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Racial differences in the association between body fat distribution and lipid profiles among reproductive-aged women

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Abstract

Aim—The aim of this study was to examine the racial and ethnic differences in the relationship between body fat distribution variables and serum lipid profiles.

Methods—Secondary data analyses were conducted on 708 healthy women (204 blacks, 247 whites and 257 Hispanics) between 16 and 33 years, seen in an outpatient clinic for contraception. Pearson correlation and multivariable linear regression techniques were used to identify racial/ethnic differences in the relationship between lipid profiles and body fat after adjusting for lean mass, as well as demographic and lifestyle variables.

Results—All body fat distribution variables were significantly associated with total cholesterol ($r = .14$ to $.26$), triglyceride ($r = .13$ to $.46$), HDL cholesterol ($r = -.13$ to $-.34$), cholesterol-to-HDL ratio ($r = .20$ to $.50$), and atherogenic index of plasma ($r = .16$ to $.49$). Significant racial/ethnic differences were observed in many associations. After adjusting for lean mass and other demographic and lifestyle factors, the study showed that black women demonstrated significantly weaker associations than their white and Hispanic counterparts using multivariable linear regression procedures.

Conclusion—The relationship between lipid profiles and body fat distribution variables varies by race/ethnicity in reproductive-aged women. A better understanding of these racial/ethnic differences has important implications for clinical and public health efforts in targeting prevention of cardiovascular disease.

Keywords

Body fat distribution; Lipid levels; Race; Women; Reproductive-age

Introduction

Cardiovascular disease (CVD) is the leading cause of mortality among women in the US (1). Although previous studies have documented the association of CVD with obesity, recent research has demonstrated that body fat distribution is more significantly related to CVD and is distinct from the overall effects of obesity (2,3). In fact, there is growing agreement that trunk/central obesity is positively associated with CVD (4,5), while leg fat has been shown to be protective against hard outcomes of CVD in monitored cohorts (6).

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However, the pathway that connects the distribution of body fat to the development of CVD is uncertain. The available evidence so far suggests that individuals with larger trunk fat mass have higher triglyceride (TG) concentrations while those with larger leg fat mass have higher concentration of high-density lipoprotein (HDL) (7). As TG and HDL concentrations differ in the way they affect the risk of CVD (8), it has been suggested that associations between body fat distribution and CVD morbidity/mortality may be mediated, in part, through unfavorable blood lipid levels (9). Other metabolic complications (insulin resistance, hyperinsulinemia and diabetes, and hypertension) have also been proposed as pathways (10,11).

While previous studies have identified that fat distribution variables and lipid profiles are related, few studies have comprehensively examined this relationship in reproductive-aged women (12,13). This is an important population to consider, as earlier studies have suggested a tendency for women to retain fat after childbirth (14,15). Indeed, the US National Health and Nutrition Examination Survey (NHANES) data collected from 1999 to 2004 also suggest an increased risk for midlife obesity in American women (16,17). In addition, the effect of race/ethnicity on the relationship between fat-distribution variables and lipid profiles has yet to be thoroughly investigated. Nevertheless, this is an important factor to address, given that: 1) race/ethnicity has been shown to be a significant determinant of female body composition and lipid profiles (18); 2) non-Hispanic black (henceforth referred to as “black”) women differ from non-Hispanic white (henceforth referred to as “white”) women in muscle mass, fat distribution, bone mass, and modulation of lipid profiles (19); 3) a previous study by the present research team demonstrated significant racial differences in body fat distribution that may have different effects on lipid profiles (20); 4) few data are available for Hispanic women, the fastest growing segment of the US population (21); and 5) Hispanic and black women are more likely to accumulate body fat than their white counterparts (22). For these reasons, the purpose of the present study was to test the hypothesis that racial/ethnic differences have an effect on the relationship between body fat distribution and lipid profiles in reproductive-age women.

Methods

Secondary data analyses were conducted on a sample of healthy, self-identified black, white and Hispanic women, aged 16–33 years, who had participated in a larger, prospective study on hormonal contraception. The methods used in the larger study are reported in detail elsewhere (23). Briefly, recruitment was conducted to obtain a sample that was balanced by age group (16–24 years and 25–33 years), race/ethnicity (black, white, Hispanic) and contraceptive method (non-hormonal, oral contraceptives, and depo-hydroxyprogesterone acetate). All women underwent eligibility screening, including a medical interview, anthropometry, bone density scanning and fasting phlebotomy during the follicular phase of their menstrual cycle. Criteria for exclusion included: current pregnancy or breastfeeding; pregnancy planned within the next 3 years; use of depo-medroxyprogesterone within the past 6 months; use of oral contraceptives within the past 3 months; current use of intrauterine device; contraindication to hormonal contraception; lack of menses for >3 months during the past year; bilateral oophorectomy; use of over-the-counter phytoestrogens (such as Estroven, Promensil); dietary isoflavone intake >84 mg/day; and having an eating disorder or following a strict vegetarian diet.

