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Body fat differences by self-reported race/ethnicity in healthy term newborns

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Abstract

Background—Ethnic differences in total body fat (fat mass [FM]) have been reported in adults and children, but the timing of when these differences manifest and whether they are present at birth are unknown.

Objectives—This study aimed to assess whether ethnic differences in body fat are present at birth in healthy infants born at term, where body fat is measured using air displacement plethysmography and fat distribution by skin-fold thickness.

Methods—Data were from a multiracial cross-sectional convenience sample of 332 term infants from four racial or ethnic groups based on maternal self-report (A, Asian; AA, non-Hispanic Black [African-American]; C, non-Hispanic White; and H, Hispanic). The main outcome measure was infant body fat at 1–3 days after birth, with age, birth weight, gestational age and maternal pre-pregnancy weight as covariates.

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Conflict of Interest Statement

Each author declared that she or he has no conflict of financial or personal interests in any company or organization sponsoring this study.

Author contributions

Current study concept: Gallagher. Data collection: Paley, Bauer, Hull, Matthews, Yu, Navder, Dorsey, Ji. Statistical expertise: Thornton. Interpretation of results: Thornton, Hull, Paley, Gallagher. Manuscript writing: Paley, Gallagher, Thornton, Ji, Toro-Ramos. Critical review of manuscript for intellectual content: Gallagher, Paley, Thornton, Hull, Dorsey. Obtained funding: Gallagher. Study supervision: Paley, Gallagher.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Table S1. Adjusted mean fat mass (kg) by ADP and difference between sexes by race.

Table S2. Adjusted mean sum of skin-folds (mm) by race and sex and between races for females and males combined.

Results—Significant effects for race (*P* = 0.0011), sex (*P* = 0.0051) and a race by sex interaction (*P* = 0.0236) were found. C females had higher FM than C males (*P* = 0.0001), and AA females had higher FM than AA males (*P* = 0.0205). C males had less FM than A males (*P* = 0.0353) and H males (*P* = 0.0001).

Conclusion—Race/ethnic and sex differences in FM are present in healthy term newborns. Although the implications of these differences are unclear, studies beginning *in utero* and birth set the stage for a life course approach to understanding disease later in life.

Keywords

Body composition; ethnicity; fatness; neonate

Introduction

Within the United States, Hispanic and African–American youth are disproportionately affected by the epidemic of paediatric obesity and represent populations experiencing the most pronounced increases in adiposity-related comorbidities (1–4). Weight for gestational age is a more sensitive predictor of cardiovascular risk later in life than birth weight (5,6). However, dependence on birth weight or any other weight-based index as an indicator of fatness is severely limited in that body weight is the sum of fat mass (FM) and fat-free mass (FFM) (7). It is unknown whether a higher birth weight represents a higher proportion of body fat or non-fat components, including lean and bone tissues. Consequently, a limitation of many previous studies has been the lack of measurement of body composition.

Sex and race are factors that contribute to variations in body composition (5,6). The Third National Health and Nutrition Examination Survey (NHANES) III study of 15 903 Americans aged 12–80 years used bioelectrical impedance analysis to report higher FM and percent body fat (%BF) for females compared with males. Racial differences in FM were not seen among males. Among females, total FM was highest among non-Hispanic blacks, followed by Hispanics and lowest among non-Hispanic whites (8). Among 1251 British school children beginning at age 5 years, girls had higher FM (by dual energy X-ray absorptiometry, DXA) than boys, and South-Asian girls and boys had the highest %BF from ages 5 to 7 compared with African–Caribbean children (9). Variations in body fat distribution among ethnic groups have been found among prepubertal children (by DXA), with Asian girls having less extremity or gynoid fat and Asian boys having less extremity fat compared with Caucasian and African–American children of the same sex (10). In newborns, no differences were found in FM among Caucasian and African-Americans using skin-fold thickness (11). Using anthropometry, others found a ‘thin fat’ phenotype (defined as smaller abdominal and chest circumferences, lower Ponderal index (PI), relatively similar crown-heel length, head circumference and skin-folds) in newborns from low- and middle-income countries (ethnic origin from Asia, Middle East, Africa and South/Central America) compared with newborns from Western Europe (Norway and North America) (12), suggesting an influence of parental socioeconomic status on infant body composition. A comparison of United Kingdom-born South-Asian and White European infants (~8 weeks old) (11) showed that South-Asian infants had greater total fat (by air displacement plethysmography, ADP) and larger subscapular skin-fold thicknesses suggestive of a greater central fat deposition. A study using ADP in 98 preterm infants at 30–36 weeks gestation found that females had less FFM and higher FM and %BF than males (13).

