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Total, resting, and activity-related energy expenditures are similar in Caucasian and African-American children

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Sun, Min, Barbara A. Gower, Tim R. Nagy, Chris A. Trowbridge, Carl Dezenberg, and Michael I. Goran. Total, resting, and activity-related energy expenditures are similar in Caucasian and African-American children. *Am. J. Physiol.* 274 (*Endocrinol. Metab.* 37): E232–E237, 1998.—There is some evidence to suggest that ethnic differences in energy expenditure in adults may modulate different propensities for obesity. However, there is lack of data for the components of energy expenditure in young children of different ethnic backgrounds. In this study, we examined total energy expenditure (TEE), resting energy expenditure (REE), and physical activity-related energy expenditure (AEE) in healthy prepubertal Caucasian (18 girls, 21 boys) and African-American (29 girls, 30 boys) children. TEE was measured over 14 days under free-living conditions with the doubly labeled water technique, REE was from indirect calorimetry after an overnight fast, and AEE was estimated from the difference between TEE and REE after reducing TEE by 10% to account for the thermic effect of feeding. Fat mass (FM) and fat-free mass (FFM) were measured by dual-energy X-ray absorptiometry. There were no significant effects of ethnicity or gender on TEE after adjustment for FFM or for both FFM and FM. For REE, there was no effect of ethnicity, but a significant effect of gender, with a higher REE in boys after adjustment for FFM and FM ($P < 0.001$). For AEE, there were no significant effects of ethnicity or gender after adjustment for FFM or for FFM and FM. In conclusion, ethnicity was not a significant determinant for any of the components of energy expenditure. TEE, REE, and AEE were similar in Caucasian and African-American prepubertal children after adjustment for FFM or for FFM and FM.

ethnicity; fat-free mass; fat mass; childhood obesity; body composition

DATA FROM THE National Health and Nutrition Examination Survey III show that the prevalence of obesity (body mass index ≥95th percentile) among children (age 6–11 yr) continued to increase between 1976 and 1980 (prevalence of 7.6%) and 1988 and 1991 (prevalence of 10.9%) (1). In a cohort of 6,200 children in Birmingham, Alabama, African-American children had a higher prevalence of obesity (defined as >120% ideal body weight) than Caucasian children of the same age (8). At age five, the prevalence in African-American girls was 23%, compared with 10% in Caucasian girls; for boys, the prevalence was 26% in African-Americans and 13% in Caucasians. By age 10, the prevalence of obesity in African-Americans vs. Caucasians was 38 vs. 21% in girls and 26 vs. 21% in boys. The underlying cause of the higher prevalence of obesity among African-American children is unknown. Some evidence suggests that a reduced energy expenditure may be involved in the etiology of obesity in children (17, 22); however, other studies do not support this concept (4, 5, 11, 14).

In the prepubertal age, ethnic differences of the components in energy expenditure have been identified. We have shown that total energy expenditure was 8.5% higher because of a 37% higher physical activity-related energy expenditure in Mohawk Indian compared with Caucasian children independent of fat-free mass and gender (15). In addition, two earlier studies that compared Mohawk or Pima Indian with Caucasian children found that ethnicity was not a significant determinant of resting energy expenditure after adjustment for fat-free mass, fat mass, and gender (9, 14). In contrast, resting energy expenditure was found to be 14% lower in African-American than in Caucasian children after adjustment for age, gender, body weight, fat-free mass, and fat mass (18). A 4% lower resting energy expenditure was also found in normal weight African-American compared with Caucasian girls, after adjustment for fat-free mass and bone density (25). These studies indicate that ethnicity may be an important determinant for resting energy expenditure in children; however, the effects of ethnicity remain uncertain.

