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ORIGINAL ARTICLE

Total daily energy expenditure in black and white, lean and obese South African women

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Background/Objectives: In South Africa (SA), the prevalence of obesity in women is 56%, with black women being most at risk (62%). Studies in the United States have demonstrated ethnic differences in resting (REE) and total daily energy expenditure (TDEE) between African American (AA) and their white counterparts. We investigated whether differences in EE exist in black and white SA women, explaining, in part, the ethnic obesity prevalence differences.
Subjects/Methods: We measured REE, TDEE and physical activity EE (PAEE) in lean (BMI $<25\,kg\,m^{-2}$) and obese (BMI $>30\,kg\,m^{-2}$) SA women ($N=44$, 30 ± 6 year). REE, TDEE, PAEE and total awake EE were measured during a 21 h stay in a respiration chamber.
Results: Black and white subjects within obese and lean groups were not significantly different for age, mass, BMI and % body fat. However, fat-free mass (kg FFM) was consistently lower in the black women ($P<0.01$) in both weight groups. After adjusting EE measurements for differences in FFM, REE was not significantly different for either body weight or ethnicity, although 24 h TDEE (kJ) was significantly greater in the obese women ($P<0.01$) and white women ($P<0.05$). Total awake non-PAEE was not significantly different for either groups, while total awake time was only significantly lower for the lean groups ($P<0.01$). Total PAEE ($kJ\,min^{-1}$) was significantly lower in the lean ($P<0.001$) and black groups ($P<0.01$).
Conclusions: In this sample of matched, lean and obese, black and white SA women, differences in TDEE were largely explained by ethnic differences in PAEE, and were not as a result of ethnic differences in REE.
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Keywords: ethnic differences; energy expenditure; physical activity

Introduction

Studies (Albu *et al*., 1997; Carpenter *et al*., 1998; Hunter *et al*., 2000; Lovejoy *et al*., 2001; Sharp *et al*., 2002; Weinsier *et al*., 2002) have reported lower resting energy expenditure (REE) in obese and reduced obese African American (AA) women compared to their white counterparts (Foster *et al*., 1997; Weinsier *et al*., 2000). This difference in REE persists even after adjusting for differences in fat-free mass (FFM) (Foster *et al*., 1999), and is thought to contribute to the higher obesity prevalence found in the AA compared to the white population. Two separate studies (Carpenter *et al*., 1998; Kimm *et al*., 2002) have shown that total daily energy expenditure (TDEE) was lower in both older and younger AA women than white women of similar ages. Differences were attributed to lower REE and physical activity energy expenditure (PAEE). In contrast, other studies report that ethnic differences in EE may be largely attributed to differences in body composition (Shetty *et al*., 1996; Soares *et al*., 1998; Luke *et al*., 2000, 2002). For example, Soares *et al*. (1998) compared REE in men and women of Indian and European ancestry. While the Indian subjects weighed less had smaller fat mass and FFM and lower absolute REEs, these

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differences were no longer significant after adjusting for body composition differences. More recently, Gallagher *et al.* (2006) attributed lower REE in AA than white adults to significantly smaller specific high metabolic rate organs (sum of liver, heart, spleen, kidneys and brain) in AA adults.

In South African (SA) adults, the prevalence of overweight and obesity is high, with 29% of men and 57% of women being classified as overweight or obese (Puoane *et al.*, 2002). Urban black SA women may be regarded as the 'most at risk' for the development of obesity-related sequelae, due to a higher prevalence of overweight or obesity (62%).

Currently, it is not known whether the high prevalence of overweight and obesity in black SA women may be attributed to lower TDEE. Data from our laboratory suggest that urban black women have less FFM ($P<0.01$) than their white counterparts, in spite of similar total body weights (Rush *et al.*, 2007). We hypothesized that after adjusting for body composition differences, TDEE would remain lower in the black women and explain ethnic obesity prevalence differences in the SA population. Therefore, the aim was to investigate and characterize possible differences in TDEE, incorporating REE, awake-time EE and PAEE in black and white, obese and lean SA women, using a respiration chamber. If EE differences exist between these two SA ethnic groups, these differences would be expected to be present in both lean and obese women.

