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ORIGINAL ARTICLE

Differences in bone size and bone mass between black and white 10-year-old South African children

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Abstract *Introduction:* Black and white South Africans hail from vastly disparate cultural and socio-economic backgrounds the result of which exposes black children to numerous factors known to impact negatively on bone mass. Thus, we studied ethnic differences in bone size and bone mass between 476 10-year-old black and white South African girls and boys (black boys n=182, white boys n=72, black girls n=158, white girls n=64) who formed part of a longitudinal cohort of children born in Johannesburg, South Africa, during 1990. *Methods:* Bone area (BA) and bone mineral content (BMC) were measured at the whole body, total hip, femoral neck, lumbar spine (L1–L4) and mid- and distal radii by dual energy X-ray absorptiometry (DXA). Vertebral heights and metacarpal indices were measured. Anthropometry, skeletal maturity and pubertal development were also assessed. *Results:* After correction for height, weight, gender and puberty, black children had greater BMC at the femoral neck (P<0.0001), total hip (P<0.05) and mid-radius (P<0.001) than white children.. At the whole body, lumbar spine, and distal one-third of the radius, there were no differences in BMC between black and white children after correction for differences in body size. After correction for height and puberty, vertebral heights were less in black children than white children, and cortical areas at the second metacarpal were greater in black children. *Conclusion:* These findings suggest that, at the femoral neck, total hip and mid-radius, these differences are not a result of differences in anthropometry, bone age or pubertal stage, or environmental factors but are most likely to result from genetic differences.

Keywords BA · BMC · Children · Dual-energy X-ray absorptiometry · Ethnic differences

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Introduction

The incidence of osteoporosis and fracturing, a late manifestation of the disease, is significantly lower in African–American populations than in Caucasian US populations [1–3] and has resulted in considerable research into ethnic differences in bone mass. The lower incidence of fracturing has, in part, been explained by a greater bone mass in African–Americans [4–7]. Although fracture rates are also low in Africans living in Africa, few studies have investigated bone mass in communities in Africa [8–11].

A greater bone mass in African–Americans than in Caucasian Americans has been explained by advantageous differences in key bone-influencing factors [4, 12]. Black South Africans, children in particular, are exposed to a multitude of environmental factors known to impact negatively on bone mass, such as poor nutrition, [13] low calcium intake, [14] little physical activity, [15, 16], patterns of compromised growth, and delayed onset of puberty, [17, 18]; thus bone mass could be expected to be reduced when compared with that of South African whites and African–Americans.

Studies of bone mass in adult South African ethnic groups have found that pre-, peri- and postmenopausal black women have a greater bone mass at the hip than white women (as had been found in African–Americans),

but their bone mass at the radius and lumbar spine is similar to that of whites (unlike African–Americans) [8, 9]. Radial bone mass is greater in black children than in white children [19], but little is known of the factors influencing bone mass in children of different ethnic groups in developing countries. This study describes the ethnic differences in bone mass in pre- and early pubertal children in South Africa.

Materials and methods

Subjects

We collected data on 476 healthy children (182 black boys, 72 white boys, 158 black girls, 64 white girls) of median age 10.6 years (range: 10.0–10.9 years) who formed part of the Birth-to-Twenty (BTT) longitudinal cohort of children born in the Greater Johannesburg metropolitan area within a 6-week period (23 April 1990−8 June 1990) [20–22]. Comprehensive sets of longitudinal data were available on 1,200 black children from which 340 were randomly enrolled into the Bone Health Study. Cross checks were performed to ensure that there were no significant differences between the Birth-to-Twenty and Bone Health cohort for key demographic variables (residential area at birth, maternal age at birth, gravidity, gestational age and birth weight). All white children with longitudinal data were enrolled into this bone health study (n=65). To increase the number of white children on the study, children of the same age from schools in the Greater Johannesburg metropolitan area were asked to volunteer. An additional 71 white children (boys n=38; girls n=33) were recruited into the study. Subjects with chronic illness (juvenile rheumatoid arthritis, epilepsy or asthma) on medication known to affect growth or bone mass development were excluded from the study (n=4). This study protocol was approved by the Committee for Research on Human Subjects of the University of the Witwatersrand, Johannesburg, and the Ethical Advisory Committee of Loughborough University, UK. Both children and guardians gave written informed consent to be studied.