Ethnic differences in energy expenditure have also been examined in other age groups. Among girls aged 6–16 yr, lower resting energy expenditure was found in African-Americans than in Caucasians after adjustment for both body weight and lean body mass (20). Lower resting energy expenditure was also observed in African-American adult women (10). Compared with Caucasians, African-American women had an 8% lower resting energy expenditure independent of fat-free mass. In addition, older (>55 yr of age) African-Americans had a 10% lower total energy expenditure, because of a 5% lower resting energy expenditure and a 19% lower physical activity-related energy expenditure than Caucasians, independent of fat-free mass and gender (3).

However, no previous study has examined the various components of total daily energy expenditure in African-American vs. Caucasian children. We hypothesized that total daily energy expenditure was not different between Caucasian and African-American children. The current study evaluated the determinants for the components of total daily energy expenditure in 98 African-American and Caucasian children. The main purpose was to examine the possible influence of ethnicity on total energy expenditure, resting energy expenditure, and physical activity-related energy expenditure after controlling for fat-free mass or for both fat and fat-free mass in African-American vs. Caucasian prepubertal children.

METHODS

Subjects. Our sample included 39 Caucasian children (18 girls, 21 boys) aged 8.3 ± 1.4 yr (range 5.2 to 10.9 yr) and 59 African-American children (29 girls, 30 boys) aged 7.5 ± 1.5 yr (range 4.7 to 10.0 yr) from Birmingham, Alabama. Children were defined as Caucasian or African-American on the basis of the ethnic status of their parents and grandparents derived by questionnaire. The children were recruited with the use of newspaper advertisements, word of mouth, and a school intervention study. Children were ineligible if they were *1*) <4 yr of age, *2*) beyond Tanner stage I, as assessed by a physical examination by a pediatrician (Tanner stage I was defined on the basis of breast stage and pubic hair development in girls and genitalia development in boys), *3*) taking medications known to affect body composition or physical activity (e.g., prednisone, ritalin, growth hormone), *4*) previously diagnosed with syndromes known to affect body composition and/or fat distribution (e.g., Cushing's syndrome, Down's syndrome, type I diabetes, hypothyroidism), or *5*) diagnosed with any major illnesses since birth. We have previously reported body composition (16) and fitness (24) data in these children. The nature, purpose, and possible risks of the study were carefully explained to the parent before consent was obtained. Studies were performed during the school year, mainly in the fall for African-Americans and mainly in the spring and fall for Caucasians. This study was approved by the Institutional Review Board at the University of Alabama at Birmingham, and parents provided informed consent before testing commenced. All measurements were performed at the General Clinical Research Center (GCRC) or in The Department of Nutrition Sciences at the University of Alabama at Birmingham between 1994 and 1997.

General outline of protocol. Children were admitted to the GCRC in the late afternoon for an overnight visit. On arrival, a baseline urine sample was collected, and subjects were dosed with the doubly labeled water. Anthropometric measurements were obtained, and dinner was served (∼1700). An evening snack was allowed, and after 2000 only water and energy-free, noncaffeinated beverages were permitted until after the morning testing. On the following morning after an overnight fast, resting metabolic rate was assessed by indirect calorimetry on awakening of subjects, and two timed urine samples were collected for the doubly labeled water analysis. Two weeks later, the children arrived at the Energy Metabolism Research Unit at 0700 in the fasted state, and body composition was determined by dual-energy X-ray absorptiometry (DEXA). Two additional timed urine samples were collected for the doubly labeled water analysis.