Unknown is the stage at which race/ethnic differences in FM or fat distribution manifest themselves during growth or whether these differences are present at birth using accurate measurement methods. Few data are available on children younger than 5 years. A finding of race differences in fatness at birth would suggest that *in utero* or genetic factors correlated with race/ethnicity influence body composition, independent of post-natal environmental factors.

The primary aim of this study was to investigate whether race/ethnic differences in total FM and fat distribution are present at birth in healthy term infants, where FM was measured using ADP and fat distribution using skin-fold thickness. A secondary aim was to investigate whether sex differences in FM are present at birth, as previously reported (14,15).

Methods

Subjects

Healthy infants aged 1–3 days were recruited prior to discharge, from the newborn nursery at St. Luke's Roosevelt Hospital Center in New York City (2006–2009). This study was approved by the St. Luke's – Roosevelt Hospital institutional review board. Subjects were full-term infants (>37 weeks gestation as determined by last menstrual period or ultrasound in the first trimester) of all ethnic and gender groups. Infants with congenital malformations, congenital infections, non-singleton birth and maternal conditions such as diabetes and pre-eclampsia known to affect foetal growth, or requiring admission to the neonatal intensive care unit, were excluded. The presence of inclusion and exclusion criteria was determined by review of the medical record and interview of the mother. Infants were classified as Asian, non-Hispanic Black (African-American), non-Hispanic White and Hispanic when the mother reported that all four of the infant's grandparents were members of that single race group. If there was not concordance for all grandparents, the infant was classified as 'other'.

Infants were not measured during the first 24 h (day 0), as previous studies suggest that there may be an initial weight loss during this period (16,17).

Anthropometry

Infant length (average of two measurements) and crown–rump length (measured once) were measured with an infant length board (Shorr Board, Shorr Productions, Olney, MD, USA) to the nearest centimetre. Body weight was determined to the nearest kilogram using the PeaPod (Life Measurement, Inc., Concord, CA, USA) electronic scale at the time of body density measurement. Circumference measures of the occipital–frontal head and abdomen (just above the umbilicus) to the nearest millimetre were measured with a disposable paper tape measure (Infant Measuring Tape, Tech-Med Services, Inc., Smithtown NY, USA). Skin-fold thicknesses of the biceps, triceps, quadriceps and subscapular regions to nearest millimetre were measured using a Lange Skinfold Caliper (Beta Technology, Inc., Cambridge, MD, USA). The average of two readings was used in the analysis. The coefficients of variation were triceps, 5.7%; biceps, 8.4%; subscapular, 6.8%; thigh, 4.7%; and abdomen, 6.0%.

PI was calculated as 100 × body weight (g)/length^3 (cm). The values obtained at birth for weight, length and head circumferences were retrieved from the infant's medical record.

ADP

Body volume was determined by ADP using the Peapod (Life Measurement, Inc.). Body density was then converted to percent fat (%BF) using sex-specific constants by Fomon *et al.* (18) as previously described (16). The Peapod was previously validated against deuterium dilution in term infants as young as 6 weeks and showed no differences in %BF (19). The instrument was calibrated daily prior to testing and two investigators who were certified to use the device performed the measurements. The infant was placed in the testing chamber unclothed except for a nylon stocking cap, identification bands and a plastic umbilical cord clamp. Identical items were placed on the scale for taring and in the empty chamber during calibration. Repeated tests performed twice on the same day on 27 infants gave a CV of 6.5% for %BF.