Anthropometry

Height was measured to the last completed 1 mm using a wall-mounted stadiometer (Holtain, UK) and weight to the nearest completed 0.1 kg using a digital electronic instrument (Dismed, USA) [23]. Both instruments were regularly calibrated, and subjects wore minimal clothing when being weighed. Forearm length, needed for dual energy X-ray absorptiometry (DXA) analyses, was measured as elbow–wrist length taken between the most posterior point of the olecranon and the most distal palpable point of the styloid process of the radius [23].

Maturity

Sexual maturity was self-assessed as pubic hair development in boys and girls, using the Tanner scaling technique [24, 25]. Children were divided into two stages of development, namely, pre-/early pubertal (Tanner stages 1–2) and mid-pubertal (Tanner stages 3–4). In addition, skeletal maturity was assessed by the scoring of bone age from hand radiographs using the Tanner–Whitehouse bone-specific scoring technique (TWII20) [26].

Dual-energy X-ray absorptiometry

Bone area (BA) and bone mineral content (BMC) of the whole body, left total hip, femoral neck, lumbar spine (anteroposterior, L1–L4) and left mid-radius (halfway between the styloid process and the tip of the olecranon of the elbow) and distal third of the radius (one-third of the distal distance between the styloid process and the tip of the olecranon of the elbow) were measured by DXA in array mode, using an Hologic QDR–4500 (Hologic, Waltham, Mass., USA). The data were analyzed with the software supplied by the manufacturer, version 11.2. A lumbar spine phantom was scanned daily to determine the machine's measurement precision, expressed as the coefficient of variation (CV), which, for BA and BMC, were 0.47% and 0.78%, respectively. All measurements were performed and analyzed by the same person.

Lumbar vertebral heights

Anterior, middle and posterior heights of lumbar vertebrae L1–L4 were measured at sites determined by the DXA operator. Vertebral heights were calculated as the mean of the heights of the anterior, middle and posterior portions of lumbar vertebrae L1–L4, which were measured (in millimeters) from a lateral DXA scan, using provided software [2].

Radiogrammetry

In addition to DXA measurements, radiogrammetry was used to measure cortical thickness of the second metacarpal from anteroposterior radiographs of the left hand. With digital callipers calibrated to the nearest 0.01 mm, measurements were made to the nearest 0.1 mm of the length of the metacarpal (L), outer cortical diameter (D) and inner cortical diameter (d) at the midpoint of the shaft. Combined cortical thickness (C=D−d), cortical cross-sectional area $\left(\pi/4[D^2 - d^2]\right)$, percent cortical cross-sectional area to total area ($[(D^2-d^2)/D^2]\times100$) and the Barnett–Nordin index $[(C/D)\times100]$ were calculated. The Barnett–Nordin

Table 1 Descriptive characteristics [mean ± SD (*n*)] of black and white children aged 10 years

Characteristic	Boys		*P*	Girls		*P*
	White (*n*=72)	Black (*n*=182)		White (*n*=64)	Black (*n*=158)	
Age (years)	10.65±0.24	10.55±0.27	<0.01	10.62±0.25	10.53±0.27	<0.05
Bone age (years)	10.31±1.04 (71)	10.13±1.05 (179)	NS	10.41±1.23 (62)	10.38±1.27 (156)	NS
Pre-/early puberty (Tanner hair 1 and 2)	99% (65)	99% (170)	NS	99% (65)	98% (154)	NS
Mid-puberty (Tanner hair 3 and 4)	1% (1)	1% (2)	NS	1% (1)	2% (3)	NS
Height (cm)	143.5±7.5	137.4±6.2	<0.0001	142.6±7.8	139.2±6.3	<0.001
Weight (kg)	36.0±6.4	32.6±6.6	<0.001	35.6±7.8	34.8±8.3	NS
Lean mass (kg)[a]	26.9±3.6	24.1±3.2	<0.0001	25.0±4.2	23.9±3.9	NS
Fat mass (kg)[a]	8.2±3.4	7.4±4.0	NS	9.8±4.3	10.1±5.1	<0.05
Body mass index (kg/m^2)	17.4±2.1	17.2±2.6	NS	17.3±2.6	17.8±3.4	NS