Experimental methods

Participants

The subjects were 44 healthy lean (BMI $<25\,\text{kg}\,\text{m}^{-2}$) and obese (BMI $>30\,\text{kg}\,\text{m}^{-2}$), black and white SA women, similar for age, weight and BMI. The black women were Xhosa-speaking and represented an ethic group indigenous to the Cape Town area. This convenience sample, recruited through local media advertisement, consisted of 10 lean (LB) and 10 obese black women (OB) and 13 lean white (LW) and 11 obese white women (OW). There were no significant differences among the women for education level and socio-economic status, although housing density was significantly higher amongt the black women. Women were only included if they had not lost or gained more than 2 kg in the preceding 3 months to their participation in the trial (self-report), not using any cardiovascular or metabolic medication, were not unwell in the preceding 6 months and had no physical limitation to exercise participation. The study was carried out in accordance with the Declaration of Helsinki and approved by the Research and Ethics Committees of the Faculty of Health Sciences of the University of Cape Town. All subjects signed an informed consent form.

Body composition

Body weight was measured to the nearest 0.2 kg and height nearest to 0.5 cm, using a combination scale and standiometer (Universal weight enterprise Detecto model BW-150, Taipei, Taiwan). Waist (measured at the level of the umbilicus) and hip girths (measured at the widest circumference over the buttock area) were used to calculate the waist-to-hip ratio (WHR). Whole body composition was measured using dual-energy X-ray absorptiometer (DXA) (Hologic QDR 4500 Discovery-W with software version 4.40, Hologic Inc., Bedford, MA, USA in South Africa) according to the standard procedures. The whole body scan obtained from the DXA enabled the assessment of whole body lean and fat tissue (kg) and % body fat (% BF). The coefficient of variation for repeated measurements in our laboratory was 0.7% for lean soft tissue mass and 1.7% for fat mass.

Socio-demographic

Subjects completed a socio-demographic questionnaire, examining education, housing, housing density and occupation. Physical activity was assessed using a self-report questionnaire based on the previously validated International Physical Activity Questionnaire (Craig *et al.*, 2003) which calculated the minimum and maximum number of expended metabolic equivalents (METS) (hours per week) of self-reported physical moderate and vigorous activity. Outcome variables included MET hours (hours per week) and daily PAEE (kJ per day).

Habitual dietary intake

All participants completed an estimated 3-day dietary record. Subjects were instructed on accurate dietary recording techniques and issued with standardized food measures. Dietary intake and macronutrient composition were analyzed by a dietician, using the computer package FoodFinder3 software application (Version 1, Medical Research Council of South Africa). Total dietary intake (kJ), total carbohydrate, protein, fat and alcohol (g and % of energy) were calculated and used to prepare the chamber diet. Macronutrient contributions were kept similar to the habitual diet while the final calorie composition was 90% of the habitual diet to accommodate the reduced physical activity as a result of the confined environment within the respiration chamber.

Energy expenditure

Resting and 21 h EE were measured in a respiration chamber, using a fixed activity protocol, including prespecified periods of sleeping, sitting, eating and exercise. The respiration chamber may be described as push-type, open-circuit, indirect chamber, approximately $19.7\,\text{m}^3$ and furnished similarly to a normal household bedroom. There is an electronically braked cycle ergometer (Lode, Gronigen, The Netherlands) as well as two stepping boxes (15 and 25 cm). Continuous samples of chamber air from the exhaust and incoming fresh air from the fresh air inlet are sampled using a Xentra 4100 Gas Purity Oxygen Analyzer (Servomex, Crowborough, United Kingdom) and an infrared Hartmann and Braun carbon dioxide analyzer (Hartmann and Braun, Frankfurt, Germany). All data are captured using a PC-based data acquisition system (Labview, National Instruments, Texas, USA) and averaged to 1-h values for the calculation of EE. The chamber is validated with independent check of the entire system, by burning a known quantity of ethanol (99.9%) inside the chamber (Schoffelen *et al*., 1997). Subjects reported to the laboratory at 1700 hours and were fully briefed with the fixed activity chamber protocol until 2100 hours.

