorphism in anthropometric parameters of children (5-11 years) in CSZ

	Boys + Girls (n = 100)		Boys (n = 50)		Girls (n = 50)				
Variable	Mean ± SD	Min - Max	Mean ± SD	Min - Max	Mean ± SD	Min - Max	t	*P*	SDI
Age (years)	8.56 ± 1.84	5.00 – 11.00	8.78 ± 1.88	5.00 – 11.00	8.34 ± 1.80	5.00 – 11.00	1.20	0.235	-5.28
Height (cm)	129.39 ± 10.75	101.00 – 160.00	129.04 ± 10.36	101.00 – 147.00	129.74 ± 11.23	107.00 – 160.00	-0.32	0.747	0.54
Weight (kg)	27.05 ± 5.92	16.00 – 49.00	26.76 ± 5.22	17.00 – 44.00	27.34 ± 6.59	16.00 – 49.00	-0.49	0.627	2.12
BMI (kg/m^2)	15.10 ± 1.78	10.06 – 20.64	15.94 ± 1.50	12.93 – 20.64	16.05 ± 2.04	10.06 – 20.16	-0.30	0.762	0.69
SHt (cm)	64.57 ± 5.13	50.50 – 73.00	64.42 ± 5.32	50.50 – 72.00	64.72 ± 4.99	50.60 – 73.00	-0.29	0.770	0.46
BGW (cm)	10.01 ± 1.04	8.00 – 12.50	10.00 ± 1.01	8.00 – 12.00	10.01 ± 1.08	8.00 – 12.50	-0.06	0.954	0.10
LOMA (cm)	16.72 ± 1.23	14.00 – 20.00	16.88 ± 1.02	15.00 – 20.00	16.56 ± 1.40	14.00 – 20.00	1.30	0.195	-1.93
NL (cm)	11.89 ± 1.66	9.00 – 18.00	12.28 ± 1.58	9.00 – 18.00	11.50 ± 1.66	9.00 – 16.00	2.41	**0.018**	-6.78
BALt (cm)	27.87 ± 2.83	20.00 – 36.00	27.42 ± 2.88	20.00 – 34.00	28.32 ± 2.74	23.00 – 36.00	-1.60	0.113	3.18
DSLt (cm)	68.11 ± 6.39	55.00 – 89.00	68.56 ± 6.76	55.00 – 89.00	67.65 ± 6.04	56.00 – 82.00	0.71	0.480	-1.35
HL (cm)	15.37 ± 1.35	13.00 – 19.20	15.34 ± 1.20	13.00 – 18.00	15.41 ± 1.50	13.00 – 19.20	-0.27	0.791	0.45
HB (cm)	8.98 ± 0.93	7.00 – 11.00	9.10 ± 0.88	7.00 – 11.00	8.85 ± 0.96	7.00 – 11.00	1.36	0.178	-2.82
WRB (cm)	7.06 ± 0.78	5.00 – 10.00	7.20 ± 0.76	6.00 – 10.00	6.92 ± 0.78	5.00 – 9.00	1.83	0.071	-4.05
ThL (cm)	39.78 ± 5.24	30.00 – 64.00	39.38 ± 5.38	30.00 – 64.00	40.18 ± 5.12	30.00 – 54.00	-0.76	0.448	1.99
LL (cm)	32.33 ± 3.96	24.00 – 44.00	32.28 ± 3.74	25.00 – 42.00	32.38 ± 4.20	24.00 – 44.00	-0.13	0.900	0.31
FL (cm)	21.32 ± 2.07	17.00 – 26.00	21.46 ± 2.11	17.00 – 26.00	21.18 ± 2.04	17.00 – 25.00	0.67	0.502	-1.32
FB (cm)	11.19 ± 1.01	9.00 – 13.00	11.54 ± 1.05	9.00 – 13.00	10.84 ± 0.84	9.00 – 12.00	3.67	**<0.001**	-6.46
AKB (cm)	11.31 ± 1.00	9.00 – 13.00	11.54 ± 1.05	9.00 – 13.00	11.08 ± 0.90	9.00 – 13.00	2.35	**0.021**	-4.15