Data analysis

Descriptive statistics, number, mean and standard deviation were calculated for each variable by sex and race/ethnicity. General linear models investigated the effects of race, sex and their interaction on demographic variables and on FM and skin-folds adjusted for infant age, infant birth weight, gestational age and mother's pre-pregnant weight. Infant birth length, mother's age, mother's weight gain, delivery type and parity were considered as potential covariates, but were not statistically significant and were excluded from the final models. If there was a race by sex interaction in the model, the effect of sex was tested separately for each racial group and the effect of race was tested separately for males and females. If there was no race by sex interaction, only the main effects are presented; i.e. males vs. females, African-Americans vs. Asians, etc. Data were analyzed using SAS version 9.2 (SAS Institute, Cary, NC, USA). The level of significance for all statistical tests of hypothesis was 0.05.

Results

Subject characteristics

Descriptive characteristics by self-reported race and sex of the infants, mothers and fathers are summarized in Table 1. Of the 332 infants studied, 13% were AA, 9% A, 56% C and 22% H. The AA and H parents were 4–5 years younger than the A and C parents. Pre-pregnancy body weight and body mass index (BMI) were greater in the AA and H women compared with the A and C women, with no differences between the latter two groups for BMI; however, C women had higher pre-pregnancy body weight compared with A women. The proportion of mothers who were overweight (BMI > 25 kg m^{-2}) or obese (BMI > 30 kg m^{-2}), respectively, were 27 and 23% AA, 10 and 3% A, 11 and 6% C, and 29 and 22% H. Weight gain during pregnancy was greater only in the C mothers compared with the AA mothers (~2.3 kg; $P = 0.0107$). Parity was higher in AA and H than C and A, and higher in C than A (mean parity: AA 0.88, H 0.96, C 0.63 and A 0.17; all $P < 0.02$ for pairwise comparisons).

Race differences in fat by ADP

Presented in Table 2 are pairwise differences in adjusted mean FM between races for males and females, respectively. Adjusted mean FM for C males was less than the adjusted mean FM for A (−0.074 kg; $P = 0.0353$) and H (−0.108 kg; $P = 0.0001$) males. There was a statistical trend suggesting that C males have a lower mean FM than AA males (−0.058; $P = 0.052$ kg). Caucasian males had 13% less fat than AA males, 16% less fat than A males and 20% less fat than H males. In females, there was a statistical trend suggesting that the adjusted mean FM for C females was less than for AA females (−0.055 kg; $P = 0.0528$). Caucasian females had 10% less fat than AA females. There were no other differences among racial groups for females.

Sex and race differences in subscapular skin-fold

Presented in Table 3 are adjusted mean subscapular (mm) values by race and sex. The race by sex interaction was not significant ($P = 0.84$). There was a main effect of race ($P = 0.0026$) but not of sex ($P = 0.31$). Because the race by sex interaction was not significant, the difference between males and females was tested using the main effect of sex. There was no difference between adjusted mean subscapular (−0.111 mm, SEE = 0.110 mm; $P = 0.31$) of males and females. The pairwise differences between adjusted mean subscapular for different racial groups are presented in Table 3. The adjusted mean subscapular (mm) for C was less than for AA (−0.415 mm, SEE = 0.139 mm; $P = 0.0030$), for A (−0.409 mm, SEE = 0.158 mm; $P = 0.0100$) and for H (−0.226 mm, SEE = 0.112 mm; $P = 0.0452$).

Sex differences in fat by ADP

There was a significant race by sex interaction ($P = 0.0236$) and main effects for race ($P = 0.0011$) and sex ($P = 0.0051$). Presented in Supplementary Table S1 are adjusted mean FM (kg) by race and sex and adjusted mean difference (male–female) in FM (kg) for each race. For C and AA, adjusted mean FM for males was less than for females (−0.08 kg). There were no differences between the adjusted mean FM of males and females for H and A infants. Caucasian males had 18% less fat than females, AA males had 17% less fat than females, H males had 2% more fat than females and A males had 6% less fat than females.