[a]After correction for ethnic differences in height
NS not significant

index is a parameter of relative bone mass that compensates for differences in skeletal size and variations in tube-to-film and hand-to-film distance [27]. Measurement precision, expressed as the coefficient of variation (CV) was determined between two observers (L.V. and S.N.), which, for metacarpal length, outer and inner diameters was 0.34%, 1.65% and 1.81%, respectively.

Socioeconomic questionnaire

Primary care givers answered questions about their social and economic status. This questionnaire had been modified appropriately for a South African population and previously validated [28]. The socioeconomic score was formulated from the presence or absence of 13 asset indicators, namely, house type, electricity, indoor flushing toilet, indoor running water, refuse removal, television, digital satellite television, motor vehicle, refrigerator, microwave oven, washing machine, video-machine and telephone).

Statistics

STATISTICA (data analysis software system) version 6 (StatSoft, 2001) was used to perform univariate and multivariate analyses to determine ethnic differences. Parametric data were analyzed by univariate analyses [age, bone age, height, weight, body mass index (BMI), BMC and BA]. Lean and fat mass, corrected for height, were analyzed by ANCOVA. Stepwise multiple regressions analyses were used to determine predictors (gender,

Table 2 Bone area and bone mineral content comparisons between ethnic groups within each gender. Values are unadjusted means (± SD)

Parameter	Boys		*P*	Girls		*P*
	White	Black		White	Black	
	n=72	*n*=182		*n*=64	*n*=158	
Whole body BA (cm^2)	1312.22±163.87	1217.08±140.59	<0.0001	1286.75±187.92	1248.58±171.87	NS
Whole body BMC (g)	1084.94±164.78	995.13±140.83	<0.0001	1036.84±196.41	992.95±179.03	NS
	n=71	*n*=180		*n*=64	*n*=158	
Femoral neck BA (cm^2)	4.32±0.33	4.13±0.31	<0.0001	4.21±0.30	4.05±0.31	<0.0001
Femoral neck BMC (g)	3.03±0.42	3.06±0.38	NS	2.70±0.46	2.77±0.41	NS
	n=71	*n*=180		*n*=64	*n*=158	
Total hip BA (cm^2)	22.36±2.68	20.42±2.43	<0.0001	23.18±3.42	20.69±2.50	<0.0001
Total hip BMC (g)	16.23±2.73	15.52±2.58	NS	15.39±3.67	14.57±3.00	NS
	n=72	*n*=182		*n*=64	*n*=158	
L1–L4 BA (cm^2)	46.00±4.96	43.02±4.26	<0.0001	43.99±4.26	42.99±4.34	NS
L1–L4 BMC (g)	26.72±4.66	19.09±3.69	<0.0001	25.54±5.10	25.33±5.24	NS
	n=69	*n*=180		*n*=64	*n*=158	
Mid-radius BA (cm^2)	4.52±0.81	4.48±0.80	NS	4.24±0.80	4.37±0.84	NS
Mid-radius BMC (g)	1.88±0.38	1.75±0.34	<0.05	1.70±0.37	1.68±0.41	NS
	n=69	*n*=180		*n*=64	*n*=158	
Distal 1/3rd radius BA (cm^2)	2.32±0.19	2.32±0.22	NS	2.19±0.20	2.18±0.20	NS
Distal 1/3rd radius BMC (g)	1.14±0.12	1.09±0.13	<0.01	1.06±0.15	1.04±0.15	NS

