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Body fat is differentially related to body mass index in U.S.-born African-American and East African immigrant girls

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Abstract

Objectives—To examine ethnic differences in adiposity at a given BMI in a sample of U.S.-born African-American and East African immigrant adolescent girls.

Methods—In a sample of black adolescent girls (n=79; ages 14–20) we compared measures of adiposity across the range of BMI-for-age among 55 U.S.-born African American (mean BMI: 30.4; age: 15.4) and 24 East African immigrant girls (mean BMI: 21.8; age: 16.7). Fat and fat-free mass were assessed with dual-energy X-ray absorptiometry (DXA). We used spline regression to examine the distributions of fat mass index and percent body fat across the range of BMI-for-age z-scores.

Results—Compared to African-American girls, East African girls were smaller on all body measures, but appeared to have higher fat mass index and percent body fat at the same BMI-forage.

Conclusions—Our findings indicate that at a given BMI East African immigrants may have greater adiposity than African-American girls. If corroborated in larger samples, our data suggest that the cardiometabolic risks attendant to elevated adiposity may affect East African girls at a lower BMI than in African-American girls.

Keywords

Body composition; adiposity; ethnicity; prenatal nutrition; immigrants; adolescents; female

Introduction

Literature has documented ethnic differences in body composition (Camhi and others 2010; Deurenberg and Deurenberg-Yap 2001). Higher adiposity and cardiometabolic risk at a low body mass index (BMI) among Asians, as compared to other ethnic groups have been reported (Deurenberg-Yap and others 2002; Deurenberg and Deurenberg-Yap 2001), prompting suggestions for Asian-specific BMI cut-points (World Health Organization 2004). Intra-ethnic group variation has been less explored, although differences have been observed. In one study, migrant Pakistanis living in Britain had higher BMI-adjusted waist-to-hip ratio and fasting glucose, as compared to Pakistanis born in Britain (Pollard and others 2008).

Differences like those between migrant and British-born Pakistanis have been hypothesized to reflect a move to a nutrient-dense environment from one of nutrient scarcity (Yajnik

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2004), such as when emigrating to Western countries (Pollard and others 2008). A growing literature suggests that the pre-natal and pre-conceptual environments exert a strong influence on developmental trajectories; if post-natal environmental conditions differ significantly, a mismatch exists that may increase the risk of disease (Godfrey and others 2007). A propensity to store fat may be protective in environments with frequent nutrient scarcity, but harmful in nutrient-dense environments.

We considered differences in body composition between U.S.-born African-American and East African-born adolescent girls, using data from a recent physical activity intervention study. Given the mismatch hypothesis and previous epidemiologic findings, we hypothesized that East African girls would have greater adiposity at a given BMI than African-American girls.

Methods

Study design and sample

We used baseline data from a school-based physical activity intervention study, New Moves (Neumark-Sztainer and others 2010), conducted in the Minneapolis/St. Paul metropolitan area (Minnesota, USA) during the 2007–2009 school years. Girls were recruited from study schools by offering an all-girls physical education class as an alternative to regular coeducational physical education class. Recruitment efforts focused on sedentary girls. Four girls were excluded because of high levels of physical activity. There were no weight- or BMI-based eligibility criteria. The study was approved by the University of Minnesota’s Institutional Review Board. Details of the study have been published (Neumark-Sztainer and others 2010).

Data collection and measures

Study participants completed a written survey that included questions about ethnicity, U.S. nativity, background (e.g., Somali, Ethiopian), and physical activity (Neumark-Sztainer and others 2010).

Anthropometry and body composition were assessed using standard procedures at the University of Minnesota’s General Clinical Research Center by trained study staff (Neumark-Sztainer and others 2010). Female BMI-for-age percentiles and BMI-for-age z-scores were calculated from the CDC 2000 growth charts (Kuczmarski and others 2000).