BMI = Body Mass Index; SHt = Sitting Height; BGW = Bigonial Width; LOMA = Length of Mandibular Arch; NL = Neck Length; BALt = Biaxillary Length; DSLt = Demispan Length; HL = Hand Length; HB = Hand Breadth; WRB = Wrist Breadth; ThL = Thigh Length; LL = Leg Length; FL = Foot Length; FB = Foot Breadth; AKB = Ankle Breadth; SDI = Sexual Dimorphism Index; CSZ = Central Senatorial Zone

Statistical significance is expressed in bold fonts

In the Northern Senatorial Zone (NSZ), the mean height for boys to girls were 126.10 ± 12.12 cm and 124.24 ± 11.21 cm respectively (Table 3), indicating that the boys were insignificantly taller in stature when compared with the girls (t = 0.08, P = 0.427). The mean anthropometric variables were insignificantly higher in boys when compared with the girls, P < 0.05, except for length of mandibular arch (LOMA) and thigh length which were insignificantly higher in the girls. More so, bigonial width and neck length were significantly higher in the boys when compared with the girls (t = 2.66, P = 0.009 and t = 3.51, P <0.001) respectively.

Table 3: Descriptive statistics and sexual dimorphism in anthropometric parameters of children (5-11 years) in NSZ

Variable	Boys + Girls (n = 100) Mean ± SD	Min - Max	Boys (n = 50) Mean ± SD	Min - Max	Girls (n = 50) Mean ± SD	Min - Max	t	*P*	SDI
Age (years)	8.06 ± 2.02	5.00 – 11.00	8.36 ± 2.25	5.00 – 11.00	7.76 ± 1.74	5.00 – 11.00	1.49	0.139	-7.73
Height (cm)	125.17 ± 11.66	100.00 – 150.00	126.10 ± 12.12	101.00 – 148.00	124.24 ± 11.21	100.00 – 150.00	0.80	0.427	-1.50
Weight (kg)	26.06 ± 7.40	14.00 – 56.00	26.74 ± 7.16	16.00 – 46.00	25.38 ± 7.65	14.00 – 56.00	0.92	0.360	-5.36
BMI (kg/m^2)	16.34 ± 2.35	12.40 – 27.76	16.56 ± 2.38	13.29 – 27.76	16.11 ± 2.32	12.40 – 24.89	0.97	0.337	-2.79
SHt (cm)	62.15 ± 4.87	50.00 – 74.00	62.70 ± 5.04	50.00 – 74.00	61.60 ± 4.69	52.00 – 73.00	1.13	0.261	-1.79
BGW (cm)	9.90 ± 0.85	8.00 – 12.00	10.12 ± 0.77	8.00 – 12.00	9.68 ± 0.88	8.00 – 12.00	2.66	**0.009**	-4.55
LOMA (cm)	17.17 ± 1.51	13.00 – 22.00	17.16 ± 1.27	15.00 – 20.00	17.18 ± 1.72	13.00 – 22.00	-0.07	0.947	0.12
NL (cm)	10.70 ± 1.87	7.00 – 19.00	11.32 ± 1.60	8.00 – 16.00	10.08 ± 1.93	7.00 – 19.00	3.51	**<0.001**	-12.30
BALt (cm)	27.13 ± 3.02	20.00 – 39.00	27.22 ± 2.54	22.00 – 32.00	27.04 ± 3.46	20.00 – 39.00	0.30	0.767	-0.67
DSLt (cm)	66.47 ± 6.96	51.00 – 81.00	67.42 ± 6.92	55.00 – 81.00	65.52 ± 6.94	51.00 – 80.00	1.37	0.173	-2.90
HL (cm)	15.19 ± 1.68	11.50 – 19.00	15.35 ± 1.67	12.50 – 19.00	15.02 ± 1.69	11.50 – 18.50	1.01	0.316	-2.20
HB (cm)	8.91 ± 1.14	6.00 – 12.00	9.09 ± 1.09	7.00 – 12.00	8.72 ± 1.17	6.00 – 11.00	1.64	0.104	-4.24
WRB (cm)	7.33 ± 1.07	5.00 – 10.00	7.50 ± 1.02	6.00 – 10.00	7.16 ± 1.11	5.00 – 10.00	1.60	0.114	-4.75
ThL (cm)	39.92 ± 5.29	20.00 – 52.00	39.78 ± 5.08	31.00 – 50.00	40.06 ± 5.53	20.00 – 52.00	-0.26	0.793	0.70
LL (cm)	31.46 ± 4.03	23.00 – 41.00	31.56 ± 4.34	23.00 – 40.00	31.36 ± 3.74	24.00 – 41.00	0.25	0.806	-0.64
FL (cm)	20.45 ± 2.21	16.00 – 26.00	20.54 ± 2.12	17.00 – 25.00	20.35 ± 2.32	16.00 – 26.00	0.43	0.670	-0.93
FB (cm)	11.32 ± 1.28	9.00 – 15.00	11.56 ± 1.11	10.00 – 15.00	11.08 ± 1.40	9.00 – 14.00	1.90	0.060	-4.33
AKB (cm)	11.43 ± 1.23	9.00 – 15.00	11.62 ± 1.11	10.00 – 15.00	11.24 ± 1.33	9.00 – 14.00	1.55	0.124	-3.38