NS not significant

Table 3 Ethnic differences in bone area and bone mineral content at the whole body, femoral neck, total hip, lumbar spine (L1–L4) and mid- and distal 1/3rd of the radius after correction for gender, puberty, height and weight

Measure of bone mass	Ethnicity β[a]	± SE	*P*	R^2	Predictors *P*<0.001	Puberty
Whole body BA (cm^2)	0.04	0.02	NS	0.86	Height, weight	NS
Whole body BMC (g)	0.02	0.03	NS	0.70	Height, weight, gender	NS
Femoral neck BA (cm^2)	–0.07	0.04	NS	0.44	Height, weight, gender	NS
Femoral neck BMC (g)	0.20	0.03	<0.0001	0.50	Height, weight, gender	NS
Total hip BA (cm^2)	–0.13	0.03	<0.0001	0.59	Height	NS
Total hip BMC (g)	0.07	0.04	<0.05	0.50	Height, weight, gender	NS
L1–L4 BA (cm^2)	0.04	0.03	NS	0.57	Height, gender	NS
L1–L4 BMC (g)	0.02	0.04	NS	0.47	Height, weight	NS
Mid radius BA (cm^2)	0.26	0.03	<0.0001	0.63	Height, weight, gender	NS
Mid radius BMC (g)	0.13	0.03	<0.0001	0.61	Height, weight, gender	NS
Distal 1/3rd radius BA (cm^2)	0.11	0.04	<0.05	0.27	Height, gender	NS
Distal 1/3rd radius BMC (g)	0.12	0.04	NS	0.36	Height, weight, gender	NS

[a]A positive β means BA or BMC is greater in black children than in white children
NS not significant

pubertal development, current height and weight) of the dependent variables (BMC or BA). A positive β meant that BMC or BA in black children was greater than it was in white children. Non-parametric data were analyzed with Fisher's exact test (pubertal development) and Mann–Whitney U test (socioeconomic status). Probability values <0.05 were considered significant for all tests. Numerous statistical comparisons were made; thus, more cognisance was placed on differences with $P \leq 0.01$.

Results

Cohort characteristics

Characteristics of the cohort that took part in this study are shown in Table 1. Black children lived in households that scored significantly lower on the socioeconomic scale (median 7, range 0–13) than white children (median 12, range 6–13) ($P<0.05$, Mann–Whitney U test). Most of our cohort was prepubertal or in early puberty (black boys 99%, white boys 99%, black girls 98%, white girls 97%) as determined by pubic hair development, and there were no ethnic differences in the distribution of sexual maturity (Fisher's exact test). Skeletal maturity, as determined by bone age, was similar between the ethnic groups within each gender, even though black boys were significantly younger than white boys at the time of their visit ($P<0.01$). Black children were significantly shorter than their white peers (boys, $P<0.0001$; girls, $P<0.01$), and black boys weighed significantly less than white boys ($P<0.001$) and had less lean mass ($P<0.0001$). After correction for differences in height, both ethnic groups had similar lean masses; however, black girls had higher fat mass ($P<0.05$) than white girls.

DXA results

Table 2 summarizes ethnic differences in BA and BMC of the whole body, femoral neck, total hip, lumbar spine and mid and distal third of the radius, as determined by DXA. The data and statistics presented in Table 2 are not corrected for current size. Table 3 shows the results from multiple regression analyses, where BA and BMC were corrected for gender, puberty, height and weight.

Whole body

Black boys had significantly less whole body BA and BMC than white boys ($P<0.0001$), but after correction for

Table 4 Vertebral heights (unadjusted means ± SD) of lumbar spine vertebrae (L1–L4) comparisons between ethnic groups within each gender

Location	Boys		*P*	Girls		*P*
	White (*n*=70)	Black (*n*=179)		White (*n*=64)	Black (*n*=155)	
L1 (mm)	18.12±1.50	16.97±1.20	<0.0001	18.54±1.33	17.95±1.48	<0.01
L2 (mm)	18.83±1.35	17.38±1.27	<0.0001	19.34±1.57	18.53±1.55	<0.001
L3 (mm)	18.98±1.32	17.46±1.19	<0.0001	19.49±1.73	18.43±1.60	<0.0001
L4 (mm)	19.14±1.53	17.65±1.27	<0.0001	19.80±1.49	18.69±1.74	<0.0001