Sex and race differences in fat by sum of skin-folds (triceps + biceps + subscapular)

Presented in Supplementary Table S2 are adjusted mean sum of skin-folds (mm) by race and sex. There was no race by sex interaction ($P = 0.61$). There were no main effects of race ($P = 0.08$) or sex ($P = 0.48$). Because the race by sex interaction was not significant, the difference between males and females was tested using the main effect of sex. Adjusted mean difference (male–female) in sum of skin-folds for the group was not significant (−0.183 mm, SEE = 0.257 mm; $P = 0.48$). Pairwise differences between adjusted mean sums of skin-folds for different racial groups are presented in Supplementary Table S2. The adjusted mean sum of skin-folds for C was less than for AA (−0.777 mm, SEE = 0.323 mm;

$P = 0.0169$). The adjusted mean sum of skin-folds was not different between C and H (−0.439 mm, SEE = 0.262 mm, $P = 0.10$).

Discussion

At birth, African–American, Asian and Hispanic males and African–American females have higher total FM than Caucasians. African–American, Asian and Hispanic newborns have a greater central fat deposition (by subscapular skin-fold) than Caucasians. We do not know the significance of these differences at birth; however, in adolescents and adulthood such a body habitus is more strongly associated with insulin resistance and type 2 diabetes than peripheral (gluteal and subcutaneous) fat depots (20–23). Studies in newborns allow examination of potential underlying biological differences across subgroups of the population to be performed in advance of the impact of neonatal influences or confounding factors imposed by the environment and diet. Studies beginning at birth set the stage for a life course approach to understanding disease later in life (7).

There have been few previous investigations of race differences in total FM or fat distribution immediately following birth. Stanfield *et al.* (24) found that United Kingdom-born South-Asians had greater FM (and less FFM) than White European infants measured at 6–12 weeks of age using ADP. Larger subscapular skin-fold thickness, suggestive of a greater central fat deposition, was found in the South-Asian infants. Adjusting for a lower *in utero* growth rate and slightly shorter gestational period of South-Asian infants removed the observed ethnic differences in FFM but not of FM. Because infants were measured at 8 weeks of age, adjustment for a measure of post-natal growth had no effect on FFM but had an attenuating effect on FM, suggesting that post-natal weight gain has a greater effect on FM. A study using ADP in premature infants after birth with race characterized as white (66%) or non-white (34%) found no race differences in FM, FFM or %BF in boys or girls (13).

Whether our findings at birth carry forward to childhood and adolescence is unknown. Ethnic differences in total FM (DXA) have been reported at ages 5–7 years in a UK cohort (9) where South-Asian girls had higher %BF than African–Caribbean girls ($P < 0.001$). South-Asian boys had higher values than African–Caribbean boys beginning at age 7 years. In prepubertal children (8 years) and adolescents, African–American males had lower %BF than Caucasian and Hispanic males (25), and African–American girls had lower %BF than Caucasian and Hispanic girls (25). During adolescence, Hispanics had the highest %BF whereas Caucasian females had the lowest (25). In the current study, we found that African–American, Asian and Hispanic newborns have greater subcutaneous fat in the truncal region compared with Caucasians which is in agreement with greater truncal (subscapular and suprailiac skin-folds) relative to peripheral (triceps and medial calf) fat in Asian adolescents (11–18 years) compared with Caucasians (26). We previously found in a prepubertal multiethnic cohort (5–12 years) greater relative truncal or central FM (measured by skin-folds and DXA) in Asian girls but not boys compared with Caucasians (10). Because newborns have negligible amounts of intra-abdominal or visceral adipose tissue (27,28), a depot that is measurable only by imaging techniques such as MRI, trunk fat is essentially all subcutaneous fat. Longitudinal body composition studies beginning at birth are needed to understand the potential role of race/ethnicity on the development of chronic/metabolic disease through the life course.