Measurement of energy expenditure components. Total energy expenditure was measured over 14 days under free-living conditions with the doubly labeled water technique with the use of a protocol with a theoretical error of <5%, as previously described (11). For deuterium relative to baseline, the average initial enrichment was 1,183.28 ± 301.19 ‰, and the mean final enrichment was 332.75 ± 125.63 ‰ (equivalent to just over 2 biological half-lives). For oxygen-18 relative to the baseline, the average initial enrichment was 110.55 ± 20.93 ‰, and the mean final enrichment was 19.00 ± 6.92 ‰ (equivalent to just over 2 biological half-lives). Samples were analyzed in triplicate for $H_2{}^{18}O$ and ^2H_2O by isotope ratio mass spectrometry at the University of Alabama at Birmingham, as previously described (11). The mean dilution space ratios (DSR) were not significantly different among Caucasian girls, Caucasian boys, African-American girls, and African-American boys. When all samples for deuterium and oxygen-18 were reanalyzed in seven subjects, values of total energy expenditure were in close agreement (±4.3%), as previously described (11). CO_2 production rate was determined using *equation R2* of Speakman et al. (23), assuming a fixed DSR of 1.0427, and energy expenditure was calculated using *equation 12* of de Weir (6). Mean value for the food quotient of the children's diet (0.90 in Caucasian and 0.87 in African-American) was determined by duplicated 24-h recall. Total energy expenditure data were screened for physiological outliers by regressing total energy expenditure against body weight, fat-free mass, and resting energy expenditure. Data were considered outliers if the residual from any of these regressions was greater or less than three standard deviations from the means. Seven values did not meet these criteria and were removed for the main analyses presented.

Resting energy expenditure was measured in the early morning after an overnight fast in the GCRC, using a Deltatrac Metabolic Monitor (Sensormedics, Yorba Linda, CA). During testing, all subjects were instructed to lie as still as possible and remain awake. An adult-size canopy hood was used to collect the expired air. After a 10-min equilibration period, data on oxygen consumption and carbon dioxide production were collected continuously for 20 min. Energy expenditure was calculated using the equation of de Weir (6).

Physical activity-related energy expenditure was estimated in two ways. One was from the difference between total and resting energy expenditure after reducing total energy expenditure by 10% to account for the thermic effect of feeding (19). Another was from the residual of the regression between total and resting energy expenditure.

Assessment of body composition and anthropometry. Total and regional body composition were measured by DEXA using a Lunar DPX-L densitometer that we have previously validated in the pediatric body weight range (13, 21). Subjects were scanned in light clothing while lying flat on their backs with arms by the side. DEXA scans were performed and analyzed using pediatric software (version 1.5e), as previously described (13, 21). On the day of each test, the DPX-L was calibrated using the procedures provided by the manufacturer. Height was measured without shoes using a stadiometer. Weight was measured in light clothing on an electronic scale.

Statistics. Differences in physical characteristics, body composition, and energy expenditure among African-American and Caucasian boys and girls were examined in a two-way (gender and ethnic groups) analysis of covariance (ANCOVA). Total energy expenditure, resting energy expenditure, and activity-related energy expenditure were examined as dependent variables with fat and fat-free mass as covariates and ethnicity and gender as the main effect variables. Total energy expenditure was also examined, with resting energy expenditure as a covariate, for differences in nonresting (i.e., mainly physical activity-related) energy expenditure. Similarity of regression slopes among the subgroups (by ethnicity and gender) was examined by the significance of the interaction between the covariate and each of the two grouping variables and was a prerequisite for proceeding with each of the ANCOVA models. Data were analyzed using SAS software version 6.10 (Carey, NC), with a significance level set at $P < 0.05$ for all tests.

RESULTS

Subject characteristics. The characteristics of the children are presented in Table 1. Caucasian children were older than the African-Americans ($P = 0.006$). The

