Ethnic differences in dietary intakes, physical activity, and energy expenditure in middle-aged, premenopausal women: the Healthy Transitions Study¹⁻³

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ABSTRACT
Background: Menopause is a time of increased risk of obesity in women. The effect of menopause in African American women, in whom obesity is already highly prevalent, is unknown.
Objective: We compared dietary intakes and energy expenditure (EE) between middle-aged, premenopausal African American and white women participating in a longitudinal study of the menopausal transition.
Design: Dietary intakes by food record, EE by triaxial accelerometer, physical activity by self-report, and body composition by dual-energy X-ray absorptiometry were compared in 97 white and 52 African American women. Twenty-four-hour and sleeping EE were measured by whole-room indirect calorimetry in 56 women.
Results: Sleeping EE (adjusted for lean and fat mass) was lower in African American than in white women (5749 ± 155 compared with 6176 ± 75 kJ/d; P = 0.02); however, there was no significant difference in 24-h EE between groups. Reported leisure activity over the course of a week was less in African American than in white women (556 ± 155 compared with 1079 ± 100 kJ/d; P = 0.02), as were the daily hours spent standing and climbing stairs. Dietary intakes of protein, fiber, calcium, magnesium, and several fatty acids were significantly less in African Americans, whereas there were no observed ethnic differences in intakes of fat or carbohydrate. Body fat within the whole group was positively correlated with total, saturated, and monounsaturated fat intakes and inversely associated with fiber and calcium intakes. Fiber was the strongest single predictor of fatness.
Conclusion: Ethnic differences in EE and the intake of certain nutrients may influence the effect of menopausal transition on obesity in African American women. Am J Clin Nutr 2001;74:90–5.

KEY WORDS Menopause, energy expenditure, physical activity, middle-aged women, Healthy Transitions Study, ethnic differences, dietary intakes

INTRODUCTION
Menopause tends to be associated with increased body weight (1, 2) and a shift to abdominal fat distribution (3, 4). Although estrogen deficiency appears to be a major regulator of shifts in fat distribution during menopause, it is less clear whether estrogen directly regulates body weight changes. Studies of hormone replacement therapy (HRT) in postmenopausal women present conflicting results with regard to effects on body weight or fat. The Postmenopausal Estrogen/Progesterin Intervention trial, for example, showed that women who received HRT gained less weight over 3 y than did women who did not receive hormones, regardless of the type of HRT (5). On the other hand, O'Sullivan et al (6) observed that oral HRT increases body fat, whereas transdermal HRT decreases it.

Poehlman et al (2) suggested that changes in energy expenditure (EE) and dietary intake patterns may play a role in weight gain during menopause. In a longitudinal study of perimenopausal women, they reported that women who experienced menopause had greater decreases in resting metabolic rate and leisure-time physical activity than did women of the same age who remained premenopausal. Both groups of women slightly increased their energy intake; thus, the women who experienced menopause had a significantly greater positive energy balance than did the premenopausal women.

Several investigators reported differences in EE between premenopausal African American and white women (7–12). These differences were typically in studies where whole-room calorimetry was used so that sleeping (ie, basal) EE could be measured directly. To our knowledge, the assessment of ethnic differences in EE or physical activity patterns in perimenopausal women has not yet been performed. Because African American women have a high prevalence for obesity (13) and menopause is a time of increased risk for obesity development in women, the present study investigated ethnic differences in EE and dietary intakes in a cohort of women participating in a longitudinal study of the menopause transition. Baseline cross-sectional data from this cohort are presented.

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SUBJECTS AND METHODS

Subjects

Volunteers were recruited by advertisement and word of mouth from the Baton Rouge, LA, area. To be eligible for the study, the women had to be healthy, had to be 43 y of age, and have had ≥5 menstrual periods in the 6 mo before screening. All potential volunteers underwent a 3-step screening process that included measures of blood chemistry and lipids, a physical exam, and a psychological interview to determine their ability to complete a 4-y longitudinal study. Women were excluded if they were taking medication regularly (including hormones), were not having regular menstrual cycles, or had clinically abnormal gas mixtures. Propane combustion tests lasting 22.5 h were interspersed into the calorimetry schedule once a week to determine the accuracy and precision of the calorimeter.