Vertebral heights were calculated as the mean of the heights of the anterior, middle and posterior portions of the first four lumbar vertebrae (in millimeters) as in the study by Gilsanz et al. [2]

Table 5 Ethnic differences in lumbar spine vertebral heights (L1–L4) after correction for gender, height and puberty

[a]A positive β means vertebral heights are greater in black children than in white children
NS not significant

Location	Ethnicity β[a]	± SE	*P*	R^2	Predictors *P* <0.001	Puberty
L1 (mm)	0.09	0.04	<0.01	0.51	Height, gender	<0.05
L2 (mm)	0.14	0.03	<0.0001	0.55	Height, gender	<0.01
L3 (mm)	0.20	0.03	<0.0001	0.54	Height, gender	NS
L4 (mm)	0.19	0.04	<0.0001	0.44	Height, gender	NS

gender, puberty, height and weight, there were no significant differences in BA or BMC (Table 3).

Femoral neck

Black children had a smaller BA at the femoral neck (both genders $P<0.0001$) but similar BMC. However, after correction for gender, puberty, height and weight, there was no difference in BA, and BMC was greater in black children than in white children (β=0.20, $P<0.0001$) (Table 3). BMC was 6% and 5% greater in black boys and girls, respectively, than in their white peers when adjusted means were compared.

Total hip

Before correction, black children had a smaller BA at the total hip (both genders $P<0.0001$) (Table 2). After corrections, despite BA remaining smaller in black children (β=−0.13, $P<0.0001$), BMC was greater in black children than in white children (β=0.07, $P<0.05$) (Table 3). BMC was 6% greater in black boys than in white boys, when adjusted means were compared, and was no different in girls.

Lumbar spine

Black boys had less BA and BMC at their lumbar vertebrae than white boys (both $P<0.0001$) (Table 2), which was explained by differences in height and weight (Table 3). That is, after correction, there were no ethnic differences at the lumbar spine in BA or BMC.

Radius

At the mid-radius, before corrections, black children had similar BA but less BMC than white children (boys $P<0.05$). After corrections, BA and BMC were significantly greater in black children than in white children (BA β=0.26, $P<0.0001$; BMC β=0.13, $P<0.0001$) (Table 3). That is, black boys and girls had 6% more BMC at the mid-radius than white boys and girls, respectively.

At the distal one-third of the radius, before correction, black boys had less BMC than white boys ($P<0.01$) (Table 2). After correction, black children had a greater BA ($P<0.05$), but there were no ethnic differences in BMC.

General

Correction of BA and BMC for ethnicity, gender, puberty, height and weight accounted for between 27% and 86% of variance in BA and between 36% and 70% of variance in BMC measurements in black and white South African children (Table 3). Puberty was never a significant predictor of BA or BMC.

Lumbar vertebral heights

Lumbar vertebral heights were less in both black boys (L1–L4 $P<0.0001$) and girls (L1–L4 $P<0.01$ to $P<0.0001$) than

Table 6 Radiogrammetric comparisons between ethnic groups within each gender. Values are unadjusted means (± SD)

Parameter	Boys		*P*	Girls		*P*
	White (*n*=71)	Black (*n*=178)		White (*n*=61)	Black (*n*=153)	
Length (mm)	54.75±3.49	54.41±3.40	NS	55.32±4.07	56.08±3.93	NS
Outer diameter (mm)	6.98±0.64	7.10±0.67	NS	6.74±0.59	6.91±0.63	NS
Inner diameter (mm)	4.00±0.71	4.36±0.72	<0.001	3.69±0.61	3.91±0.66	<0.05
Combined cortical thickness (mm)	2.98±0.42	2.75±0.41	<0.0001	3.05±0.49	3.00±0.45	NS
Cortical cross-sectional area (mm^2)	25.61±4.26	24.66±4.40	NS	25.00±4.73	25.45±4.66	NS
Percent cortical area to total area	67.03±7.59	62.29±7.49	<0.0001	69.73±7.56	67.79±7.24	NS
Barnett–Nordin index (%)	42.98±6.80	38.91±6.27	<0.0001	45.41±6.90	43.62±6.49	NS