BMI = Body Mass Index; SHt = Sitting Height; BGW = Bigonial Width; LOMA = Length of Mandibular Arch; NL = Neck Length; BALt = Biaxillary Length; DSLt = Demispan Length; HL = Hand Length; HB = Hand Breadth; WRB = Wrist Breadth; ThL = Thigh Length; LL = Leg Length; FL = Foot Length; FB = Foot Breadth; AKB = Ankle Breadth; SDI = Sexual Dimorphism Index; NSZ = Northern Senatorial Zone

Statistical significance is expressed in bold fonts

Comparing the mean height of boys (Table 4) and girls (Table 5) across senatorial zones, One-way Analyses of Variance (ANOVA) shows a higher and insignificant stature among boys in the CSZ when compared with the SSZ and NSZ (F = 1.08, *P* = 0.342). Whereas, in girls, ANOVA shows a higher and significant stature among girls in the SSZ when compared with the CSZ and NSZ (F = 6.74, *P* = 0.002).

Table 4: Comparison of anthropometric characteristics of boys (5-11 years) in relation to senatorial zones

Variables	SSZ (n = 50) Mean ± SD	CSZ (n = 50) Mean ± SD	NSZ (n = 50) Mean ± SD	F	*P*
Age (years)	8.84 ± 1.66	8.78 ± 1.88	8.36 ± 2.25	0.91	0.406
Height (cm)	128.84 ± 10.93	129.04 ± 10.36	126.10 ± 12.12	1.08	0.342
Weight (kg)	27.32 ± 5.45	26.76 ± 5.22	26.74 ± 7.16	0.15	0.861
BMI (kg/m^2)	16.36 ± 1.82	15.94 ± 1.50	16.56 ± 2.38	1.34	0.265
SHt (cm)	64.76 ± 6.06	64.42 ± 5.32	62.70 ± 5.04	2.03	0.135
BGW (cm)	10.09 ± 0.10	10.00 ± 1.01	10.12 ± 0.77	0.23	0.796
LOMA (cm)	17.20 ± 1.49	16.88 ± 1.02	17.16 ± 1.27	0.94	0.393
NL (cm)	10.70 ± 1.33^{a}	12.28 ± 1.58^{b}	11.32 ± 1.60^{c}	13.97	**<0.001**
BALt (cm)	27.22 ± 2.10	27.42 ± 2.88	27.22 ± 2.54	0.08	0.917
DSLt (cm)	67.34 ± 5.94	68.56 ± 6.76	67.42 ± 6.92	0.54	0.583
HL (cm)	15.34 ± 1.32	15.34 ± 1.20	15.35 ± 1.67	0.00	0.997
HB (cm)	8.64 ± 0.92^{ab}	9.10 ± 0.88^{abc}	9.09 ± 1.09^{bc}	3.69	**0.027**
WRB (cm)	7.06 ± 0.87^{ab}	7.20 ± 0.76^{abc}	7.50 ± 1.02^{bc}	3.22	**0.043**
ThL (cm)	40.26 ± 3.84	39.38 ± 5.38	39.78 ± 5.08	0.42	0.658
LL (cm)	32.18 ± 4.33	32.28 ± 3.74	31.56 ± 4.34	0.44	0.643
FL (cm)	20.87 ± 2.28	21.46 ± 2.11	20.54 ± 2.12	2.31	0.103
FB (cm)	11.64 ± 1.06	11.54 ± 1.05	11.56 ± 1.11	0.12	0.886
AKB (cm)	11.70 ± 1.07	11.54 ± 1.05	11.62 ± 1.11	0.28	0.760

