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ETHNIC DIMORPHISM IN PREPUBESCENT BOYS

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Abstract: *Striking proportional differences between black and white athletes measured at the Olympic Games in Mexico City in 1968 raises questions about similar ethnic dimorphism in children. Proportionality profiles constructed from mean values taken from cross-sectional data base of white boys from Coquitlam, British Columbia and black boys from Ibadan, Nigeria (ages, from 5 to 11 years) demonstrate clearly that the ethnic-specific traits observed in adults also exist in children. Previous reports that black males have proportionally longer limbs, narrower hips and shorter sitting heights compared to white males are confirmed.*

Key words: Proportionality; Anthropometry; Black and white children; Phantom stratagem.

Introduction

Consistent proportional morphological differences between white and black Olympic athletes measured in Mexico City in 1968 across a range of track and field specialties were demonstrated by Ross (1978) using the Phantom stratagem (*Figure 1*). Phantom z-values simply represent departures, in standard deviation units, from a reference physique after a correction has been made for body size (see Ross and Marfell-Jones 1991). The finding that black athletes had narrower hips and longer limbs than white athletes is clearly identifiable on the proportionality profile in *Figure 1*; non-overlapping of standard error (SE) bars being the criterion for significance. Since the bars in *Figure 1* represent 2 SE, it is not clear on the diagram that proportional trunk length was also found to be significantly smaller in the black athletes compared to the white athletes in that study (Ross 1978). Differences larger than the 2 SE overlapping range, however, were not observed for weight and biacromial (shoulder) breadth.

Differences among children have been reported (Evelith and Tanner 1976, Krogman 1970, Malina, Brown and Zavaleta 1987, Martorell et al. 1988, Meredith 1968), although not always in terms of proportional size. Whenever proportionality assessments have been attempted, however, ratios and indices have been used. Problems with the interpretation of ratios stemming from allometric differences in the variables of the numerator and the denominator (and, hence, the confusion of mixed variances) have been identified by Packard and Boardman (1987) and emphasize the need for alternative approaches to the study of human proportionality.

We have found that the study of human proportionality is greatly simplified by the use of the Phantom stratagem (see Ross and Marfell-Jones 1991). In the present study, proportional morphological characteristics of black and white children are re-examined using this method. How proportional differences between the two age-matched, cross-sectional samples of prepubescent black and white boys compare with the differences observed among adult black and white male Olympians relative to the same standard reference human can then be determined.