REE and physical activity measurements
The REE was measured immediately over a 1-h period on waking, on the second day, with the subjects supine. Following the REE measurement, the subjects received their breakfast. There were two structured exercise sessions, one mid-morning and another after lunch, in the mid-afternoon, both of which were followed by a light snack according to subjects individually prepared diets.

The first exercise session was performed on the stationary cycle ergometer and comprised three 10-min light-to-moderate intensity workloads. The workloads were based on the starting workloads for unconditioned females (American College of Sports Medicine, 2006), with the lightest intensity workload corresponding to an intensity level of three METs or light effort and the highest intensity workload corresponding to a value six METs or moderate effort. The second exercise session was weight bearing and comprised six stepping workloads. All workloads were 5-min in length and conducted at a set cadence using an electronic metronome (Model SQ 50, Seiko, Japan) and two different step heights (15 and 25 cm). The stepping workloads were also considered to be of light- and moderate-intensity effort, with the lightest intensity workload corresponding to four METs and the hardest intensity workload corresponding to an intensity level of seven METs. During both the cycling and box-stepping exercise sessions if participants displayed any signs of fatigue or reduced effort, they were verbally encouraged by the investigator.

Statistics
The statistical package Statistica 7.0 (Statsoft Inc., Oklahoma, USA) was used in the analysis. A two-way ANOVA was used to examine main effects for ethnicity (black vs white) and lean vs obese, as well as any interaction effects. Analysis of covariance was also used to adjust for differences between groups for FFM. The Pearson's χ^2-test was used to examine between group differences in family medical history, previous weight loss history, marital status, housing density and socio-economic status. Statistical significance was accepted at a level of $P<0.05$. Data are presented as means ± s.d.

Table 1 Subject demographics and characteristics for lean and obese, black and white women

	LB (N = *10*)	*LW* (N = *13*)	*OB* (N = *10*)	*OW* (N = *11*)
Age (years)	27.4 ± 5.6	31.8 ± 5.7	30.9 ± 8.0	31.9 ± 4.4
Weight (kg)$^{\Phi}$	58.7 ± 6.9	64.6 ± 6.9	89.9 ± 14.9	90.8 ± 14.0
Height (m)$^{\psi}$	1.64 ± 0.04	1.71 ± 0.04	1.57 ± 0.04	1.65 ± 0.04
BMI (kg m^{-2})$^{\Phi}$	21.8 ± 1.5	22.1 ± 1.7	36.2 ± 5.4	33.4 ± 3.3
WHR$^{\Omega}$	0.76 ± 0.07	0.78 ± 0.05	0.79 ± 0.06	0.84 ± 0.04
Fat (kg)$^{\Phi}$	15.9 ± 4.4	16.1 ± 6.9	41.3 ± 10.0	38.1 ± 8.3
FFM (kg)$^{\psi}$	40.2 ± 3.2	45.5 ± 5.3	45.4 ± 6.1	49.6 ± 7.0
Body fat (%)$^{\Phi}$	27.0 ± 5.0	24.7 ± 9.4	46.0 ± 4.1	42.3 ± 3.2

Abbreviations: LB, lean black; LW, lean white; OB, obese black; OW, obese white.
$^{\Phi}$Significant effect of lean/obese, $P<0.001$.
$^{\psi}$Significant effect of lean/obese and ethnicity, all $P<0.01$.
$^{\Omega}$Significant effect of lean/obese and ethnicity, all $P<0.05$.

Results

Body composition
Subject characteristics are shown in Table 1. The mean age was 30.6 ± 6.1 years, and did not differ between groups. Subjects in the lean groups were, by design, significantly lighter and had lower BMIs ($P<0.001$) compared to the obese groups. There were no ethnic differences in weight and BMI within the lean or obese groups. Black and obese women were significantly shorter than the white and lean women (all $P<0.01$).