Table 1. *Subject characteristics*

	All Children ($n = 98$)	Caucasian Girls ($n = 18$)	Caucasian Boys ($n = 21$)	African-American Girls ($n = 29$)	African-American Boys ($n = 30$)	2-Way ANOVA (*P* value)
Age, yr	7.8 ± 1.5 (4.7–10.9)	8.4 ± 1.1 (5.2–9.8)	8.3 ± 1.6 (5.6–10.9)	7.6 ± 1.6 (4.7–9.9)	7.3 ± 1.5 (5.1–10.0)	Ethnicity ($P = 0.006$)
Weight, kg	33.4 ± 11.9 (17.0–68.4)	41.2 ± 13.0 (18.5–66.0)	29.3 ± 7.2 (17.0–45.1)	34.5 ± 11.9 (18.8–62.6)	30.5 ± 11.2 (19.8–68.4)	Gender ($P = 0.001$)
Height, cm	129.5 ± 10.8 (107.0–155.0)	131.9 ± 11.1 (110.0–152.8)	129.8 ± 9.9 (110.0–148.5)	129.4 ± 11.3 (107.8–155.0)	127.8 ± 11.1 (107.0–153.0)	NS
FFM, kg	22.0 ± 5.4 (12.4–37.6)	23.9 ± 6.2 (13.4–37.6)	20.8 ± 3.8 (12.4–25.9)	21.7 ± 5.0 (14.0–31.6)	21.9 ± 5.9 (14.6–35.3)	NS
FM, kg	10.8 ± 8.2 (2.0–44.7)	16.0 ± 9.9 (4.2–44.7)	7.1 ± 4.7 (2.6–19.7)	12.7 ± 7.6 (3.8–29.2)	8.2 ± 7.7 (2.0–30.8)	Gender ($P = 0.0001$)
TEE, kcal/day	1,757 ± 403 (972–2,749)	1,946 ± 432 (1,246–2,723)	1,704 ± 330 (1,189–2,537)	1,717 ± 377 (1,221–2,538)	1,718 ± 441 (972–2,749)	NS
REE, kcal/day	1,247 ± 215 (919–2,116)	1,280 ± 221 (919–1,869)	1,244 ± 198 (919–1,765)	1,210 ± 199 (967–1,611)	1,265 ± 242 (930–2,116)	NS
AEE, kcal/day	334 ± 255 (−232–998)	472 ± 260 (95–928)	290 ± 206 (−80–715)	335 ± 242 (−183–965)	282 ± 277 (−232–998)	Gender ($P = 0.02$)

Data are means ± SD with range in parentheses; *n*, no. of children/group. FFM, fat-free mass; FM, fat mass; TEE, total energy expenditure; REE, resting energy expenditure; AEE, activity-related energy expenditure; ANOVA, analysis of variance; NS, not significant.

girls overall were heavier ($P = 0.001$), had greater fat mass ($P = 0.0001$), and had a higher absolute physical activity-related energy expenditure than boys ($P = 0.02$). Caucasian girls had the highest weight, body mass, and absolute total energy expenditure among the four subgroups.

Analysis of ethnic differences in total energy expenditure. The relationships between total energy expenditure and fat-free mass in the four subgroups are summarized in Table 2 and Fig. 1. The regression slopes were not significantly different among the four subgroups. After adjustment for fat-free mass or for fat-free and fat mass, adjusted least square means of total energy expenditure were not significantly influenced by ethnicity or the interaction of ethnicity and gender (Table 2). When the interaction of ethnicity and gender was excluded from the ANCOVA model, the effect of ethnicity remained insignificant ($P = 0.2$). When genders were combined, there were still no significant effects of ethnicity on total energy expenditure after adjustment for fat-free mass ($P = 0.2$) or for fat-free and fat mass ($P = 0.2$) (data not shown).

Analysis of ethnic differences in resting energy expenditure. The relationships between resting energy expenditure and fat-free mass in the four subgroups are summarized in Table 3 and Fig. 1. The regression slopes were not significantly different among the four subgroups. Resting energy expenditure was not significantly influenced by ethnicity or the interaction of ethnicity and gender after adjustment for fat-free mass or both fat-free mass and fat mass. When the interaction of ethnicity and gender was excluded from the ANCOVA model, the effect of ethnicity remained insignificant.