BMI = Body Mass Index; SHt = Sitting Height; BGW = Bigonial Width; LOMA = Length of Mandibular Arch; NL = Neck Length; BALt = Biaxillary Length; DSLt = Demispan Length; HL = Hand Length; HB = Hand Breadth; WRB = Wrist Breadth; ThL = Thigh Length; LL = Leg Length; FL = Foot Length; FB = Foot Breadth; AKB = Ankle Breadth; Means with different superscripts are significantly different with $p < 0.05$

Statistical significance is expressed in bold fonts

Table 5: Comparison of anthropometric characteristics of girls (5-11 years) in relation to senatorial zones

Variables	SSZ (n = 50) Mean ± SD	CSZ (n = 50) Mean ± SD	NSZ (n = 50) Mean ± SD	F	*P*
Age (years)	9.10 ± 1.59[ab]	8.34 ± 1.80[abc]	7.76 ± 1.74[bc]	7.70	**<0.001**
Height (cm)	131.98 ± 10.07[ab]	129.74 ± 11.23[ab]	124.24 ± 11.22[c]	6.74	**0.002**
Weight (kg)	27.50 ± 5.56	27.34 ± 6.59	25.38 ± 7.65	1.58	0.211
BMI (kg/m^2)	15.69 ± 1.94	16.05 ± 2.04	16.11 ± 2.32	0.57	0.565
SHt (cm)	65.43 ± 5.95[ab]	64.72 ± 4.99[ab]	61.60 ± 4.69[c]	7.34	**<0.001**
BGW (cm)	9.89 ± 1.02	10.01 ± 1.08	9.68 ± 0.88	1.40	0.249
LOMA (cm)	18.04 ± 1.46[a]	16.56 ± 1.40[b]	17.18 ± 1.72[c]	11.75	**<0.001**
NL (cm)	10.46 ± 1.50[ac]	11.50 ± 1.66[b]	10.08 ± 1.95[ac]	9.31	**<0.001**
BALt (cm)	270.36 ± 2.50	28.32 ± 2.74	27.04 ± 3.46	2.59	0.079
DSLt (cm)	69.48 ± 5.75[ab]	67.65 ± 6.04[abc]	65 52 ± 6.94[bc]	5.01	**0.008**
HL (cm)	15.87 ± 1.36[ab]	15.41 ± 1.50[ab]	15.02 ± 1.69[bc]	4.03	**0.020**
HB (cm)	8.65. ± 0.82	8.85 ± 0.96	8.72 ± 1.17	0.52	0.594
WRB (cm)	7.16 ± 0.77	6.92 ± 0.78	7.16 ± 1.11	1.19	0.309
ThL (cm)	43.56 ± 4.66[a]	40 18 ± 5.12[bc]	40.06 ± 5.53[bc]	7.44	**<0.001**
LL (cm)	33.66 ± 4.12[ab]	32.38 ± 4.20[abc]	31.36 ± 3.74[bc]	4.10	**0.019**
FL (cm)	21. 53 ± 1.84[ab]	21.18 ± 2.04[abc]	20.35 ± 2.32[bc]	4.27	**0.016**
FB (cm)	11.64 ± 1.03[a]	10.84 ± 0.84[bc]	11.08 ± 1.40[bc]	6.81	**0.001**
AKB (cm)	11.68 ± 1.06[ac]	11.08 ± 0.90[bc]	11.24 ± 1.33[abc]	3.91	**0.022**