EE and substrate oxidation were calculated from oxygen consumption ($V\text{O}_2$), carbon dioxide production ($V\text{CO}_2$), and urinary nitrogen excretion by using the equations of Acheson et al (17). Sleeping EE was calculated from the lowest sustained metabolic rate achieved between 0200 and 0500, extrapolated to 24 h. Exercise EE was calculated as total EE during the prescribed exercise periods, which varied from individual to individual on the basis of their habitual activity. Spontaneous physical activity in the calorimeter was the amount of time (excluding treadmill walking) that the subject moved at a speed above a threshold of ±7 cm.

Food intake

All subjects completed a 4-d food record following instruction from a dietician. In most cases this record was collected during the same 4 d that the subjects wore the triaxial motion sensor. Intake data were analyzed by using Moore’s Extended Nutrient database (MENu; Pennington Biomedical Research Foundation, 1998). Most foods in the database were derived from the US Department of Agriculture’s most current data sets, the Nutrient Database for Standard Reference (release 13, 2000) and the Survey Nutrient Database for the Continuing Survey of Food Intakes by Individuals (1994–1996). The database also contains many unique regional foods and combination food items. The database was validated and used in multicenter trials funded by the National Institutes of Health (18).

Statistical analysis

Data were analyzed by using SAS-PC version 6.12 (SAS Institute Inc, Cary, NC). Descriptive statistics were calculated for each variable and normality was assessed. Variables that were not normally distributed were log transformed before analysis. The general linear models procedure (PROC GLM) was used to assess differences between African American and white women, adjusted as needed for covariates. Partial correlation analyses (adjusted for total energy intake) were performed to determine the relation between dietary intakes and body-composition variables in the whole population and in African American and white women separately. PROC GLM was used to compare the slopes of the relations between body composition and dietary variables by race. Multiple regression analysis with use of the $R^2$ selection procedure was performed to examine the relative importance of diet and activity factors on body composition. A $P$ value of 0.05 was considered significant.

RESULTS

Subject characteristics are shown in Table 1. The mean age of the subjects was 47.4 ± 0.2 y. African American women had a
significantly higher body mass index, fat mass, lean mass, and percentage body fat than did white women. EE measured by triaxial motion sensor and calorimetry and self-reported physical activity (by activity recall and activity diary) are shown in Table 2. On the physical-activity-recall questionnaire, African American women reported significantly less leisure activity than did white women during the past week (both h/wk and kJ/d), although reported total activity (leisure and occupational) over the past year did not differ significantly by race. No women in the study reported anything other than light or moderate occupational activity, so it is unlikely that ethnic differences in occupational activity accounted for the discrepant results between activity over the past week and past year. In the daily activity diary, significant ethnic differences were observed in self-reported hours spent standing and in flights of stairs climbed daily. African American women spent significantly fewer hours standing (as opposed to sitting or lying down) and climbed significantly fewer flights of stairs/d than did white women. In contrast with self-reported data, there were no ethnic differences in measures of EE by triaxial motion sensor. In the subset of African American women who underwent whole-room calorimetry measures, African Americans had significantly lower sleeping EE when adjusted for lean and fat mass, but there was no significant difference in total 24-h EE, total exercise EE, or spontaneous physical activity (i.e., fidgeting) between the 2 groups (data not shown).

Dietary intakes are shown in Table 3. There were no significant differences in energy, fat, or carbohydrate intakes between the races. Protein intake was slightly but significantly higher in white subjects. Additionally, polyunsaturated fat intakes were significantly higher in African Americans, whereas fiber, calcium, and magnesium intakes were significantly lower in the diets of African American women.

There were also significant race differences in the intakes of several dietary fatty acids. Specifically, white women consumed significantly more myristic acid (14:0), whereas African American women consumed more linoleic (18:2), arachidonic (20:4n-6), eicosapentaenoic (EPA; 22:5n-3), and gadoleic (20:1) acids. When the database was accessed to determine the specific food sources of these fatty acids, the myristic acid intake in our population was found to be primarily from coffee creamer, cheese, and butter. The predominant sources of linoleic acid were salad dressings and mayonnaise, whereas arachidonic acid came primarily from chicken, turkey, and eggs; EPA from fish (mainly trout, salmon, and catfish); and gadoleic acid from jambalaya, peanuts, and canola oil.