Farr (14) and McGowan (15) were the first to report greater skin-fold thicknesses in girls compared with boys within 48 h of birth. Fomon (18,29) reported 1% higher FM in females (14.9%) vs. males at birth (13.7%) while Butte *et al* (30), in healthy term infants (72% Caucasian) at 14 days, reported 14.2% fat in females and 11.4% fat in males. In that study (30), body composition measures were acquired using a more robust multi-compartment approach. Others have reported that girls and boys at birth have lower %BF (ADP) compared with the Fomon values (18,31), but values were consistently higher than Fomon's from 1 to 4 months, except for boys at 4 months (32).

Compared with the birth weights of Fomon's (18,29) reference male (3.5 kg) and female infant (3.35 kg), the mean birth weights of the current male (3.55 kg) and female (3.40 kg) infants are similar. Percent fat of the Caucasian males (12.7% fat) and females (14.3% fat) are within 1% of the Fomon values (18) (13.7% males and 14.9% females). Compared with the reference infant from Butte (males 11.4% fat and females 14.2% fat) (30), Caucasian males had 1.3% more FM while Caucasian females were not different.

Notable racial and ethnic differences in the prevalence of obesity exist among children (30). There is a need beginning at birth or earlier (*in utero*) to conduct appropriate longitudinal investigations involving the measurement of FM and fat distribution using validated measures and with less reliance on surrogate measures (BMI and circumference measures). In paediatric populations, longitudinal studies with appropriate measures of environmental and cultural influences are required to better understand racial and ethnic differences in obesity and related comorbidities. Such studies could help us understand whether these differences carry forward to childhood and adolescence and whether such differences impact the risk of cardiovascular/metabolic diseases. Were causation established, there would be a clear precedent established for intervening in early life to mitigate risk.

The strengths of our study include a validated body composition measurement method, a relatively large sample where body composition measures were acquired in the same laboratory, a sampling of four ethnic groups and models with high r^2 values (0.964–0.971). Limitations include the lack of information on pre-pregnancy and pregnancy maternal dietary/nutritional and socioeconomic status, factors that could differ across ethnic groups and therefore influence infant body composition. We did not measure the impact of potential *in utero* influences (maternal diet/nutrition, physical activity) on FM accretion in the developing foetus, which might impact FM and fat distribution at birth. We designed the study to minimize known confounding factors by recruiting women who were healthy both before and during pregnancy (e.g. non-diabetic), carried their singleton pregnancy to term and where the offspring was healthy. Ethnic group was determined by self-report, which is reported to be a suitable proxy for genetic ancestry, especially when assessing disease risk (33) but does not take into account degrees of admixture. For example, members of this Hispanic ethnic group carry the cultural and genetic background from different combinations of Amerindian, European and African ancestry. These populations are also highly admixed in terms of cultural and dietary factors.

These findings demonstrate that phenotyping of body composition traits beginning at birth requires sex and race/ethnicity specificity as a proxy for genetic ancestry. This suggests that physiological processes that lead to disparities in obesity and related comorbidities might begin *in utero*. Additional research is needed to determine the relationship between differences in adiposity beginning *in utero* and at birth and long-term health. Future studies should examine prenatal factors and body composition of infants to identify potential interventions to reduce these differences.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Infant, mother and father characteristics by race and sex