Analysis of ethnic differences in activity-related energy expenditure. The relationships between activity-related energy expenditure (expressed as the difference between total and resting energy expenditure) and fat-free mass in the four subgroups are summarized in Table 4 and Fig. 1. The regression slopes were not significantly different among the four subgroups. Activity-related energy expenditure was not significantly influenced by ethnicity or the interaction of ethnicity and gender. When the interaction of ethnicity and gender was excluded from the ANCOVA model, the effect of ethnicity remained insignificant ($P = 0.2$). When genders were combined, there was still no significant effect of ethnicity on activity-related energy expenditure after adjustment for fat-free mass ($P = 0.2$) or for fat-free and fat mass ($P = 0.2$) (data not shown). The relationships between total energy expenditure and resting energy expenditure are summarized in Table 5.

Table 2. *Linear regression between TEE and FFM and adjusted least square means for TEE obtained from ANCOVA adjusted either for FFM or for both FFM and FM*

	Intercept, kcal/day	Slope,* $kcal \cdot day^{-1} \cdot kg^{-1}$	Adjusted r^2	Adjusted Least Square Means, kcal/day: TEE adjusted for FFM†	Adjusted Least Square Means, kcal/day: TEE adjusted for FFM and FM‡
Caucasian girls ($n = 18$)	550 ± 232	58.3 ± 9.4	0.69	1,831 ± 60	1,766 ± 57
Caucasian boys ($n = 21$)	721 ± 371	47.3 ± 17.6	0.25	1,774 ± 56	1,824 ± 53
African-American girls ($n = 29$)	414 ± 191	60.1 ± 8.6	0.63	1,734 ± 47	1,686 ± 44
African-American boys ($n = 30$)	385 ± 180	70.0 ± 8.0	0.67	1,725 ± 46	1,777 ± 44

Data are means ± SE. Least square means were adjusted for ethnicity, gender, and the interaction of ethnicity and gender. *Slopes are not significantly different among 4 subgroups ($P > 0.2$). †Least square means of TEE adjusted for FFM are not significantly different among subgroups (ethnicity, $P = 0.2$; gender, $P = 0.5$; interaction, $P = 0.7$). ‡Least square means of TEE adjusted for both FFM and FM are not significantly different among subgroups (ethnicity, $P = 0.2$; gender, $P = 0.2$; interaction, $P = 0.7$). ANCOVA, analysis of covariance.