Waist, hip and WHR were significantly greater in the obese than the lean women, with no ethnic differences in waist or hip circumferences. White women had a significantly greater WHR than the black women ($P<0.05$). BF (%) and fat mass (kg) did not differ between ethnic groups, only between the lean and obese ($P<0.001$). However, the black women had significantly less FFM (kg) than the white women (42.7 ± 5.4 vs 47.4 ± 6.4 kg, respectively, $P<0.01$), and the obese women had overall larger FFM than the lean women (47.6 ± 6.0 vs 43.2 ± 5.2 kg, respectively, $P<0.01$).

Demographic characteristics
Although the black women had a significantly greater housing density (persons per room, $P<0.05$), there were no differences for asset index, employment, marital status or weight loss history between groups. Moreover, there were no differences for family incidence of stroke, hypertension or cardiovascular disease. Black women reported 33% greater prevalence of family history of diabetes.

Dietary intake
Dietary intake is presented in Table 2. There were no significant differences in mean total energy, carbohydrate or protein intakes between groups. There was a significant interaction ($P<0.05$) for lean vs obese and ethnicity for fat intake (%), white women consumed less fat than the black

Table 2 Habitual and chamber energy (EI) and macronutrient intake for lean and obese, black and white women

	LB (N = 10)	LW (N = 13)	OB (N = 10)	OW (N = 11)
Habitual EI (kJ day^{-1})	7909 ± 2247	8631 ± 3481	8471 ± 3121	10004 ± 4091
Habitual carbohydrate (%)	53 ± 8	55 ± 9	53 ± 10	47 ± 6
Habitual protein (%)	17 ± 3	16 ± 4	16 ± 3	16 ± 4
Habitual fat (%)$^{\Phi}$	29 ± 7	26 ± 8	27 ± 4	34 ± 8
Chamber EI (kJ day^{-1})	7119 ± 1407	7795 ± 2129	7472 ± 2411	9038 ± 2877
Chamber carbohydrate (%)	55 ± 5	58 ± 10	57 ± 5	54 ± 69
Chamber protein (%)	20 ± 4	17 ± 3	18 ± 4	18 ± 7
Chamber fat (%)	25 ± 6	25 ± 9	25 ± 7	28 ± 8

Abbreviations: LB, lean black; LW, lean white; OB, obese black; OW, obese white.
$^{\Phi}$Significant interaction effect for lean/obese and ethnicity, $P<0.05$.

Table 3 Energy expenditure, adjusted for FFM, in black and white, lean and obese women

	LB (N = 10)	LW (N = 13)	OB (N = 10)	OW (N = 11)
TDEE (kJ)$^{\Phi}$	9289 ± 699	9732 ± 635	9827 ± 635	10617 ± 684
Total awake time (kJ min^{-1})$^{\Psi}$	8.36 ± 1.04	8.68 ± 0.94	8.93 ± 0.94	9.68 ± 1.02
Total awake time no PAEE (kJ min^{-1})	6.32 ± 0.97	6.74 ± 0.88	6.70 ± 0.88	7.27 ± 0.95
REE (kJ min^{-1})	4.27 ± 0.64	4.21 ± 0.58	4.40 ± 0.58	4.44 ± 0.63
24 h REE (kJ 24 h^{-1})	6154 ± 923	6059 ± 839	6341 ± 839	6391 ± 904
Sleep EE (kJ min^{-1})	4.96 ± 0.80	4.92 ± 0.72	4.87 ± 0.72	5.22 ± 0.78
24 h RER	0.89 ± 0.06	0.88 ± 0.04	0.93 ± 0.06	0.90 ± 0.07
Resting RER	0.86 ± 0.11	0.83 ± 0.13	0.83 ± 0.19	0.83 ± 0.23

Abbreviations: EE, energy expenditure; FFM, fat-free mass; LB, lean black; LW, lean white; OB, obese black; OW, obese white; PAEE, physical activity energy expenditure; REE, resting energy expenditure; RER, respiratory exchange ratio; TDEE, total daily energy expenditure.
$^{\Phi}$Significant effect of lean/obese, $P<0.001$ and ethnicity, $P<0.05$.
$^{\Psi}$Significant effect of lean/obese, $P<0.05$.