Partial correlation coefficients (adjusted for total energy intake) between dietary intakes and measures of obesity are shown in Table 4. Positive correlations between percentage body fat or BMI and total fat, saturated fat, and dietary cholesterol were found. Additionally, intakes of 14:0, palmitic (16:0), palmitoleic (16:1), stearic (18:0), and oleic (18:1) acids were positively correlated with percentage body fat or BMI. Inverse correlations were observed between percentage body fat and fiber, calcium, magnesium, EPA, and docosahexaenoic acid (22:6n-3) intakes. In general, the magnitude of the correlations was similar between African American and white women, although a few differences were noted. For example, the

| TABLE 1 | Characteristics of the subjects<sup>1</sup> |
|---------|---------------------------------------------|
|         | African American<sup>2</sup> | White<sup>2</sup> |
| Age (y) | 46.7 ± 0.3 (44–51) | 47.7 ± 0.2<sup>2</sup> (43–56) |
| Height (cm) | 164.5 ± 0.8 (152–181) | 163.9 ± 0.6 (147–175) |
| Weight (kg) | 78.3 ± 2.3 (51.2–130.8) | 68.0 ± 1.2 (51.2–100.9) |
| BMI (kg/m²) | 28.9 ± 0.6 (18.5–47.5) | 25.4 ± 0.4<sup>2</sup> (18.9–36.3) |
| Fat mass (kg) | 33.4 ± 1.7 (13.0–71.9) | 27.0 ± 1.0<sup>2</sup> (10.5–56.4) |
| Lean mass (kg) | 41.0 ± 0.8 (29.7–56.7) | 37.7 ± 0.4<sup>2</sup> (27.2–51.5) |
| Percentage body fat (%) | 42.2 ± 0.8 (24.2–55.9) | 39.2 ± 0.8<sup>2</sup> (20.0–57.0) |

<sup>1</sup>x ± SEM; ranges in parentheses.

<sup>2</sup>Significantly different from African Americans, P < 0.05.

| TABLE 2 | Measures of energy expenditure (EE) and physical activity in the African American and white women<sup>1</sup> |
|---------|----------------------------------------------------------|
|         | African American<sup>2</sup> | White<sup>2</sup> |
| Triaxial accelerometer | | |
| Total EE (kJ/d) | 8494 ± 134 | 8619 ± 92 |
| Activity EE (kJ/d) | 1958 ± 130 | 2113 ± 88 |
| Physical activity recall | | |
| Leisure activity in past week (kJ/d) | 556 ± 155 | 1079 ± 100<sup>2</sup> |
| (h/wk) | 2.5 ± 0.5 | 5.1 ± 0.4<sup>2</sup> |
| Total activity in past year (kJ/d) | 4920 ± 360 | 4489 ± 259 |
| Activity diary<sup>3</sup> | | |
| Flights of stairs climbed/d | 1.4 ± 0.9 | 4.7 ± 0.7<sup>2</sup> |
| Hours standing/d | 3.2 ± 0.3 | 4.1 ± 0.2<sup>2</sup> |
| Television and video watching (h/d) | 1.6 ± 0.2 | 1.3 ± 0.1 |
| Exercise (h/d) | 0.34 ± 0.1 | 0.45 ± 0.1 |
| Whole-room calorimeter<sup>4</sup> | | |
| Total 24-h EE (kJ/d) | 8468 ± 222 | 8874 ± 105 |
| Sleeping EE (kJ/d) | 5749 ± 155 | 6176 ± 75<sup>2</sup> |

<sup>1</sup>x ± SEM; adjusted for lean body mass and fat mass. To convert to kcal/d, divide kJ/d by 4.184.

<sup>2</sup>Significantly different from African Americans, P < 0.05.

<sup>3</sup>Diary kept during the same days on which the accelerometer was worn.