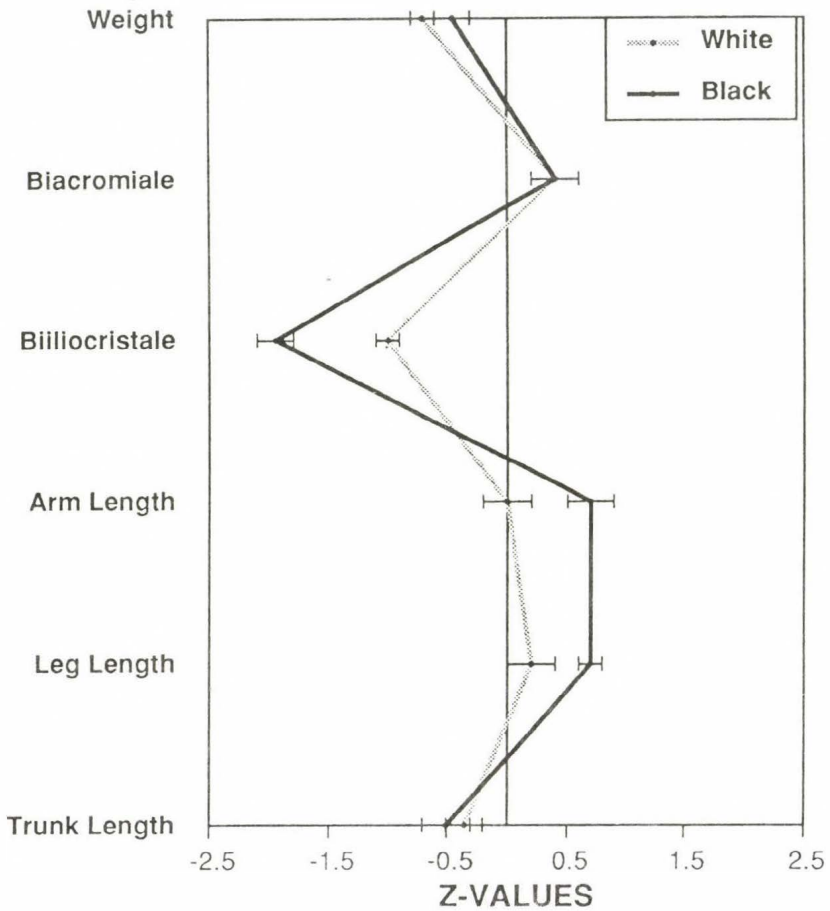


Fig. 1: Proportionality profiles showing mean phantom z-values (± 2 SE) for black (N = 107) and white (N = 88) male runners and jumpers. From Ross, 1978

Subjects and Methods

A cross-sectional sample of boys from Coquitlam, British Columbia served as the representative white sample, while Nigerian boys from fee-paying schools in Ibadan, Nigeria served as the black sample. Subject numbers and descriptive statistics of the variables used in this study are provided in *Table 1.* Age categories are standardized such that a 5 year old is any boy between 5.000 and 5.999 in decimal years (see Tanner 1978).

The N of 9 for each age group in the Nigerian sample results from a research design consisting of two phases:

Phase 1. Measurement of weight and height of a stratified, random sample (N = 522) selected from the fee-paying school system in Ibadan.

Table 1. **Anthropometric means and standard deviations of variables used in the comparison of proportional morphological differences between black and white boys**

Age	Group (yrs)	N	Height		Weight		Biacromial Breadth		Biiliocristal Breadth		Arm Length		Leg Length		Sitting Height	
			(cm)	SD	(kg)	SD	(cm)	SD	(cm)	SD	(cm)	SD	(cm)	SD	(cm)	SD
5	Black	9	112.1	4.75	17.7	2.73	23.9	1.36	16.8	1.66	49.7	2.98	52.5	2.88	59.6	2.19
	White	14	115.9	6.58	21.0	2.34	25.1	1.22	18.4	0.69	50.0	3.83	52.3	4.19	64.0	3.18
6	Black	9	120.4	4.01	21.1	2.79	25.7	0.97	18.0	0.86	55.0	2.17	58.9	3.72	61.5	3.52
	White	18	121.8	3.54	23.9	3.04	26.4	1.11	19.3	0.99	52.9	1.81	54.7	2.43	67.1	1.97
7	Black	9	123.7	4.62	21.4	3.37	26.2	1.29	18.2	1.07	55.9	1.94	59.5	2.52	64.2	2.88
	White	19	125.7	6.31	25.4	4.19	27.4	1.42	19.5	1.02	54.7	3.69	57.1	3.81	68.6	2.96
8	Black	9	126.3	3.94	22.8	3.00	27.1	1.63	18.7	0.99	57.5	2.04	60.4	2.31	65.9	2.31
	White	30	132.3	7.39	28.6	5.27	28.5	1.62	20.6	1.44	56.6	3.33	61.2	4.67	71.2	3.20
9	Black	9	135.5	4.11	26.6	3.18	28.0	1.66	19.2	1.58	61.4	2.93	66.3	3.01	69.2	1.98
	White	21	136.3	6.47	30.5	4.08	29.6	1.73	21.1	1.28	59.1	3.19	64.1	3.73	72.2	3.50
10	Black	9	137.8	8.66	28.8	6.19	29.3	2.68	19.9	0.96	62.8	3.78	67.2	5.15	70.5	4.44
	White	21	142.8	7.13	35.9	7.60	30.9	1.90	22.3	1.61	62.2	3.74	68.0	5.04	74.8	2.69
11	Black	9	141.1	8.85	29.8	4.39	29.2	2.30	20.3	0.91	64.1	3.97	70.6	5.25	70.5	4.50
	White	21	147.3	7.04	39.9	8.6	31.5	1.88	22.7	1.77	64.5	3.35	70.3	4.62	76.9	3.36