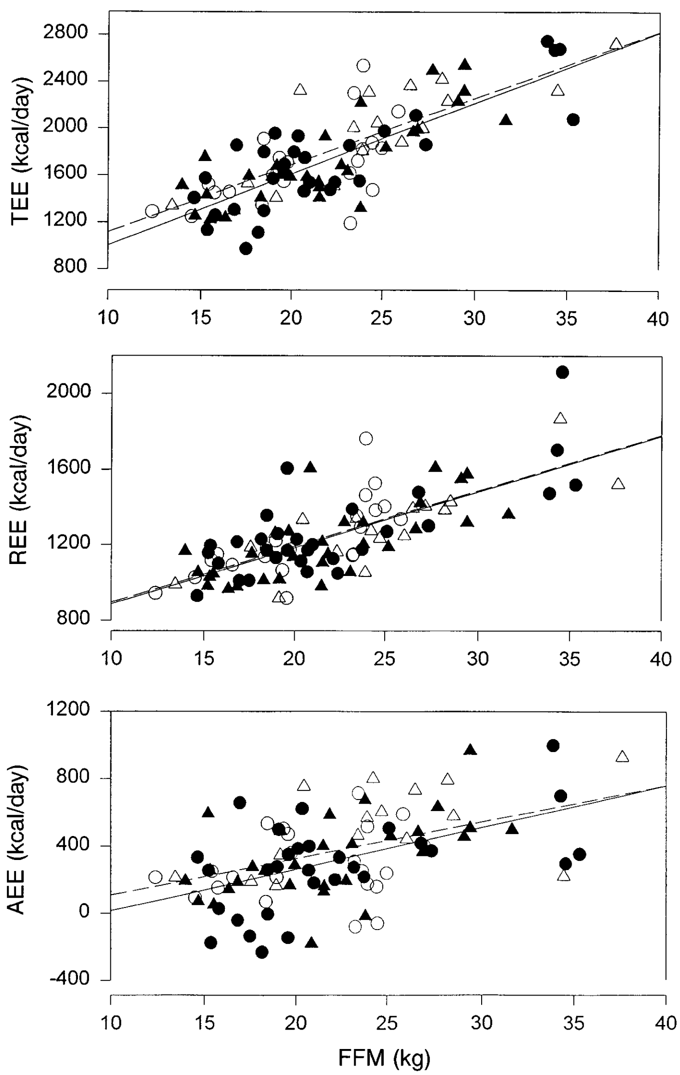

Fig. 1. Relationships between total energy expenditure (TEE) and fat-free mass (FFM), resting energy expenditure (REE) and FFM, and activity-related energy expenditure (AEE) and FFM in 39 Caucasian (dotted line, open symbols) and 59 African-American (solid line, filled symbols) children. Triangles, girls; circles, boys. Regression slopes are not significantly different for both ethnic groups for all components of energy expenditure. Regression equations for Caucasian children: TEE (kcal/day) = 57.0 FFM + 548.5; REE (kcal/day) = 29.6 FFM + 599.8; AEE (kcal/day) = 21.7 FFM − 106.2. Regression equations for African-American children: TEE (kcal/day) = 60.6 FFM + 397.9; REE (kcal/day) = 29.7 FFM + 590.1; AEE (kcal/day) = 24.8 FFM − 232.0.

The regression slopes were not significantly different among the four subgroups. When resting energy expenditure was the only covariate in the model, there was not a significant effect of ethnicity on total energy expenditure. When fat-free mass or both fat-free and fat mass were added to the model, the effects of ethnicity remained insignificant.

DISCUSSION

Our study is the first attempt to examine ethnic differences in all components of daily energy expenditure in a heterogenous group of African-American and Caucasian prepubertal children. The primary finding is that ethnicity (African-American vs. Caucasian children) was not a significant independent determinant of total energy expenditure, resting energy expenditure, or physical activity-related energy expenditure after adjustment for fat-free mass or for both fat-free and fat mass.

We did not observe an ethnic difference in total energy expenditure when we compared African-American with Caucasian children. No previous study has examined the ethnic influence (African-American vs. Caucasian) on total energy expenditure in prepubertal children. The effect of ethnicity (African-American vs. Caucasian) on total energy expenditure has been described in only one previous study in older (>55 yr of age) adults ($n = 164$) (3). In that study, total energy expenditure was 10% lower in African-American than in Caucasian subjects after adjustment for fat-free mass. The mechanism is unclear for the inconsistency in the ethnic effect on total energy expenditure in different age groups.

Resting energy expenditure was not significantly influenced by ethnicity when African-American and Caucasian children were compared. This result does not support previous data, which showed a significantly lower resting energy expenditure in African-American compared with Caucasian children (18, 20, 25). Despite similar methodology compared with the current study, two of the prior studies (18, 20) have found a strikingly lower resting energy expenditure (>200 kcal/day) in African-American than in Caucasian children. One explanation could be the small sample sizes in those two studies (<10 in some subgroups) that confounded the results. However, the lower resting energy expendi-

Table 3. *Linear regression between REE and FFM and adjusted least square means for REE obtained from ANCOVA adjusted either for FFM or for both FFM and FM*

	Intercept, kcal/day	Slope,* kcal·day^{-1}·kg^{-1}	Adjusted r^2	Adjusted Least Square Means, kcal/day: REE adjusted for FFM†	REE adjusted for FFM and FM‡
Caucasian girls ($n = 18$)	589 ± 127	28.8 ± 5.1	0.64	1,220 ± 35	1,183 ± 33
Caucasian boys ($n = 21$)	462 ± 186	37.5 ± 8.8	0.47	1,278 ± 33	1,306 ± 31
African-American girls ($n = 29$)	591 ± 117	28.5 ± 5.3	0.50	1,219 ± 27	1,192 ± 26
African-American boys ($n = 30$)	599 ± 115	30.4 ± 5.1	0.55	1,267 ± 27	1,297 ± 26