<sup>4</sup>Studies were conducted in a subset of 12 African American and 44 white women.

| TABLE 3 | Measures of dietary intake by 4-d food record in the African American and white women<sup>1</sup> |
|---------|---------------------------------------------|
|         | African American<sup>2</sup> | White<sup>2</sup> |
| Total energy (kJ/d) | 6740 ± 1732 | 7067 ± 1431 |
| (kcal/d) | 1611 ± 414 | 1689 ± 342 |
| Fat (g/d) | 62 ± 2 | 60 ± 1 |
| Carbohydrate (g/d) | 215 ± 5 | 210 ± 4 |
| Protein (g/d) | 65 ± 2 | 69 ± 1<sup>2</sup> |
| Saturated fat (g/d) | 19 ± 1 | 20 ± 1 |
| Monounsaturated fat (g/d) | 23 ± 1 | 23 ± 1 |
| Polyunsaturated fat (g/d) | 14 ± 0.5 | 12 ± 0.4<sup>2</sup> |
| Fiber (g/d) | 14 ± 1 | 16 ± 1<sup>2</sup> |
| Dietary cholesterol (g/d) | 200 ± 14 | 198 ± 10 |
| Calcium (mg/d) | 518 ± 34 | 758 ± 25<sup>2</sup> |
| Magnesium (mg/d) | 216 ± 9 | 271 ± 6<sup>2</sup> |

<sup>1</sup>x ± SEM; adjusted for total energy intake.

<sup>2</sup>Significantly different from African Americans, P < 0.05.
absolute magnitude of the correlations between body fat and fiber, calcium, and magnesium was greater in white than in African American women, whereas the correlation between 14:0 and body fat was greater in African American than in white women. When the slopes of the regression equations in the 2 groups were statistically compared by use of general linear models procedures, significant differences between races were found for the relation between BMI and dietary calcium (P = 0.04). The race difference in the slope between calcium and body fat was nearly significant (P = 0.07).

Multiple regression analysis indicated that dietary fiber was the strongest independent predictor of percentage body fat, explaining 12% of the variance in a model that included fiber, total fat, saturated fat, monounsaturated fat, hours of exercise/d, and flights of stairs climbed/d (Table 5). Exercise was the second strongest individual predictor, explaining 9% of the variance in body fat. The best model (ie, maximum R² and minimum mean square error) accounted for 21% of the variance in body fat and included fiber, saturated fat, exercise, and flights of stairs climbed/d.

### DISCUSSION

It has been recognized for some time that the prevalence of obesity is higher in African American than in white women and continues to increase (13). Nevertheless, the causes of the high obesity prevalence rates in African American women, which likely include both genetic and lifestyle factors, have not been clearly elucidated. Several studies reported race differences in resting metabolic rate (8, 9, 11) or total or sleeping EE assessed by whole-room calorimetry (7, 10, 12). These studies consistently reported that African American women have lower metabolic rates (adjusted for body-composition variables) than do white women. Of our finding that sleeping EEs are lower in African American women than in whites is consistent with these reports, although we did not observe a difference in total daily EE measured by calorimetry or by activity monitor between these 2 groups.

Recently, Luke et al (19) showed that the resting metabolic rate in Nigerian blacks does not differ from that in African Americans, suggesting that the difference in obesity prevalence between these 2 groups results from lifestyle or gene-environment interactions. Although this may be the case for populations that are genetically similar (eg, Nigerian and US blacks), it may not be true for more genetically dissimilar populations. Certainly, our data and the data from the other studies cited above suggest that there are differences in EE between US whites and blacks, although it is not clear whether this lower EE contributes to greater obesity in African Americans.

Race differences in physical activity patterns have not been as widely studied, but several studies have compared physical activity between African American and white women. With the use of a physical-activity-recall instrument, Tuten et al (20) found that white women had a greater mean physical activity in

### TABLE 4

Partial correlation coefficients, adjusted for total energy intake, between dietary intakes and measures of obesity in African American and white women