	African-American (n = 44: 21 m/23 f) Mean ± SD	Asian (n = 30: 14 m/16 f) Mean ± SD	Caucasian (n = 186: 88 m/98 f) Mean ± SD	Hispanic (n = 72: 40 m/32 f) Mean ± SD
Age at test (days)				
Females *	1.39 ± 0.50	1.38 ± 0.62	1.48 ± 0.65	1.41 ± 0.50
Males *	1.48 ± 0.68	1.86 ± 0.36	1.50 ± 0.64	1.65 ± 0.62
Length (cm)				
Females *	49.34 ± 2.65 ^{A,C}	49.00 ± 1.13 ^{AA}	49.29 ± 2.04 ^{AA}	48.98 ± 1.92
Males *	48.86 ± 2.44 ^{A,C}	51.21 ± 2.09 ^{AA}	50.39 ± 1.82 ^{AA}	49.69 ± 2.83
Weight (kg)				
Females *	3.09 ± 0.34 ^{C,H}	3.06 ± 0.31	3.21 ± 0.41 ^{AA}	3.09 ± 0.39 ^{AA}
Males *	3.05 ± 0.49 ^{C,H}	3.46 ± 0.50	3.36 ± 0.39 ^{AA}	3.37 ± 0.54 ^{AA}
Body mass index (kg m^{-2})				
Females	12.71 ± 1.24	12.71 ± 0.90	13.19 ± 1.45	12.83 ± 1.15
Males	12.68 ± 1.25	13.12 ± 1.08	13.20 ± 1.08	13.60 ± 1.66
Ponderal index (kg m^{-3})				
Females	25.87 ± 2.97	25.94 ± 1.65	26.83 ± 3.47	26.22 ± 2.46
Males	25.96 ± 2.33	25.63 ± 1.85	26.21 ± 2.23	27.50 ± 4.41
Fat (kg) ADP				
Females	0.48 ± 0.16	0.37 ± 0.15	0.47 ± 0.18	0.44 ± 0.20
Males	0.36 ± 0.18 ^{H}	0.43 ± 0.16	0.43 ± 0.19 ^{H}	0.51 ± 0.24 ^{AA,C}
Fat (%) ADP				
Females	15.40 ± 4.18	11.72 ± 3.92	14.28 ± 4.49	13.99 ± 5.46
Males	11.61 ± 4.70	12.24 ± 3.05	12.66 ± 4.78	14.51 ± 5.30
Triceps (mm)				
Females	4.15 ± 1.07	3.80 ± 0.96	4.15 ± 1.02	3.90 ± 1.11
Males	3.63 ± 0.84	3.98 ± 0.77	4.22 ± 1.03	4.38 ± 1.07
Biceps (mm)				
Females	3.15 ± 0.81	2.88 ± 0.76	3.23 ± 0.85	3.18 ± 1.08
Males	3.52 ± 0.98	2.95 ± 0.73	3.23 ± 0.80	3.30 ± 0.94
Subscapular (mm)				
Females	3.82 ± 0.68	3.64 ± 0.83	3.64 ± 0.88	3.59 ± 0.87
Males	3.63 ± 1.12	3.95 ± 1.00	3.63 ± 0.87	3.86 ± 1.14
Thigh (mm)				
Females	6.95 ± 1.35	5.63 ± 1.66	6.54 ± 1.84	6.00 ± 2.14
Males	4.75 ± 0.43	5.78 ± 1.72	6.66 ± 1.95	6.14 ± 1.81
Abdomen (cm)				
Females	29.21 ± 2.19 ^{C,H}	29.57 ± 2.55	30.06 ± 2.24 ^{AA}	29.76 ± 2.27 ^{AA}