Percent body fat, fat mass (FM), and fat-free mass (FFM) were assessed using a whole-body, fan-beam DXA scanner (Lunar Prodigy, Madison, WI; Encore 2005, version 9.3 software). Percent body fat was calculated as fat mass (kg)/(fat mass (kg) + fat-free mass (kg)). Fat mass index (FMI) and fat-free mass index (FFMI) were calculated, respectively, as: fat mass (kg)/height (m)^2 and fat-free mass (kg)/height (m)^2.

Statistical analysis

Of the 356 New Moves participants, 101 girls reported black race. We excluded participants who were missing data for BMI (n=1) or DXA (n=16) or who were not either U.S.-born African-American or East African immigrant (n=6). After exclusions, we had 54 African-American and 25 East African girls.

Given the small sample, we used non-parametric statistical methods. We used the Wilcoxon signed-rank test to evaluate differences between means in the total sample and for those with BMI-for-age <85th percentile. We used spline regression to examine group-specific curves for the distributions of FMI and body fat percent across the distribution of BMI-for-age z-scores. Group differences in FMI or body fat percent were determined based on overlapping 95% confidence intervals of the fitted spline curves. All analyses were conducted with SAS (PC version 9.2). Statistical significance was based on an alpha < 0.05.

Results

East African girls were older than African-American girls and smaller on all body measurements (table 1). The prevalence of obesity (≥95th percentile BMI-for-age) was higher among African-American girls (49%), compared to East African girls (7%) (p<0.001). The two groups had similar body fat percentages (40.8% in African-American and 37.9% in East African girls). FMI and FFMI were both higher in African-American girls (both p=0.002). Among girls who were <85th percentile of BMI-for-age, differences were not as strong and some differences no longer remained, such as the difference in height. An exception was that East African girls now had a significantly higher mean percent body fat (35.6%), compared to African-American girls (28.3%) (p<0.001).

Age-adjusted spline regression curves are shown in figure 1. Across the distribution of BMI-for-age z-score, East African girls tended to have higher FMI (figure 1.a.) and percent body fat (figure 1.b). Differences were most notable below the 85th percentile of BMI-for-age, particularly for percent body fat. R-square estimates were 0.94 for the FMI model and 0.80 for the percent body fat model. Analyses were limited by small numbers. There was one East African girl above the 95th percentile of BMI-for-age; below the 85th percentile, there were 17 African-American and 20 East African girls.

Discussion

In this study, East African girls had markedly lower obesity prevalence as well as lower stature and fat-free mass than U.S.-born African-American girls. Within the normal BMI range (<85th percentile for age), however, East African girls had higher fat mass index and percent body fat than African-American girls. These findings require confirmation in larger samples, but may illustrate a potentially significant health consideration for the East African immigrant population, since a higher adiposity at the same BMI may yield increased cardiometabolic risk than that observed in other populations.

Our findings contribute to the literature around ethnic differences in body composition. For instance, African-American women have lower levels of visceral adipose tissue at a given total adiposity than do European-American women (Camhi and others 2010). Asians have been shown to have relatively higher adiposity and cardiometabolic risk, as compared to other populations, at low BMIs (Deurenberg-Yap and others 2002); there is also evidence of intra-Asian variation in body composition (Deurenberg-Yap and others 2001).

More specifically, our data align with other studies that have supported possible metabolic health effects of migrating from a nutrient scarce to a nutrient dense environment. We lacked information on early life, including birth weight, but the shorter stature and lower body weight of the East African girls is consistent with a history of poorer nutritional status. According to the WHO, the prevalence of malnutrition among Somali children under age 5 is estimated to be 36% (World Health Organization 2008)., Based on data from another study, Project EAT, conducted in the Minneapolis/St. Paul metropolitan area, 45% of adolescents with Somali or Ethiopian background had been in the U.S. less than 5 years and 33% between 5 and 10 years (unpublished data). We were unable to examine an extensive set of covariates and cannot exclude the possibility of other important explanatory variables, such as diet. Apparent differences in physical activity, however, did not support observed differences in body composition, since East Africans girls appeared to have higher mean physical activity levels (table 1).