| Dietary intake | African American | White | Percentage body fat | African American | White |
|----------------|------------------|-------|---------------------|------------------|-------|
| Fat (g/d)      | 0.18             | 0.17  | 0.19                | 0.32             | 0.32  |
| Monounsaturated fat (g/d) | 0.15          | 0.10  | 0.19                | 0.24             | 0.24  |
| Saturated fat (g/d)     | 0.29             | 0.17  | -0.24               | 0.17             | 0.17  |
| Polyunsaturated fat (g/d) | -0.12            | 0.13  | -0.24               | 0.17             | 0.17  |
| Dietary cholesterol (mg/d) | 0.26           | 0.23  | 0.34                | 0.24             | 0.24  |
| Fiber (g/d)      | -0.19            | -0.24 | -0.24               | -0.44            | 0.44  |
| Calcium (mg/d)   | -0.13            | -0.21 | -0.01               | -0.25            | 0.25  |
| Magnesium (mg/d) | -0.17            | -0.30 | -0.20               | -0.52            | 0.52  |
| 14:0 (g/d)       | 0.30             | 0.00  | 0.33                | 0.19             | 0.19  |
| 16:0 (g/d)       | 0.27             | 0.19  | 0.28                | 0.36             | 0.36  |
| 16:1 (g/d)       | 0.27             | 0.19  | 0.27                | 0.25             | 0.25  |
| 18:0 (g/d)       | 0.27             | 0.27  | 0.31                | 0.43             | 0.43  |
| 18:1 (g/d)       | 0.15             | 0.08  | 0.23                | 0.21             | 0.21  |
| 20:4n−6 (g/d)    | -0.03            | 0.13  | -0.02               | 0.11             | 0.11  |
| 22:5n−3 (g/d)    | -0.23            | -0.10 | -0.08               | -0.13            | 0.13  |
| 22:6n−3 (g/d)    | -0.22            | -0.13 | -0.19               | -0.16            | 0.16  |

1 P < 0.01.
2 P < 0.05.
3 P < 0.0001.

### TABLE 5

Multiple regression analysis of dietary and physical activity predictors of percentage body fat in 149 perimenopausal women

| Number of | Variables included | R² | Mean square error |
|-----------|--------------------|----|------------------|
| model     |                    |    |                  |
| 1         | Fiber              | 0.12| 55.6             |
|           | Hours of exercise/d| 0.09| 576              |
| 2         | Saturated fat      | 0.07| 59.3             |
|           | Fiber and hours of exercise/d | 0.18| 52.4             |
| 3         | Fiber and saturated fat | 0.14| 55.1             |
|           | Fiber, hours of exercise/d, and flights of stairs climbed/d | 0.20| 51.7             |
| 4         | Fiber, saturated fat, hours of exercise/d, and flights of stairs climbed/d | 0.21| 51.4             |
| 5         | Fiber, saturated fat, dietary fat, hours of exercise/d, and flights of stairs climbed/d | 0.21| 51.7             |

1 Dietary variables were adjusted for total energy intake.
the previous 24-h time frame than did black women and that black women were significantly more sedentary. Additionally, 2 studies that used the doubly labeled water method (21, 22) showed that total daily EE was significantly lower in African American women than in white women, mainly because the African American women had lower physical-activity EEs. A third doubly labeled water study (23) found no significant differences in total daily EE between the 2 races but observed that African American women had lower physical activity EEs.

The present study indicated that in the week prior to assessment, African American women reported less leisure-time activity, fewer hours spent standing, and fewer flights of stairs climbed/d, than did white women. However, the accelerometer data, a more objective measure of EE, showed no significant differences between groups. Furthermore, it is now recognized that inactivity, or sedentary behavior, may be as important a predictor of weight gain as activity per se. Although we did not directly assess inactivity, the fact that the number of hours spent standing was lower in African American women implies that they spent more time sitting or lying down. Television watching, however, a specifically recorded sedentary behavior, did not differ significantly between groups. Thus, it is not clear from the present data whether differences in physical activity contribute to racial differences in obesity.

There is little consensus on dietary differences between African American and white populations. Although some studies reported that total fat consumption is higher in African Americans than in whites in the United States (24), others did not find this difference (25). The present study did not observe a difference in total dietary fat intake; however, intakes of polyunsaturated fat and several specific fatty acids differed between races. Interestingly, both groups of women reported consuming ≈35% energy as fat, which is higher than the current recommendations, particularly during a period of life involving increased risk of obesity. Additionally, African American women consumed lower amounts of protein, fiber, calcium, and magnesium than did white women. Both high fiber and high protein intakes have been associated with increased satiety and decreased food intake (26, 27), and fiber was the strongest single predictor of body fat in our multiple regression analysis. High protein and high-carbohydrate diets were also shown to increase thermogenesis and satiety, relative to high-fat diets (28).