BMI = Body Mass Index; SHt = Sitting Height; BGW = Bigonial Width; LOMA = Length of Mandibular Arch; NL = Neck Length; BALt = Biaxillary Length; DSLt = Demispan Length; HL = Hand Length; HB = Hand Breadth; WRB = Wrist Breadth; ThL = Thigh Length; LL = Leg Length; FL = Foot Length; FB = Foot Breadth; AKB = Ankle Breadth; Means with different superscripts are significantly different with $p < 0.05$

Statistical significance is expressed in bold fonts

DISCUSSION

Based on statistical analysis higher, statistically insignificant mean values of total stature and body anthropometrics were obtained among the girls when compared to boys in the Southern and Central Senatorial Zones of the state and can therefore be inferred that the girls grow taller than the boys, except in the Northern Senatorial Zone where the boys grow taller than their female counterparts. However, the boys showed insignificantly higher mean values of measured anthropometric variables than the girls in the Central and Northern Senatorial Zones, except in the Southern Senatorial Zone where the children girls showed insignificantly higher mean values than the boys. There is observable diversity in sexual dimorphism between the three regional populations of Cross River State, and some studies have attempted to understand the associated factors [1, 18-21]. As with all aspects of morphological differences, behavioral and environmental factors greatly affect sexual dimorphism. This intersection of behavior and biology is studied through biocultural approaches, which account for behavior along with external pressures in human adaptation and evolution [22]. With this approach, studies of sexual dimorphism have demonstrated that physical differences between males and females have been greatly affected by general patterns of cultural behavior as well as gender roles in the division of labor [18,21,23]. Sexual dimorphism may also be affected by patterns of sexual selection and preference, but these behaviors are more difficult to discern in the archaeological record [20,24,25]. However, studies have also demonstrated that male and female biology react differently to environmental pressures, where in colder climates males create more lean mass and females create more adipose tissue, and environmental pressures seemingly affect males more prominently than females [1,21,26]. Cross River State with varying and diverse weather conditions is not an exception, and as such there are sexual dimorphism in stature and body anthropometrics, which in turn affects the bio-diversity and ethnic variability in the state.

Climate can significantly influence anthropometric measurements. Studies have shown a correlation between climate and height. For instance, populations in colder climates tend to be taller on average compared to those in warmer climates. This phenomenon is often attributed to nutritional factors influenced by climate, such as food availability and quality, which can affect growth during childhood and adolescence [27]. Limb lengths and body proportions can also vary with climate. Bergmann's rule suggests that body size tends to be larger in colder climates to minimize heat loss, whereas Allen's rule posits that appendages (such as limb lengths) are shorter in colder climates to conserve heat. These principles highlight the adaptive responses of human populations to different climatic conditions [28].

Sexual dimorphism refers to the differences in size, shape and other physical traits between males and females of the same species. Climate can influence sexual dimorphism in anthropometric measurements. For instance, in colder climates where there is a greater need for thermoregulation, males might exhibit more pronounced differences in body size and shape compared to females. This can be seen in variations in stature and muscularity between males and females across different climatic zones [29]. Anthropometric measurements can also vary significantly within regions influenced by climate, particularly due to factors such as diet, physical activity patterns and cultural practices. For example, populations living in high-altitude regions may exhibit adaptations related to oxygen availability and thermal stress, impacting their body sizes and proportions [30].

CONCLUSION

Climate exerts a multifaceted influence on anthropometric measurements and sexual dimorphism. These influences are mediated through physiological adaptations to environmental conditions, nutritional factors and cultural practices, resulting in observable variations in human body size, shape, and proportions across different climatic zones.

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