A total of 805 out of 2,999 women who responded to advertisements agreed to participate. Of these 805 women, five withdrew before completing the first visit, and 92 had abnormal laboratory results. Thus, 708 women met all eligibility criteria and were included in the current analyses. The excluded women (n=97) did not differ significantly from those included in the analyses (n=708) in terms of age, marital status, parity or education (all $P < .05$). Also, forms completed by the patients were examined to determine their use of lipid-lowering agents, as this was not among the original exclusion criteria; none of the 708 respondents had a history

of using these medications at the time of baseline interview. Written, informed consent was obtained from all participants, and parental consent was obtained for those <18 years of age. All participants received free Well-Woman care while participating in the study, and all were compensated for their time and travel costs to attend the clinic. Every attempt was made to maintain confidentiality and anonymity. The study received approval from the Institutional Review Board at the University of Texas Medical Branch at Galveston.

The present analyses included data on weight, height, current age and lifestyle variables (such as smoking, alcohol use and physical activity) that had been collected during the first clinic visit. Body weight while wearing light indoor clothing was measured using a digital scale that was accurate to the nearest 0.1 kg. Height was measured using a wall-mounted Heightronic Digital Stadiometer, accurate to the nearest 0.001 m. Body Mass Index (BMI) was calculated as weight (kg) divided by the square of the height (m²). Body fat measures (kg) included: 1) total body fat mass (FM_{total}); 2) trunk fat mass (FM_{trunk}); 3) arm fat mass (FM_{arm}); and 4) leg fat mass (FM_{leg}). Dual-energy X-ray absorptiometry (DXA; Hologic QDR 4500W densitometer, Hologic Inc, Bedford, MA, USA) was used to assess body composition and the percentage of body fat mass (%FM_{total}) was calculated using the following formula: [(fat mass in kg/total body weight in kg) × 100]. The trunk-to-limb fat mass ratio (FMR_{trunk-to-limb}) and leg-to-total fat mass ratio (FMR_{leg-to-total}) were calculated using body fat distribution data generated by the DXA machine.

Life style related variables, such as alcohol use, were calculated from questions on the Diet History Questionnaire regarding how often subjects drank alcohol (either beer, wine or wine coolers, or liquor or mixed drinks) during the past 12 months, and the amount usually consumed when drinking (24). Weight-bearing physical activity was assessed using a measure that included a list of 56 common activities, and questions on the frequency and duration of up to two physical activities performed during the past month. Kolle et al. (25) reported that the total number of min/week devoted to weight-bearing exercise should be >120 minutes to produce any positive impact. Therefore, we divided weight-bearing exercise into two groups: ≤ 120 min/week and >120 min/week.

Outcomes of interest were lipid profiles related to cardiovascular risk factors—namely, total cholesterol (TC), total TG, HDL, low-density lipoprotein cholesterol (LDL), very low density lipoprotein cholesterol (VLDL), TC-to-HDL ratio and atherogenic index of plasma (AIP), a marker of plasma atherogenicity calculated as the logarithmically transformed ratio of molar concentrations of TG-to-HDL (26). Fasting blood samples were collected between 07 00 and 10 00 hours in the morning. All assays were performed on the VITROS 5.1 FS Chemistry System (Ortho-Clinical Diagnostics, Raritan, NJ) using the manufacturers reagents and calibrators, and TG and cholesterol tests were carried out using the VITROS TRIG and CHOL slides, respectively, along with the VITROS Chemistry Products Calibrator Kit 2. Each slide analyzed 5.5 µL of serum using a multilayered analytical element coated on a polyester support, with colorimetric detection and analysis based on an enzymatic method. Direct HDL (dHDL) cholesterol was measured using the VITROS dHDL slide with the VITROS Chemistry Products Calibrator Kit 25. For this test, each slide used 10 µL of serum and a colorimetric test on a multilayered analytical element coated on a polyester support. Analyses were based on a non-HDL precipitation method followed by enzymatic detection. Coefficients of variation for TG, TC and dHDL were 0.9%, 1.5%, and 3%, respectively, and were determined using a single lot of reagents calibrated weekly. Indirect lipid measures, HDL, LDL, and VLDL, were calculated based upon values obtained for TC and dHDL cholesterol.

For continuous variables, comparison of means across all three racial/ethnic groups was performed using one-way analysis of variance (ANOVA), with post-hoc analysis using Bonferroni multiple-comparison test. The significance level at this stage was retained at

$P < 0.017$ (0.05/3). Chi-square tests were performed for categorical variables, and pairwise Pearson correlation was used to measure the correlation between various fat-distribution variables and lipid profiles by race/ethnicity. The difference between two correlation coefficients was also assessed, using the 'z' test with Fisher's r-to-z transformation technique (27). Multivariate linear regression analysis was used to model the relationship between lipid profiles and body fat distribution variables after adjusting for age, race/ethnicity, lean mass, alcohol intake, smoking, exercise, parity and prior contraceptive use. Regression analysis was adjusted for lean mass instead of BMI as BMI showed a very high collinearity with body fat variables (>0.84). To examine racial/ethnic differences in the relationship between lipid profiles and body fat distribution, the interaction term (body fat variable X race) was also included in the model. All analyses were performed using STATA 10 (STATA Corporation, College Station, TX).