Given the large East African population in MN (Minnesota Department of Administration and others 2010), we were uniquely poised to describe, for the first time, differences in body composition between African-American and East African girls. Our measures of body composition were of high quality, with clinical assessment of height, weight, and the use of DXA for fat and fat-free mass estimates. Although consistent with biologic plausibility and statistically significant, our findings nonetheless relied on a limited sample.

The black girls in our study were not representative of girls in the U.S., having higher median body fat percents and a greater percentage of girls ≥95th percentile of BMI-for-age (Kelly and others 2009). Differential participation by body size may have biased body composition comparisons (table 1), but should not have affected BMI-adjusted analysis (figure 1). The East African girls were significantly older than African American girls, but age-adjusted analysis did not alter the findings. We lacked biologic samples and were thus unable to examine associations between BMI and other cardiometabolic risk variables, such as lipid or glucose levels.

In summary, adolescent girls who emigrated to the U.S. from East Africa had a higher fat mass index and percent body fat than African-American girls, in BMI-controlled analysis. This body composition pattern, observed even at BMIs considered healthy (<85th percentile-for-age), may translate into increased cardiometabolic risk, and point to a need for further research to explore the unique health needs of immigrants from developing countries.

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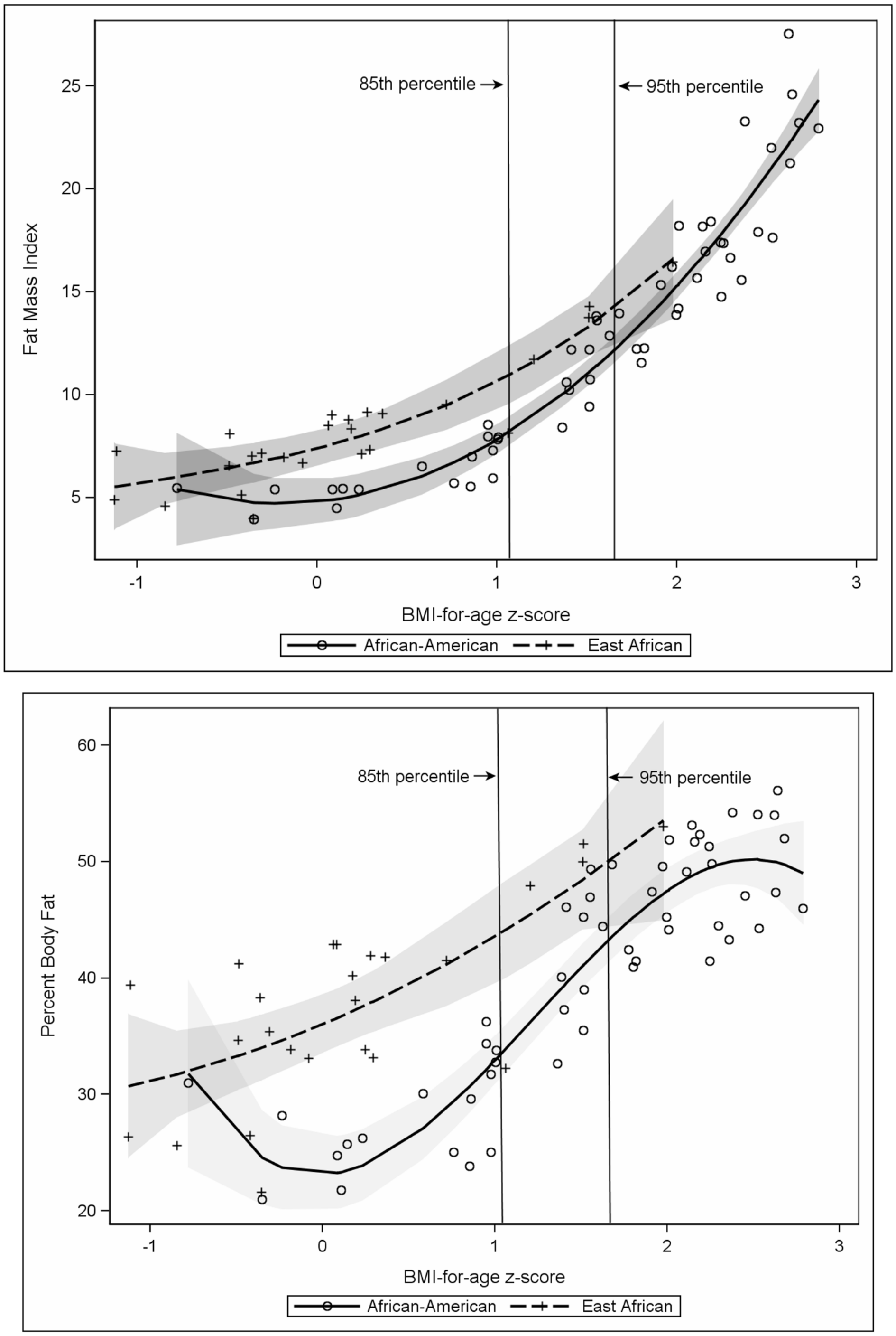