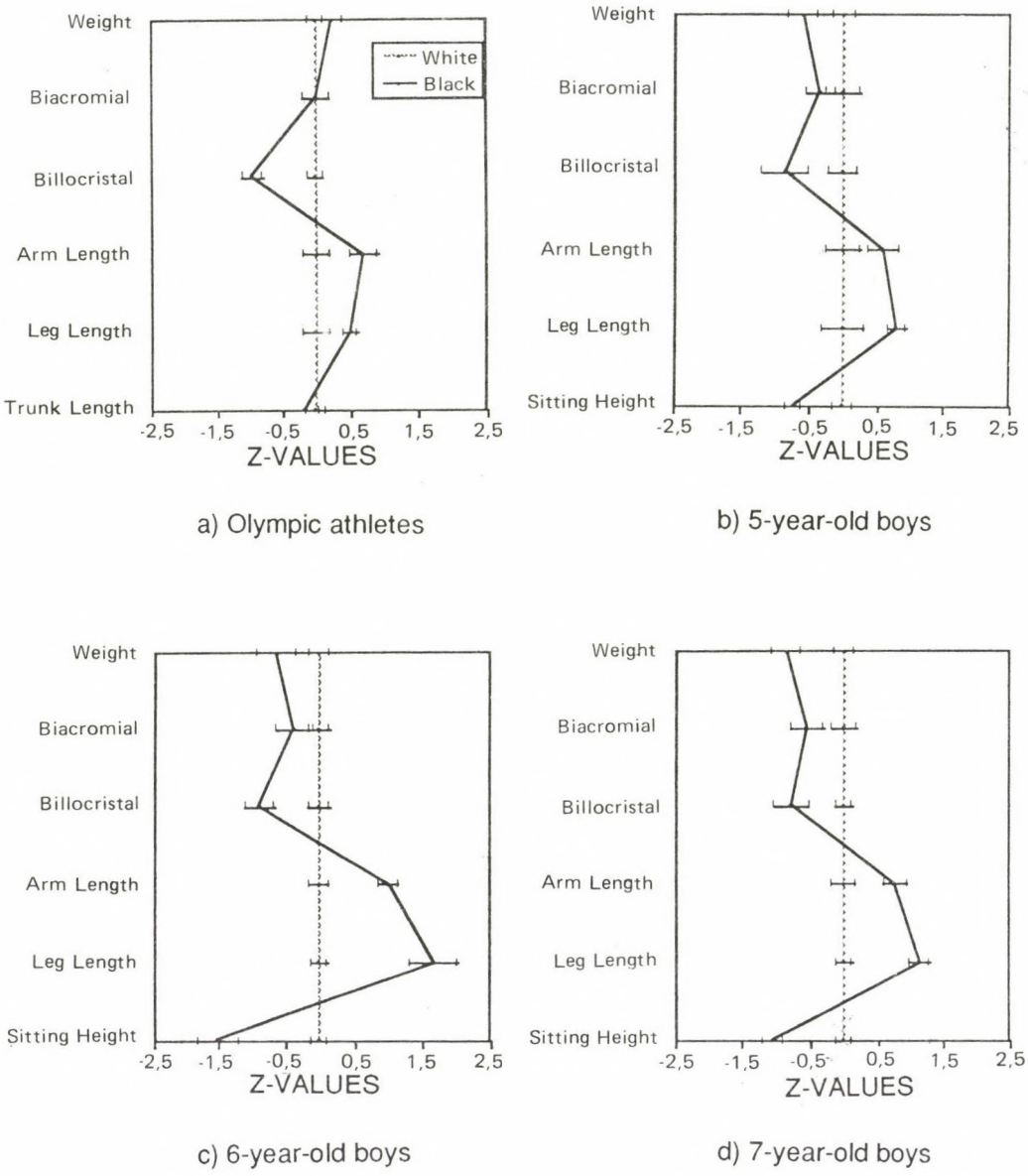
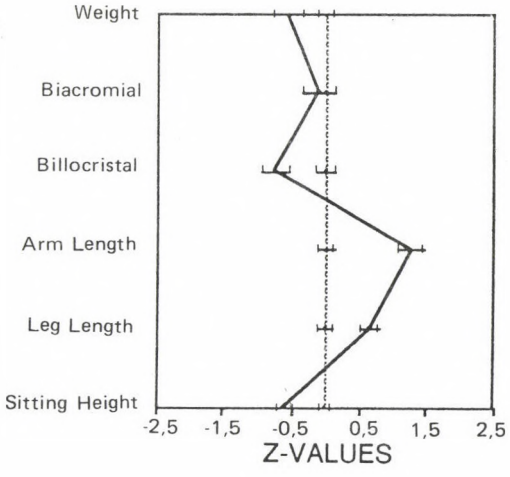
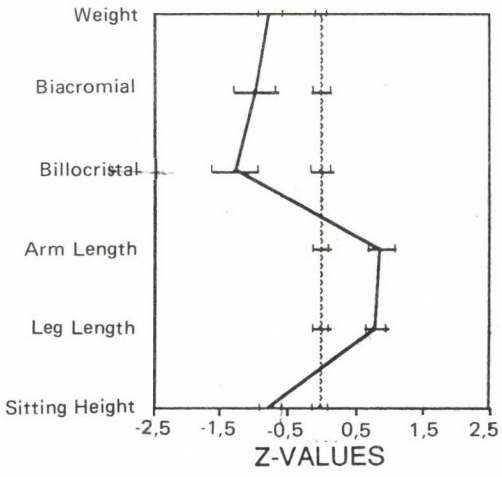