Recent studies in both animals and humans suggest that high dietary calcium is associated with decreased body weight (29). Although our data generally support this finding, the observation of ethnic differences in calcium intake, and the significantly different relation between calcium intake and body fat in whites and in African Americans indicate that the results should be interpreted with caution. Nevertheless, the dietary pattern followed by the African American women in our study, which consisted of low intakes of protein, fiber, and calcium, and high intakes of certain types of fat, may promote obesity.

The present study had several limitations that deserve comment. First, we recognize that cross-sectional data provide little information about the predictive value of ethnic differences in EE and diet. A longitudinal study of this cohort is in progress that should provide important information on whether activity or dietary patterns predict weight gain during the menopause transition.

Second, the limitations of self-reported physical activity and dietary intakes are well recognized. Our data indicate obvious underreporting of dietary intake in relation to the more objective triaxial motion sensor measures of EE. As shown in Tables 2 and 3, subjects reported consuming ≈6700–7100 kJ/d (1600–1700 kcal/d) although their measured EE was ≈8300 kJ/d (2000 kcal/d). Assuming that most individuals were weight stable, this represents an underreporting of intake of ≈1250–1675 kJ/d (300–400 kcal/d). On the other hand, self-reported physical activity may have been overestimated, particularly estimates of habitual activity over the past year. Activity estimates over the past week (2.5 and 5.1 h/wk in African Americans and whites, respectively) seemed reasonable, especially given that our study population appeared to be somewhat health conscious and may have been more physically active than the average population.

Finally, Kumanyika (30) recently indicated the difficulties in separating socioeconomic and genetic factors from other ethnicity-related factors when interpreting observed differences in variables such as EE. Although our population was fairly well-matched for socioeconomic status with most of the participants being middle class, the genetic issue cannot be easily addressed. Kumanyika also notes the importance of collecting longitudinal data and examining differences within race (ie, factors that differ over time between women who gain excess weight and those who do not). Our ongoing longitudinal study of this population will hopefully allow us to address such issues.

In conclusion, the present study suggests several ethnic differences in factors contributing to the energy balance in women nearing menopause. Specifically, African American women had significantly lower EE, both in terms of basal metabolism and self-reported physical activity, although measured total EE was not lower in this group. Furthermore, although reported total energy and total fat intakes did not differ significantly between groups, there were significant ethnic differences in intakes of fiber, protein, calcium, and specific fatty acids that may have implications for the development of obesity. Longitudinal follow-up of this cohort will clarify the role of such EE and dietary differences on the development of obesity during menopause.

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REFERENCES

1. Wing RR, Matthews KA, Kuller LH, Meilahn EN, Plantinga P. Waist to hip ratio in middle-aged women: associations with behavioral and psychosocial factors and with changes in cardiovascular risk factors. Arterioscler Thromb 1991;11:1250–7.
2. Poehlman ET, Toth MJ, Gardner AW. Changes in energy balance and body composition at menopause: a controlled longitudinal study. Ann Intern Med 1995;123:673–5.
3. Toth MJ, Tchernof A, Sites CK, Poehlman ET. Effect of menopausal status on body composition and abdominal fat distribution. Int J Obes 2000;24:226–31.
4. Svendsen OL, Hassager C, Christiansen C. Age- and menopause-associated variations in body composition and fat distribution in healthy women as measured by dual-energy X-ray absorptiometry. Metabolism 1995;44:369–73.
5. Espeland MA, Stefanick ML, Kritz-Silverstein D, et al. Effect of postmenopausal hormone therapy on body weight and waist and hip girths. Postmenopausal Estrogen-Progestin Interventions Study Investigators. J Clin Endocrinol Metab 1997;82:1549–56.
6. O’Sullivan AJ, Crampton LJ, Freund J, Ho KKY. The route of estrogen replacement therapy confers divergent effects on substrate oxidation and body composition in postmenopausal women. J Clin...
DIET AND ENERGY EXPENDITURE IN MIDDLE-AGED WOMEN

Invest 1998;102:1035–40.

7. Weinsier RL, Hunter GR, Zuckerman PA, et al. Energy expenditure and free-living physical activity in black and white women: comparison before and after weight loss. Am J Clin Nutr 2000;71:1138–46.

8. Albu J, Shur M, Curi M, Murphy L, Heymsfield SB, Pi-Sunyer FX. Resting metabolic rate in obese, premenopausal black women. Am J Clin Nutr 1997;66:531–8.