	African-American (*n* = 44: 21 m/23 f) Mean ± SD	**Asian (*n* = 30: 14 m/16 f)** Mean ± SD	**Caucasian (*n* = 186: 88 m/98 f)** Mean ± SD	**Hispanic (*n* = 72: 40 m/32 f)** Mean ± SD
Males	28.80 ± 2.31 ^{C,H}	29.45 ± 1.95	30.07 ± 2.34 ^{AA}	30.14 ± 2.61 ^{AA}
Head (cm)				
Females *	34.04 ± 1.06 ^{A,C}	34.29 ± 1.16 ^{AA}	34.52 ± 1.05 ^{AA,H}	34.10 ± 1.22 ^{C}
Males *	34.32 ± 1.57 ^{A,C}	35.61 ± 1.12 ^{AA}	35.20 ± 1.13 ^{AA,H}	34.94 ± 1.54 ^{C}
Crown to rump (cm)				
Females	34.11 ± 1.71 ^{A,C}	35.19 ± 3.25 ^{AA,H}	34.41 ± 1.73 ^{AA}	33.97 ± 1.32 ^{A}
Males	33.62 ± 1.99 ^{A,C}	35.36 ± 1.60 ^{AA,H}	34.77 ± 1.51 ^{AA}	34.97 ± 2.17 ^{A}
Birth characteristics				
Gestational age (week)				
Females	39.37 ± 0.98	39.66 ± 0.97	39.69 ± 1.11	39.36 ± 1.21
Males	39.33 ± 1.21	40.37 ± 0.80	39.68 ± 1.15	39.63 ± 1.22
Weight (kg)				
Females *	3.21 ± 0.40 ^{C,H}	3.16 ± 0.35	3.40 ± 0.43 ^{AA,H}	3.20 ± 0.41 ^{AA,C}
Males *	3.14 ± 0.52 ^{C,H}	3.56 ± 0.50	3.55 ± 0.40 ^{AA,H}	3.49 ± 0.54 ^{AA,C}
Length (cm)				
Females *	50.22 ± 2.18 ^{A,C}	50.66 ± 1.90 ^{AA}	50.94 ± 2.12 ^{AA}	50.60 ± 1.73
Males *	50.35 ± 2.42 ^{A,C}	52.55 ± 1.82 ^{AA}	52.02 ± 2.20 ^{AA}	51.49 ± 2.57
Head circumference (cm)				
Females *	33.28 ± 1.46 ^{A,C,H}	34.23 ± 1.42 ^{AA}	34.26 ± 1.29 ^{AA}	33.83 ± 1.30 ^{AA}
Males *	33.65 ± 1.82 ^{A,C,H}	35.03 ± 1.37 ^{AA}	34.71 ± 1.10 ^{AA}	34.56 ± 1.57 ^{AA}
Mothers	African-American (*n* = 44) Mean ± SD	Asian (*n* = 30) Mean ± SD	Caucasian (*n* = 186) Mean ± SD	Hispanic (*n* = 72) Mean ± SD
Age at birth (years)				
Females	28.27 ± 6.80 ^{A,C}	32.56 ± 4.44 ^{AA,H}	33.85 ± 4.13 ^{AA,H}	27.53 ± 5.67 ^{A,C}
Males	27.43 ± 5.72 ^{A,C}	31.79 ± 4.21 ^{AA,H}	33.64 ± 4.32 ^{AA,H}	28.18 ± 5.74 ^{A,C}
Height (cm)				
Females	164.99 ± 6.83 ^{H}	162.12 ± 6.68 ^{C}	165.87 ± 7.35 ^{A,H}	161.33 ± 7.62 ^{AA,C}
Males	163.32 ± 7.65 ^{H}	162.38 ± 5.68 ^{C}	165.04 ± 6.29 ^{A,H}	161.21 ± 6.58 ^{AA,C}
Weight pre-pregnancy (kg)				
Females	74.41 ± 16.84 ^{A,C}	58.10 ± 11.36 ^{AA,C,H}	62.35 ± 10.78 ^{AA,A,H}	68.49 ± 14.07 ^{A,C}
Males	66.77 ± 13.09 ^{A,C}	54.42 ± 7.32 ^{AA,C,H}	61.82 ± 11.60 ^{AA,A,H}	66.99 ± 14.70 ^{A,C}
Body mass index pre-pregnancy (kg m^{-2})				
Females	27.31 ± 5.77 ^{A,C}	22.10 ± 3.87 ^{AA,H}	22.68 ± 3.78 ^{AA,H}	26.36 ± 5.20 ^{A,C}