Table 4 Energy expenditure, unadjusted for differences for FFM, in black and white, lean and obese women

	LB (N = 10)	LW (N = 13)	OB (N = 10)	OW (N = 11)
TDEE (kJ)$^{\Phi}$	8672 ± 731	9761 ± 9225	9840 ± 1198	11132 ± 1035
Total awake time (kJ min^{-1})$^{\Psi}$	7.89 ± 0.93	8.70 ± 0.86	8.95 ± 0.98	10.08 ± 1.10
Total awake time no PAEE (kJ min^{-1})$^{\Omega}$	5.91 ± 0.86	6.76 ± 0.92	6.71 ± 0.98	7.61 ± 1.12
REE (kJ min^{-1})$^{\Pi}$	3.96 ± 0.44	4.22 ± 0.76	4.41 ± 0.51	4.70 ± 0.89
24 h REE (kJ)$^{\Pi}$	5703 ± 636	6079 ± 1012	6351 ± 733	6767 ± 1278

Abbreviations: FFM, fat-free mass; LB, lean black; LW, lean white; OB, obese black; OW, obese white; PAEE, physical activity energy expenditure; REE, resting energy expenditure; TDEE, total daily energy expenditure.
$^{\Phi}$Significant effect of lean/obese, $P<0.01$ and ethnicity, $P<0.05$.
$^{\Psi}$Significant effect of lean/obese and ethnicity, all $P<0.05$.
$^{\Omega}$Significant effect of lean/obese, $P<0.001$ and ethnicity, $P<0.05$.
$^{\Pi}$Significant effect of lean/obese, $P<0.05$.

women, while the LW consumed less fat than the OW and the LB consumed more fat than the OB women.

Energy expenditure
As there were significant ethnic differences in FFM, in Table 3 all EE data were co-varied for FFM; Table 4 presents the unadjusted EE data. We found a significant main effect for the total 24 h EE (kJ) for both ethnicity and BMI (lean vs obese: $P<0.001$ and ethnicity: $P<0.05$) with black and lean women accumulating significantly less total 24 h EE than the white and obese women. There were, however, no differences for REE, resting RER and 24 h RER for either BMI or ethnic groups. The total awake time EE (kJ min^{-1}), including PAEE (cycling and stepping), was only significantly different for BMI groups ($P<0.05$), with obese women accumulating more EE than lean women. Separating the data into total awake time EE minus physical activity EE, we found no differences for the BMI or ethnic groups.

Physical activity EE
Table 5 presents all the PAEE data, adjusted for FFM. Overall, the obese and white groups accumulated significantly

Table 5 Physical activity EE, adjusted for FFM and self-reported physical activity results, in lean and obese, black and white women

	LB (N = *10*)	*LW* (N = *13*)	*OB* (N = *10*)	*OW* (N = *11*)
Total PAEE (kJ min^{-1})$^{\Phi}$	23.86 ± 7.70	26.89 ± 7.00	28.04 ± 7.00	39.53 ± 7.54
Cycling PAEE (kJ min^{-1})$^{\Omega}$	17.88 ± 2.70	18.35 ± 2.46	18.47 ± 2.46	21.28 ± 2.65
Stepping PAEE (kJ min^{-1})$^{\psi}$	15.48 ± 2.16	14.86 ± 1.97	17.36 ± 1.97	19.47 ± 2.12
Minimum MET hours (h week^{-1})$^{\Lambda}$	10.4 ± 13.4	11.3 ± 3.9	3.6 ± 5.2	4.4 ± 5.5
Minimum PAEE per day (kJ day^{-1})	336.3 ± 402.0	435.1 ± 160.8	186.7 ± 271.3	244.7 ± 341.5
Maximum MET hours (h week^{-1})$^{\Pi}$	33.3 ± 26.7	57.9 ± 25.7	15.0 ± 21.6	18.5 ± 21.4
Maximum PAEE per day (kJ day^{-1})$^{\Sigma}$	1104.5 ± 808.8	2220.0 ± 6678.9	799.2 ± 1185.8	1037.5 ± 1333.2