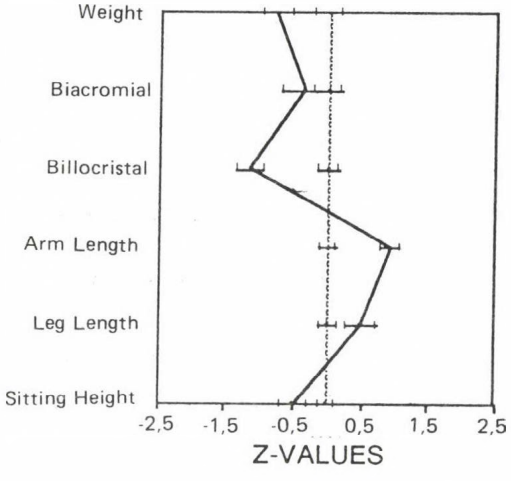
Fig. 2: Proportionality profiles showing phantom z-values for black and white males



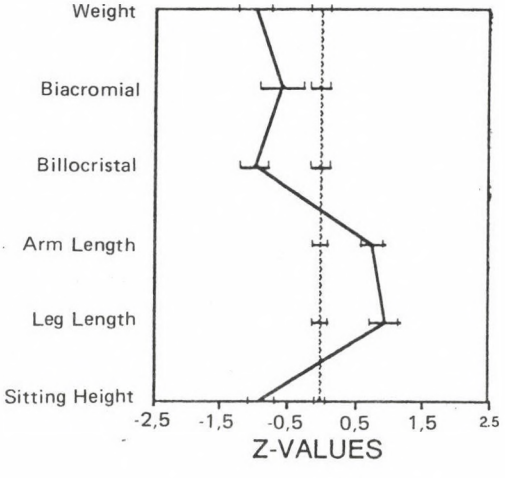
e) 8-year-old boys



f) 9-year-old boys



g) 10-year-old boys



h) 11-year-old boys

Fig. 2 continued

Phase 2. Selection of highest, lowest and median poderosity boy from each age category at each of three schools to ensure the widest range of body types for complete anthropometric assessment. The Benn Index (Benn 1971) was used in the calculation of ponderosity. Thus, the black means in *Table 1* represent a pooling of anthropometric data from three highly ponderous boys, three minimally ponderous boys and three boys each of whom had a ponderosity which represented the median value for the given age group at a given school (N = 9).

All of the measurements except for arm length were measured in the same manner for both black and white samples following guidelines identical to those described in Ross and Marfell-Jones (1991). In the white sample, arm length was determined by subtracting dactylion height from acromiale height using a Harpenden anthropometer. Alternatively, a segmometer constructed from cotter pins and a steel construction tape was used to measure direct segmental lengths in the black sample. Thus, for the black children total arm length is the sum of arm length, forearm length and hand length.

Phantom z-values of the variables of each subject were calculated and group means and standard errors of the means were then computed to construct the proportionality profiles shown in *Figure 2b–2h*. For ease in the comparison of black and white differences across age categories, the profiles were adjusted with white values at the center line. Proportional differences are considered to be significant when the standard error bars do not overlap.

Results

To facilitate comparisons between the children and the adult Olympians, the proportionality profile of the athletes is provided in standard format in *Figure 2a* with the white value set the center line as described above. Clearly, there is consistency in the overall proportionality pattern at every age (*Figure 2b–2h*), with the black boys having narrower biiliocristal breadth, longer limb lengths and smaller sitting height than their white counterparts. Whenever there was a significant difference in proportional biacromial breadth (i.e. at ages 7, 9 and 11) it was in the direction of blacks being smaller than whites, although there was not a persistent difference with respect to this variable across all age groups. Also, the Nigerian boys were consistently smaller in proportional weight than the Coquitlam boys.