Figure 1.

Figure 1a. Fit (95% CI) from spline regression of fat mass index and BMI-for-age z-score in African-American and East African girls.

Figure 1b. Fit (95% CI) from spline regression of percent body fat and BMI-for-age z-score in African-American and East African girls.

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Table 1

Characteristics for U.S.-born African-American and East African immigrant adolescent girls, total sample and <85th percentile BMI-forage.

Total sample	African-American (n=54)						East African (n=25)						Difference between means
	Min	25th %	Median	75th %	Max	Mean (SD)	Min	25th %	Median	75th %	Max	Mean (SD)	p-value
Age (yr)	14.0	15.0	15.0	16.0	18.0	15.4 (1.1)	14.0	16.0	17.0	18.0	20.0	16.7 (1.6)	<0.001
Height (cm)	147.6	158.7	162.2	165.5	187.3	162.4 (6.5)	150.6	155.7	160.4	162.7	165.6	159.3 (4.6)	0.031
Weight (kg)	47.9	58.0	79.1	90.8	143.7	80.5 (24.0)	42.7	48.9	52.5	59.4	85.6	55.5 (10.7)	<0.001
BMI (kg/m^2)	17.9	23.7	29.0	35.3	52.2	30.3 (8.2)	17.9	19.4	21.0	22.3	31.2	21.8 (3.3)	<0.001
BMI-for-age z-score	−0.8	1.0	1.7	2.2	2.8	1.5 (0.9)	−1.1	−0.4	0.1	0.4	2.0	0.2 (0.8)	<0.001
Fat mass (kg)	11.1	18.7	34.2	44.8	75.8	34.4 (16.5)	10.0	16.8	18.9	24.4	45.1	21.5 (8.6)	0.002
Fat mass index (kg/m^2)	3.9	7.8	12.6	17.3	27.5	12.9 (6.0)	4.0	7.0	8.1	9.1	16.5	8.4 (3.0)	0.002
Trunk fat (kg)	4.6	8.5	18.1	22.5	40.7	17.0 (8.7)	3.9	7.0	8.1	10.9	22.4	9.7 (4.5)	<0.001
Arm and leg fat (kg)	5.5	9.7	15.3	21.7	34.0	16.4 (7.8)	5.5	8.8	10.1	12.1	21.6	11.0 (4.0)	0.003
Fat-free mass (kg)	31.1	39.9	43.5	47.7	70.5	45.6 (8.7)	26.2	31.7	33.3	35.6	45.3	33.6 (3.9)	<0.001
Fat-free mass index (kg/m^2)	12.2	15.7	16.6	17.8	26.9	17.2 (2.7)	11.1	12.6	13.4	13.8	17.1	13.2 (1.3)	<0.001
Percent body fat (%)	21.0	32.6	43.7	49.4	56.1	40.8 (10.0)	21.6	33.2	38.3	41.9	53.0	37.9 (8.1)	0.16
Total physical activity (hr/wk)	0.0	1.0	2.5	4.3	11.7	3.4 (3.3)	0.7	2.3	4.0	6.0	12.0	4.5 (2.9)	0.042
Moderate-vigorous physical activity (hr/wk)	0.0	0.3	1.3	2.7	10.0	2.1 (2.5)	0.0	1.0	2.0	3.0	5.7	2.0 (1.5)	0.41
Total sedentary activity (hr/wk)	11.7	31.3	33.3	35.0	36.0	31.9 (4.4)	24.0	30.0	31.7	33.7	35.3	31.4 (3.0)	0.11
Bone mass (kg)	2.1	2.5	2.9	3.5	4.0	3.0 (0.6)	1.8	2.0	2.2	2.5	3.1	2.3 (0.4)	<0.001