Data are means ± SE. Least square means were adjusted for ethnicity, gender, and interaction of ethnicity and gender. *Slopes are not significantly different among 4 subgroups ($P > 0.2$). †Least square means of REE adjusted for FFM are not different among subgroups (ethnicity, $P = 0.8$; gender, $P = 0.08$; interaction, $P = 0.9$). ‡Least square means of REE adjusted for both FFM and FM are significantly influenced by gender ($P = 0.0005$) but not by ethnicity ($P = 0.9$) and interaction ($P = 0.8$).

Table 4. *Linear regression between AEE and FFM and adjusted least square means obtained from ANCOVA adjusted either for FFM or for both FFM and FM*

	Intercept, kcal/day	Slope,* kcal/day · kg^{-1}	Adjusted r^2	Adjusted Least Square Means, kcal/day	
				AEE adjusted for FFM†	AEE adjusted for FFM and FM‡
Caucasian girls ($n = 18$)	−93.7 ± 212.1	23.6 ± 8.6	0.28	428 ± 53	406 ± 54
Caucasian boys ($n = 21$)	186.5 ± 273.1	5.2 ± 12.9	−0.05	318 ± 50	335 ± 51
African-American girls ($n = 29$)	−218.9 ± 174.3	25.5 ± 7.8	0.26	342 ± 41	326 ± 42
African-American boys ($n = 30$)	−252.4 ± 169.4	24.4 ± 7.5	0.25	284 ± 40	302 ± 42

Data are means ± SE. All least square means were adjusted for ethnicity, gender, and interaction of ethnicity and gender. *Slopes are not significantly different among 4 subgroups ($P > 0.2$). †Least square means of AEE adjusted for FFM are not significantly different among subgroups (ethnicity, $P = 0.2$; gender, $P = 0.08$; interaction, $P = 0.6$). ‡Least square means of AEE adjusted for both FFM and FM are not significantly different among subgroups (ethnicity, $P = 0.2$; gender, $P = 0.4$; interaction, $P = 0.6$).

ture in African-American is supported by data in adult women (10) and in older adults (3).

Ethnicity did not have a significant influence on physical activity-related energy expenditure in this study. We have previously shown that a subgroup of African-American children ($n = 44$) had a 15% lower maximal oxygen consumption ($\dot{V}O_{2\,max}$) compared with a subgroup ($n = 31$) of Caucasian children from the same population, independent of differences in soft lean tissue, leg lean tissue, fat mass, total energy expenditure, and physical activity-related energy expenditure ($P < 0.001$) (24). Because activity-related energy expenditure was similar and $\dot{V}O_{2\,max}$ was lower, African-American children may either have a decreased capacity to sustain exercise aerobically for extended periods of time or participated in less intense activities for longer periods of time compared with Caucasian children. Therefore, there may be ethnicity-related differences in qualitative aspects of physical activity. However, in this study, ethnicity was not found to affect activity-related energy expenditure. Thus additional studies that focus on potential ethnic differences in qualitative aspects of physical activity and activity pattern are needed.

In addition, our study did not find a significant effect of gender on total energy expenditure (Table 2) and activity-related energy expenditure (Tables 4 and 5). Our previous study in 30 Caucasian children (4–6 yr of age) also did not find a significant gender effect on total energy expenditure after adjustment for body composition (12). Conversely, in older adults (3), total energy expenditure was 16% higher in males than in females ($P < 0.01$) after controlling for fat-free mass. In our study, gender was a significant determinant of resting energy expenditure, which was higher in boys than in girls (Table 3) after adjustment for fat-free and fat mass. This result is consistent with other findings that observed higher resting energy expenditure in boys than in girls of different ethnic groups (9, 14, 15). The higher resting energy expenditure in males was suggested to be a hormonal influence (7). However, because all the children in our study were at prepubertal age and the same Tanner stage, a hormonal effect would not be expected at this young age (2). Thus the independent effect of gender may not be attributed entirely to differences in sex hormone levels.