	African-American (*n* = 44: 21 m/23 f)	**Asian (*n* = 30: 14 m/16 f)**	**Caucasian (*n* = 186: 88 m/98 f)**	**Hispanic (*n* = 72: 40 m/32 f)**
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Males	24.94 ± 4.01^{A,C}	20.68 ± 3.07^{AA,H}	22.64 ± 3.79^{AA,H}	25.83 ± 5.79^{A,C}
Weight gain (kg)				
Females	12.62 ± 4.36	13.52 ± 2.81	14.26 ± 4.09	13.62 ± 6.28
Males	12.58 ± 4.71	15.68 ± 3.68	15.53 ± 4.83	14.08 ± 6.97
Fathers				
Age at birth (years)				
Females	29.81 ± 7.92^{A,C}	35.93 ± 4.80^{AA,H}	35.94 ± 5.20^{AA,H}	31.72 ± 6.47^{A,C}
Males	32.65 ± 6.93^{A,C}	34.14 ± 4.85^{AA,H}	36.13 ± 5.15^{AA,H}	30.60 ± 7.55^{A,C}
Height (cm)				
Females	180.59 ± 6.61^{A,H}	175.10 ± 6.24^{AA,C}	179.82 ± 7.56^{A,H}	175.43 ± 7.54^{AA,C}
Males	180.47 ± 7.69^{A,H}	174.17 ± 7.37^{AA,C}	180.13 ± 6.86^{A,H}	175.85 ± 7.98^{AA,C}
Weight (kg)				
Females	89.38 ± 13.55^{A,H}	76.67 ± 15.62^{AA,C,H}	85.32 ± 12.36^{A}	85.80 ± 13.22^{AA,A}
Males	88.83 ± 15.29^{A,H}	75.73 ± 10.28^{AA,C,H}	83.23 ± 12.95^{A}	80.05 ± 12.04^{AA,A}
Body mass index (kg m^{-2})				
Females	27.21 ± 4.96	26.86 ± 8.36	26.38 ± 3.55	27.87 ± 3.63
Males	27.02 ± 4.10	24.74 ± 2.26	25.91 ± 4.54	25.58 ± 3.63

Values are mean ± SD.

Asterisk (*) indicates significant difference between males and females ($P \leq 0.05$).

Superscript letters indicate significant differences between races: ^{A}, Asian; ^{AA}, African-American; ^{C}, Caucasian; ^{H}, Hispanic.

ADP, air displacement plethysmography; f, female; m, male; SD, standard deviation.

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Table 2

Differences in adjusted mean fat mass (kg) by ADP between races for males and females

		Males		Females	
Race (i)	**Race (j)**	**Difference (i–j)**	***P*-value***	**Difference (i–j)**	***P*-value****
African-American	Caucasian	0.058 ± 0.030	0.0515	0.055 ± 0.028	0.0528
Hispanic	Caucasian	0.108 ± 0.023	0.0001	0.011 ± 0.025	0.6630
Asian	Caucasian	0.074 ± 0.035	0.0353	0.017 ± 0.032	0.5896
Hispanic	African-American	0.050 ± 0.032	0.1219	−0.044 ± 0.032	0.1689
Asian	African-American	0.016 ± 0.043	0.7086	−0.038 ± 0.039	0.3381
Asian	Hispanic	−0.034 ± 0.038	0.3703	0.007 ± 0.037	0.8585

Values are Least squares (LS) mean ± standard error estimate (SEE).

* *P*-value within males.

** *P*-value within females.

ADP, air displacement plethysmography.

Table 3

Mean adjusted subscapula (mm) by race and sex and between races for females and males combined

	By race and sex	
Race	**Females***	**Males***
Caucasian	3.65 ± 0.09	3.45 ± 0.10
African-American	4.02 ± 0.18	3.91 ± 0.18
Hispanic	3.78 ± 0.15	3.77 ± 0.13
Asian	4.02 ± 0.20	3.90 ± 0.23

	Between races for females and males combined		
Race (i)	**Race (j)**	**Difference (i–j)†**	***P*-value**
African-American	Caucasian	0.415 ± 0.139	0.0030
Hispanic	Caucasian	0.226 ± 0.112	0.0452
Asian	Caucasian	0.409 ± 0.158	0.0100
Hispanic	African-American	−0.189 ± 0.151	0.2106
Asian	African-American	−0.006 ± 0.195	0.9742
Asian	Hispanic	0.183 ± 0.176	0.2988

*Values are mean ± SEE.

†Values are LS mean ± standard error estimate (SEE).