9. Foster GD, Wadden TA, Vogt RA. Resting energy expenditure in obese African American and Caucasian women. Obes Res 1997;5:1–8.

10. Hunter GR, Weinsier RL, Darnell BE, Zuckerman PA, Goran MI. Racial differences in energy expenditure and aerobic fitness in premenopausal women. Am J Clin Nutr 2000;71:500–6.

11. Nicklas BJ, Berman DM, Davis DC, Dobrovolny CL, Dennis KE. Racial differences in metabolic parameters of obesity in postmenopausal women. Obes Res 1999;7:463–8.

12. Weyer C, Snitker S, Bogardus C, Ravussin E. Energy metabolism in African Americans: potential risk factors for obesity. Am J Clin Nutr 1999;70:13–20.

13. Kuczynsarski RJ, Flegal KM, Campbell SM, Johnson CL. Increasing prevalence of overweight among US adults. The National Health and Nutrition Examination Surveys, 1960 to 1991. JAMA 1994;272:205–11.

14. Kriska AM, Knowler WC, LaPorte RE, et al. Development of a questionnaire to examine the relationship of physical activity and diabetes in Pima Indians. Diabetes Care 1990;13:401–11.

15. Bandini LG, Must A, Dietz WH. Sedentary behavior and physical activity level in premenarcheal girls. Obes Res 1996;4(suppl):8S (abstr).

16. Roy HJ, Lovejoy JC, Keenan MJ, Bray GA, Windhauser MM, Wilson JK. Substrate oxidation and energy expenditure in athletes and nonathletes consuming isoenergetic high- and low-fat diets. Am J Clin Nutr 1998;67:405–11.

17. Acheson KJ, Schutz Y, Bessard T, Ravussin E, Flatt JP. Nutritional influences on lipogenesis and thermogenesis after a carbohydrate meal. Am J Physiol 1984;246:E61–70.

18. McCullough ML, Karanja NM, Lin PH, et al. Comparison of 4 nutrient databases with chemical composition data from the Dietary Approaches to Stop Hypertension. DASH Collaborative Research Group. J Am Diet Assoc 1999;99(suppl):S45–53.

19. Luke A, Rotimi CN, Adebowale AA, et al. Comparability of resting energy expenditure in Nigerians and US Blacks. Obes Res 2000;8:351–9.

20. Tuten C, Petosa R, Sargent R, Weston A. Biracial differences in physical activity and body composition among women. Obes Res 1995;3:313–8.

21. Starling RD, Toth MJ, Matthews DE, Poehlman ET. Energy requirements and physical activity of older free-living African Americans: a doubly-labeled water study. J Clin Endocrinol Metab 1998;83:1529–34.

22. Carpenter WH, Fonong T, Toth MJ, et al. Total daily energy expenditure in free-living older African Americans and Caucasians. Am J Physiol 1998;274:E96–101.

23. Kushner RF, Racette SB, Neil K, Schoeller DA. Measurement of physical activity among black and white obese women. Obes Res 1995;3(suppl):261S–5S.

24. Patterson BH, Harlan LC, Block G, Kahle L. Food choices of whites, blacks, and Hispanics: data from the 1987 National Health Interview Survey. Nutr Cancer 1995;23:105–19.

25. Popkin BM, Siega-Riz AM, Haines PS. A comparison of dietary trends among racial and socioeconomic groups in the United States. N Engl J Med 1996;335:716–20.

26. Astrup A, Ryan L, Grunwald GK, et al. The role of dietary fat in body fatness: evidence from a preliminary meta-analysis of ad libitum low-fat dietary intervention studies. Br J Nutr 2000;83(suppl):S25–32.

27. Burton-Freeman B. Dietary fiber and energy regulation. J Nutr 2000;130(suppl):S27S–5S.

28. Westerterp-Plantenga MS, Rolland V, Wilson SA, Westerterp KR. Satiety related to 24-h diet-induced thermogenesis during high protein/high carbohydrate vs. high fat diets measured in a respiration chamber. Eur J Clin Nutr 1999;53:495–502.

29. Zemel MB, Shi H, Greer B, Drizenzo D, Zemel PC. Regulation of adiposity by dietary calcium. FASEB J 2000;14:1132–8.

30. Kumanyika SK. Understanding ethnic differences in energy bal-