Abbreviations: LB, lean black; LW, lean white; OB, obese black; OW, obese white; MET, metabolic equivalent; PAEE, physical activity energy expenditure.
$^{\Phi}$Significant effect of lean/obese and ethnicity, all $P<0.001$.
$^{\Omega}$Significant effect of lean/obese, $P<0.05$.
$^{\psi}$Significant effect of lean/obese, $P<0.001$ and significant interaction effect lean/obese and ethnicity, $P<0.05$.
$^{\Lambda}$Significant effect of lean/obese, $P<0.01$.
$^{\Pi}$Significant effect of lean/obese, $P<0.001$.
$^{\Sigma}$Significant effect of lean/obese and ethnicity, all $P<0.05$.

greater amounts of PAEE than the lean and black groups (all $P<0.001$). During the cycling and stepping sessions, obese women accumulated greater amounts of PAEE than the lean women, cycling: 20.10 ± 2.04 vs 18.01 ± 3.19 kJ min^{-1}, $P<0.05$, lean obese, respectively, and stepping: 14.50 ± 2.10 vs 19.15 ± 3.40 kJ min^{-1}, $P<0.001$). Furthermore, there was a significant interaction effect ($P<0.05$) between the lean/obese and black/white women during PAEE 2. Using Fischer's *post hoc* analysis the OW women accumulated significantly greater amount of PAEE than the OB women, while the LB women accumulated a significantly greater level of PAEE than the LW women. With the combination of the two exercise sessions to obtain total PAEE, obese women accumulated a greater total PAEE than lean women (33.78 ± 0.28 vs 25.38 ± 0.26 kJ min^{-1}, $P<0.001$) and white women accumulated a greater total amount of PAEE than black women (33.21 ± 0.25 vs 25.95 ± 0.29 kJ min^{-1}, $P<0.001$).

Self-reported minimum and maximum MET hours per week and PAEE per day (kJ per day) were calculated from the self-report questionnaire data (Table 5). Lean women reported significantly more physical activity per week than the obese women ($P<0.001$). The maximum daily self-reported PAEE (kJ per day) was different between the lean and obese and black and white groups (all, $P<0.05$).

Discussion

Using a respiration chamber, we found differences in TDEE, between black and white women, independent of differences in body composition. However, these ethnic differences were largely attributed to differences in PAEE, and not as a result of lower REE, as previously reported in studies from the United States (Albu *et al*., 1997; Foster *et al*., 1997; Carpenter *et al*., 1998; Hunter *et al*., 2000; Weinsier *et al*., 2000, 2002; Lovejoy *et al*., 2001; Sharp *et al*., 2002). In the present study, total PAEE was on average 25% lower in the black as compared to white women, largely due to between-group differences in the weight-bearing stepping exercise, where white obese women accumulated a significantly greater PAEE (11%) than black women.

These differences may be partly explained by two observations. Firstly, the obese black women were significantly shorter than their obese white counterparts and may have found the box stepping relatively more difficult, particularly during the stepping on the second higher (25 cm) step. Secondly, black obese women appeared to take more unscheduled stoppages during the stepping exercise and this may relate to their lower levels of reported fitness (Table 5). We did not obtain a measure of spontaneous physical activity for the non-exercise periods and assumed that any differences would have been reflected as differences in total awake time EE. However, we did not find any ethnic differences in awake-time EE, similar to previously reported findings in AA and white women. Two previous studies (Hunter *et al*., 2000; Weinsier *et al*., 2000), using the doubly labeled water (DLW) technique, report no ethnic differences in PAEE in AA and white women. However, in one study (Hunter *et al*., 2000), TDEE was significantly different between the two groups of women, but was attributed to differences in REE and trunk lean tissue masses.