NS not significant

Table 7 Ethnic differences in metacarpal indices after correction for gender, height and puberty

Parameter	Ethnicity β[a]	± SE	*P*	R^2	Predictors *P* <0.001	Puberty
Length (mm)	0.26	0.03	<0.0001	0.62	Gender, height	NS
Outer diameter (mm)	0.25	0.04	<0.0001	0.24	Gender, height	NS
Inner diameter (mm)	0.27	0.05	<0.01	0.18	Gender, height	NS
Combined cortical thickness (mm)	–0.07	0.05	NS	0.13	Gender, height	NS
Cortical cross–sectional area (mm^2)	0.11	0.04	<0.05	0.20	Height	NS
Percent cortical cross-section area to total cross-sectional area	–0.21	0.05	<0.01	0.13	Gender	NS
Barnett–Nordin index (%)[a]	–0.20	0.05	<0.0001	0.13	Height	NS

[a]A positive β means the respective metacarpal indices are greater in black children than in white children
NS not significant

in their white peers before and after correction for ethnic differences in height (Tables 4 and 5).

Radiogrammetry results

Before correction, the inner diameter of the 2nd metacarpal was greater in black children than in white (boys $P<0.001$; girls $P<0.05$). (Table 6). Black boys also had a greater combined cortical thickness ($P<0.0001$) than white boys but a smaller Barnett–Nordin index ($P<0.001$) and percent cortical area to total area ratio ($P<0.0001$). After correction, black children had greater metacarpal length (β=0.26, $P<0.0001$), outer (β=0.25, $P<0.0001$) and inner diameters (β=0.27, $P<0.01$), as well as the cortical cross sectional area (β=0.11, $P<0.05$). However, this translated to a greater Barnett–Nordin index (β=−0.20, $P<0.0001$) and percent cortical area to total area (β=−0.21, $P<0.0001$) in white children. (Table 7).

Discussion

Ethnic differences in bone mass (BMC) between black and white 10-year-old South African children, as measured by DXA and corrected for gender, pubertal development, current height and weight, were most apparent at the femoral neck, total hip and mid-radius. That is, black children had a greater BMC at the femoral neck (boys 6%; girls 5%), total hip (boys 6%) and mid-radius (boy and girls 6%) than white children, despite black children being more exposed to environmental factors known to impact negatively on bone mass, such as living in poorer households and having poorer nutrition, compromised growth and development, as reflected by their lower birth weights, shorter stature, lighter body weights and later onset of pubertal development, lower calcium intake (estimated to be approximately 400 mg/day) [14] and less physical activity [16]. Black children had similar whole body and lumbar spine bone masses to white children. These data suggest that ethnic differences are site-specific in our cohort of 10-year-old black and white South Africans, which are not the result of differences in current height or weight (for which statistical corrections were made), bone age and pubertal stage (which did not differ between ethnic groups), but are more likely the result of differences in genetic factors.

The finding that bone mass at the femoral neck, total hip and mid-radius was greater in 10-year-old South African black than white children is consistent with national and international studies, which have explored black–white ethnic differences in both adults and children. Before correction for differences in height and weight, pre- and early pubertal African–American children had greater femoral neck bone mass [BMC and/or bone mineral density (BMD)] than white children [29, 30]. Wang et al., after correcting for differences in both height and weight, found bone mineral apparent density (BMAD) to be greater in African–American pre-/early pubertal girls than in white girls [31]. Our results in children are also consistent with studies conducted in South African women (20–64 years), where BMC of the femoral neck was greater in blacks than in whites, before and after correction for body and bone size [8, 9]. Greater weight-bearing was proposed to explain the greater femoral neck bone mass in black South African women. However, given that black 10-year-old children, of similar weights to white children, also have a greater femoral neck bone mass, other reasons, such as genetics, are likely to account for a greater bone mass at the femoral neck and total hip in South Africa's black population.