<85th percentile BMI-for-age	African-American (n=17)						East African (n=20)						Difference between means
	Min	25th %	Median	75th %	Max	Mean (SD)	Min	25th %	Median	75th %	Max	Mean (SD)	p-value
Age (yr)	14.0	15.0	15.0	15.0	18.0	15.2 (1.0)	14.0	16.0	17.0	18.0	20.0	17.0 (1.7)	0.001
Height (cm)	151.9	156.4	158.9	163.8	170.6	160.3 (5.5)	150.6	155.5	159.0	161.7	165.5	158.5 (4.4)	0.39
Weight (kg)	47.9	53.4	55.4	58.0	69.0	56.1 (5.2)	42.7	47.5	49.9	55.9	60.1	51.3 (5.3)	0.015
BMI (kg/m^2)	17.9	20.7	22.9	23.6	23.9	21.9 (1.9)	17.9	18.9	20.4	21.9	23.1	20.4 (1.6)	0.017
BMI-for-age z-score	−0.8	0.1	0.8	0.9	1.0	0.5 (0.6)	−1.1	−0.5	−0.1	0.2	0.7	−0.2 (0.5)	0.002
Fat mass (kg)	11.1	13.8	14.9	18.4	22.7	16.0 (3.4)	10.0	16.0	17.8	22.3	25.0	18.3 (4.6)	0.097

<85th percentile BMI-for-age	African-American (n=17)						East African (n=20)						Difference between means
	Min	25th %	Median	75th %	Max	Mean (SD)	Min	25th %	Median	75th %	Max	Mean (SD)	p-value
Fat mass index (kg/m^2)	3.9	5.4	5.7	7.3	8.5	6.2 (1.3)	4.0	6.6	7.2	8.6	9.5	7.3 (1.6)	0.053
Trunk fat (kg)	4.6	6.0	7.3	8.3	11.3	7.3 (1.8)	3.9	6.7	7.4	10.0	11.6	8.0 (2.3)	0.49
Arm and leg fat (kg)	5.5	6.7	7.6	9.4	11.2	8.0 (1.7)	5.5	8.2	9.7	11.9	13.3	9.6 (2.3)	0.037
Fat-free mass (kg)	32.7	37.7	39.9	41.7	47.7	40.2 (3.7)	26.2	31.6	32.9	34.5	36.2	32.6 (2.6)	<0.001
Fat-free mass index (kg/m^2)	12.2	15.1	15.7	16.4	17.8	15.6 (1.4)	11.1	12.2	13.2	13.6	14.8	13.0 (1.1)	<0.001
Percent body fat (%)	21.0	25.0	28.2	31.8	36.2	28.3 (4.6)	21.6	33.1	36.7	41.4	42.9	35.6 (6.4)	<0.001
Total physical activity (hr/wk)	0.0	0.3	2.0	4.0	11.7	2.6 (3.1)	0.7	2.3	4.3	6.0	12.0	4.7 (3.1)	0.018
Moderate-vigorous physical activity (hr/wk)	0.0	0.0	0.7	2.0	8.0	1.5 (2.3)	0.0	0.8	1.8	2.7	4.7	1.9 (1.3)	0.11
Total sedentary activity (hr/wk)	11.7	32.0	33.7	35.0	36.0	31.9 (6.1)	24.0	29.8	31.5	33.7	35.3	31.2 (3.2)	0.051
Bone mass (kg)	2.1	2.2	2.4	2.5	3.2	2.4 (0.3)	1.8	2.0	2.1	2.3	2.7	2.2 (0.2)	0.006