In contrast, Weyer *et al*. (1999) found that AA women accumulated more spontaneous PAEE, measured by Doppler radar during a 24 h stay in a respiration chamber, in which the activity protocol was not fixed, as compared to their white counterparts. Similarly, Weinsier *et al*. (2002) reported significantly higher free-living PAEE levels in AA compared to white women of similar age using DLW to calculate TDEE and estimate PAEE. These two studies might suggest that women of AA origin display greater free-living PAEE levels than their white counterparts. However, when we examined the self-reported physical activity behavior, (Table 5), we found that not only did the lean women report a significantly greater amount of daily PAEE (32%) than obese women, but also the black women reported significantly lower daily PAEE than the white women (44%). It is conceivable that lower PAEE levels in the black women may be accompanied by lower levels of physical fitness and may further help explain the difficulty experienced with the stepping protocol.

This finding is in line with others (Lovejoy *et al*., 2001; Hunter *et al*., 2004) reporting lower levels of habitual PAEE in AA compared to white adults (Lovejoy *et al*., 2001). Aerobic fitness, measured using a modified Bruce graded treadmill protocol, was found to be 13% lower in premenopausal AA compared to white women, independent of the larger FFM in the AA women (Hunter *et al*., 2004). This difference in the self-reported leisure time PAEE, and therefore self-reported fitness, would therefore provide a plausible explanation as to why the black women, particularly the obese black women, would have struggled more with the exercise sessions than the white women.

In common with other reports (Shetty *et al*., 1996; Soares *et al*., 1998; Jones *et al*., 2004), we found no differences in REE between women of different ethnicities after adjusting for differences in body composition. These previous studies compared AA to white women (Jones *et al*., 2004) and women of Western decent to Indian women (Shetty *et al*., 1996). The divergent results between studies completed in the United States and elsewhere have been attributed to differences in body composition and metabolic organ masses (Weinsier *et al*., 2000; Hunter *et al*., 2004) in AAs. Recently, Gallagher *et al*. (2006) found that after adjusting for differences in specific high-metabolic rate organs, differences in REE was no longer significantly different between AAs and Caucasians. While in the current study we were unable to adjust for smaller higher metabolic organ tissue, our results are similar because after adjusting for differences in FFM, differences in REE were no longer significant. It is notable that the black women in the current study had overall smaller FFM (kg) than the white women, this is contrary to the data from the United States that consistently report AA women have either no difference in FFM or, in some cases, greater amounts of FFM than their white counterparts (Carpenter *et al*., 1998; Weyer *et al*., 1999; Lovejoy *et al*., 2001; Kimm *et al*., 2002; Sharp *et al*., 2002) but in line with the published data on SA women (Rush *et al*., 2007) and similar to data on African women living outside the the United States (that is, Nigeria) who have lower body weights, FFM and fat masses than AA women (Luke *et al*., 2000, 2002).

Body composition differences have been attributed to differences in specific habitual dietary intake patterns and trends in populations undergoing the nutrition transition, as suggested by Popkin (1998). These factors might also play a role in the ethnic differences in body composition found in our study; however, this is beyond the scope of the current research. Furthermore, methodological limitations to the current include the relatively small subject numbers and convenience sampling.

In summary, this comparative study in adult black and white SA women found that TDEE was lower in black as compared to white women. However, these differences could be accounted for by the lower measured PAEE, as well as the smaller FFM in the black as compared to the white women, and not due to differences in REE as previously reported in the United States. Lower levels of TDEE may be attributed to the relative shortness of the black women, and perhaps lower levels of fitness due to less self-reported habitual physical activity in the black as compared to the white women. Differences in habitual physical activity should be investigated more objectively as it might provide a focus area for the management and treatment of obesity in black SA women.

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