Forearm BMC has also been found to be greater in black children than in white American children before and after correction for weight and age, in 7–12 year olds [30] and, before correction, in 1–6 year old children [32, 33]. In a previous study using single photon absorptiometry, South African blacks aged 6–20 years were found to have more BMC at the midshaft radius than white children, after correction for differences in height [34].

At the lumbar spine and whole body, ethnic differences in bone mass were absent. The results are similar to those found in South African pre-, peri- and postmenopausal women [8, 9]. Although the majority of studies from the USA have demonstrated greater bone masses in African–Americans [30, 32, 35–38], there are, indeed, US studies comparable to ours, where no differences in bone mass have been found; uncorrected lumbar spine BMC and BMD have been reported to be similar in African–American and Caucasian children [29–31, 39, 40], as have results after correction for ethnic differences in size or maturity [4, 41]. Adult Somalis, living in the USA, have also been reported to have a similar lumbar spine BMD to Caucasian Americans [42]. At the whole body, a site for which there is less literature in children to make com-

parisons, two studies did not find ethnic differences between their African–American and Caucasian children [29, 31].

In addition to bone density, ethnic differences in bone architecture and geometry have more recently received attention as a measure of bone strength. Histomorphometric analysis of iliac crest biopsies have shown that South African black adults have thicker trabeculae than whites [1, 5, 43] At the proximal femur, both US and South African black populations have been shown to have a narrower marrow cavity, thicker cortex and a lower buckling ratio, despite non-significant differences in outer bone diameter, characteristics that are consistent with greater bone strength and lower fracture rates in blacks at this region [44] Geometrically, wider bones are stronger bones, which African–American populations have been found to have [1, 2]. We that found black children had shorter lumbar vertebral heights for the same BA before and after correction for differences in height, suggesting that the vertebrae are wider. Further, DXA-measured BA at the mid-shaft of the radius was consistently greater in black children than in white children after correction for differences in height.

A number of candidate gene polymorphisms have been linked to bone mass, such as of the vitamin D receptor gene (VDR), calcium-sensing receptor gene (CASR), alpha2HS-glycoprotein gene (ASHG), estrogen receptor alpha gene (ESR1), calcitonin gene, parathyroid hormone gene (PTH), collagen I alpha 1 gene, transforming growth factor beta (TGF-beta) gene, interleukin-1 (IL–1) gene, interleukin-6 (IL–6) and LDL receptor-related protein 5 (LRP5) apolipoprotein E gene [45–47]. All these genes have the potential to explain ethnic differences in bone mass, but none has unequivocally been proven to do so.

In conclusion, black children in South Africa have greater bone mass at the femoral neck, total hip and mid-radius than their white peers, and similar bone mass at the lumbar spine and whole body. This bone mass pattern, at the femoral neck in particular, is similar to that reported in US children, yet our black South African children, unlike their African–American peers, are comparatively disadvantaged. These findings suggest that the femoral neck, total hip and mid-radius bone mass patterns described in our black children are likely to be under similar genetic influences to those of African–American children, rather than due to environmental influences. Support for this hypothesis comes from studies that suggest that the South African black population and the African–American population (originating from West Africa) had similar genetic pools, as the South African Bantu-speaking ethnic groups migrated from West Africa [43, 48, 49]. It is unclear, at this stage, whether improvement in the adverse environmental factors in our black children would greatly change the bone mass findings at other sites. However, it does raise an intriguing question about how the genetic influences maintain bone mass in the face of what are generally considered to be adverse environmental factors. Not only do these genetic influences have a positive effect on bone mass during childhood, but these are maintained through adult life and are associated with a very low incidence of femoral neck and vertebral fractures in the elderly.

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