A possible explanation for the inconsistent findings relating to ethnic differences in energy expenditure may be the tremendous variation in total energy expenditure, especially activity-related energy expenditure. Total and activity-related energy expenditures were measured for only 14 days, which may not reflect variation over time. Moreover, changes in energy expenditure and energy intakes may occur in some critical periods of time in development (such as in early infancy or adolescence). In addition, differences in energy expenditure among different ethnic and gender groups may appear at different stages of development.

In our study, total energy expenditure may also have been influenced by other factors such as age, body mass, and the study design. There was a small age difference between African-American (7.4 yr) and Cau-

Table 5. *Linear regression between TEE and REE and adjusted least square means obtained from ANCOVA adjusted for REE, REE and FFM, or FFM and FM*

	Intercept, kcal/day	Slope,* kcal · day^{-1} · kg^{-1}	Adjusted r^2	Adjusted Least Square Means, kcal/day		
				Adjusted for REE†	Adjusted for REE and FFM‡	Adjusted for REE, FFM and FM§
Caucasian girls ($n = 18$)	15.7 ± 404	1.5 ± 0.3	0.57	1,902 ± 65	1,865 ± 56	1,790 ± 57
Caucasian boys ($n = 21$)	212 ± 333	1.2 ± 0.3	0.49	1,707 ± 60	1,755 ± 53	1,801 ± 53
African-American girls ($n = 29$)	83 ± 314	1.4 ± 0.3	0.49	1,766 ± 51	1,750 ± 44	1,706 ± 44
African-American boys ($n = 30$)	45 ± 305	1.3 ± 0.2	0.51	1,695 ± 50	1,712 ± 43	1,758 ± 44

Data are means ± SE. All least square means were adjusted for ethnicity, gender, and interaction of ethnicity and gender. *Slopes are not significantly different among 4 subgroups ($P > 0.2$). †Least square means of TEE adjusted for REE are significantly influenced by gender ($P = 0.02$) but not by ethnicity ($P = 0.2$) and interaction ($P = 0.3$). ‡Least square means of TEE adjusted for REE and FFM are not significantly different among subgroups (ethnicity, $P = 0.1$; gender, $P = 0.2$; interaction, $P = 0.6$); §Least square means of TEE adjusted for REE, FFM, and FM are not significantly different among subgroups (ethnicity, $P = 0.2$; gender, $P = 0.6$; interaction, $P = 0.7$).

casian (8.3 yr) children. Because all the children were at the same Tanner stage, we do not believe this small age difference had a major impact on the primary findings. This fact was confirmed by including age in the ANCOVA models as a covariate. When that was done, we still did not see a significant effect of ethnicity on energy expenditure components. The observation of a larger body mass in Caucasian girls may have been due to selection bias. Approximately one-half of our cohort was obese (defined by a weight-for-height >90th percentile) and one-half was nonobese. Therefore, the difference in body mass among subgroups raises the question of whether this particular group represents the general population. The limitation of this study was the use of cross-sectional study design. Although we did not observe an ethnic difference in any component of daily energy expenditure, we cannot rule out the possible influence of energy expenditure on the development of obesity on a long-term basis. Longitudinal studies may better describe the influences of different components of energy expenditure on the changes of body composition in the development of obesity, especially in African-American children. Further longitudinal studies are needed to examine the underlying etiology of obesity.

In conclusion, ethnicity was not a significant determinant for any of the components of energy expenditure in this cross-sectional analysis. Total energy expenditure, resting energy expenditure, and physical activity-related energy expenditure were similar in Caucasian and African-American prepubertal children after adjustment for body composition.

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