Discussion

Ethnic dimorphism in prepubescent children has been reported previously (Evelith and Tanner 1976, Krogman 1970, Malina, Brown and Zavaleta 1987, Martorell et al. 1988, Meredith 1969). While ethnic differences in proportional weight were not observed in elite athletes, there was a significant difference between black and white boys, not only in the current study but also in those reported by Krogman (1970) and Meredith (1969). Whether this is indicative of a greater incidence of obesity in the white sample or undernutrition among the Nigerian boys is difficult to determine. Given that proportions of linear, bony measurements have never been shown to be altered by fluctuations in body mass, even in extreme cases of semi-starvation (Evelith and Tanner 1976, Tanner 1978), differences in weight between the black and white boys would not

be expected to have any bearing on other proportionality differences observed in this study.

Perhaps due to the difficulty of selecting an appropriate denominator, few attempts have been made previously to study proportional differences in widths of the trunk among children, although mean black and white values for children without a correction for size have been reported by Evelith and Tanner (1976), Krogman (1970) and Meredith (1969). While Krogman (1970) concluded that there were no differences in transverse measurements of the trunk between black and white boys, black means for hip width were consistently smaller than white means both in Meredith's (1969) mixed sample of boys and girls and in Evelith and Tanner's (1976) comparison of boys from the United Kingdom and Nigeria (elite). The fact that the latter two groups were similar in stature indicates that mean differences in biiliocristal width would probably translate into phantom z-value differences, as well; with black boys being proportionally smaller than white boys. Therefore, the results of the current study are in general agreement with comparisons of proportionality characteristics of transverse trunk measurements reported previously.

Differences in both arm and leg length between black and white children have been reported by Meredith (1969) and Krogman (1970). Among eight-year-old children from various parts of the world, Meredith (1969) found the U. S. black children to have the longest arm length of all; approximately 2 cm. longer than the U. S. white children. Proportionality assessments of limb lengths were not attempted by Meredith (1969).

Krogman's analysis (1970) distinguishes between the sexes and for the boys (ages 7–14 years) consistent differences were observed between groups means in limb lengths. Black males had consistently longer limbs than white males, except at age 10 years when white means appear to catch-up to black means for a year or two; presumably due to an early growth spurt by the white boys. The same phenomenon appears to occur in our sample when only the means are considered (*Table 1*). Yet, Phantom z-scores even at those ages (*Figures 2g* and *2h*) continue to show distinct differences in proportional limb length, with the black groups having a marked length advantage.

Although arm length was measured differently in each sample, a recent study in this laboratory demonstrated that these two methods of measurement produced no significant systematic differences in arm length values (personal communication). Also, since the criterion anthropometrists in both studies learned their techniques in the same laboratory at Simon Fraser University, there should be little, if any, systematic error with respect to the other variables included in this study.

Since leg length and sitting height account for stature, it is not surprising that these two variables are the most widely used to assess human proportionality. The results of the current study, along with those reported by others (Krogman 1970, Malina, Brown and Zavaleta 1987, Martorell et al. 1988), show clearly that a relatively short sitting height and a relatively long leg length is a general characteristic of black males of all ages in comparison to white males.

In conclusion, the ethnic dimorphism which was observed in adult males (Ross 1978) has been shown to exist in prepubescent boys, as well; confirming previously reported ethnic differences among children in an entirely novel way. The Phantom stratagem implemented here has a number of advantages over ratios in the assessment of human

proportionality. Firstly, it allows for the comparison of variables which differ dimensionally, e.g. weight (d = 3) versus a length (d = 1), since phantom z-values are given in a geometrically corrected form. Secondly, the Phantom stratagem can identify degrees of departure between variables. Taking eight-year-olds as an example (*Figure 2e*), we can state in absolute terms that the black-white difference in proportional arm length is greater than the difference in proportional leg length. Thirdly, the method can be used to make comparisons across age and sex categories, since all values, whether male or female, young or old, are given with respect to the same standard. Finally, phantom z-values can be directly compared from one study to the next whenever they are reported, allowing for a standardized approach to the study of human proportionality.

Summary

This study clearly demonstrates that there are consistent proportional differences between black and white males at all ages in biiliocristal width, upper body length and limb lengths. In agreement with virtually every study which has examined these morphological features, black males have narrower hip widths, shorter upper body lengths and longer limb lengths than white males. The Phantom stratagem for the assessment of human proportionality is recommended for future investigations.

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