Results

A total of 708 black, white and Hispanic women, with a mean age of 24.3 years, were included in the present study. Age, physical activity, percent body fat, alcohol use, and mean serum LDL level did not differ across the three racial/ethnic groups (Table 1). However, black women were more likely to have higher values of body weight, lean mass, BMI, FM_{total} , FM_{trunk} and HDL compared to white and Hispanic women whereas, on the other hand, TC, TG, VLDL and AIP were lowest in black women. Hispanic women were more likely to have higher % FM_{total} and $FMR_{trunk-to-limb}$, while white women were more likely to be current smokers, and had a lower BMI and parity.

Table 2 shows that body fat distribution variables correlated with serum lipid variables. Further examination of these correlations revealed differences according to racial/ethnic group. In general, the relationship was stronger in white and Hispanic women compared with black women. Significant racial/ethnic differences were observed in many of these correlations. The relationship between FM_{trunk} versus TG and FM_{trunk} versus VLDL were significantly stronger in white than in black women, whereas the relationship between $FMR_{trunk-to-limb}$ versus HDL and $FMR_{trunk-to-limb}$ versus TC-to-HDL were stronger in white and Hispanic women compared with black women. In many cases, the relationship between body fat variables and AIP and Chol-to-HDL ratio was stronger in Hispanics compared with blacks. However, no significant differences were observed between Hispanic and white women for any variable studied.

Table 3 shows the relationship of fat-distribution variables and each of the serum lipid concentrations, based on a multiple linear regression procedure after adjusting for age, lean mass and life style variables. When overall regression coefficients and race-specific regression coefficients were generated based on full and race-specific models, black women were found to have the lowest regression coefficient of the three races, while white or Hispanic women had the highest values. However, one exception was observed: black women had the highest coefficient for HDL with % FM_{total} .

Multiple regression models with interaction terms between race/ethnicity and fat distribution variables showed significant statistical differences by race/ethnicity in the relationships between body fat distribution variables and serum lipid profiles (Table 3). Significant differences were observed between black and Hispanic women in the following relationships: 1) TG versus FM_{total} , % FM_{total} , FM_{trunk} , $FMR_{trunk-to-limb}$ and $FMR_{leg-to-total}$ ($P=0.002$, 0.005 , 0.001 , 0.04 , and 0.004 , respectively); 2) HDL versus FM_{total} and FM_{trunk} ($P=0.04$ and 0.03 , respectively); 3) VLDL versus FM_{total} , % FM_{total} , FM_{trunk} , $FMR_{trunk-to-limb}$ and $FMR_{leg-to-total}$ ($P=0.002$, 0.004 , 0.001 , 0.04 and 0.002 , respectively); 4) TC-to-HDL versus FM_{total} , % FM_{total} , FM_{trunk} and $FMR_{leg-to-total}$ ($P=0.001$, 0.009 , 0.001 , and 0.007 , respectively); 5) AIP versus FM_{total} , % FM_{total} , FM_{trunk} and $FMR_{leg-to-total}$ ($P=0.001$, 0.001 , 0.001 and 0.028 ,

respectively). In most of the relationships mentioned above, significant differences were also observed between black and white women: 1) TG versus FM_{total} , $\%FM_{total}$ and FM_{trunk} ($P=0.002$, 0.013 and 0.002 , respectively); 2) HDL versus FM_{trunk} , $FMR_{trunk-to-limb}$ and $FMR_{leg-to-total}$ ($P=0.04$, 0.045 , and 0.03 , respectively); 3) VLDL versus FM_{total} , $\%FM_{total}$ and FM_{trunk} ($P=0.001$, 0.013 and 0.002 , respectively); 4) TC-to-HDL versus FM_{total} , FM_{trunk} , $FMR_{trunk-to-limb}$ and $FMR_{leg-to-total}$ ($P=0.007$, 0.003 , 0.03 , and 0.004 , respectively); 5) AIP versus FM_{total} and FM_{trunk} ($P=0.01$ and 0.014 , respectively). However, no significant differences were observed between white and Hispanic women in these associations.

Discussion

To our knowledge, this is the first large-scale study to examine the association between body fat and serum lipid profiles in reproductive-age women that included Hispanic women as a separate ethnic group. The study demonstrates that total body fat distribution variables and trunk fat are positively associated with TC, TG, LDL, and AIP. Conversely, peripheral fat variables, such as $FMR_{leg-to-total}$ were found to be protective in all three racial/ethnic groups, demonstrating a negative relationship with TC, TG, LDL and AIP. In addition, although significant racial/ethnic differences were observed, no notable differences were observed between white and Hispanic women. Taken together, these findings suggest that the independent and opposite associations of total/trunk fat and peripheral fat with lipid levels observed in white and black women can be extended to include Hispanic women (28,29). Furthermore, total/trunk or peripheral fat-distribution variables generally resulted in smaller changes in lipid levels in black women compared with their white and Hispanic counterparts.

The present study results are in agreement with earlier studies demonstrating that the relationship of body fat distribution variables with the lipid profile is weaker in black women than in their white counterparts (18,30). This may be due to either higher lipid-clearance capacity or lower lipid production in blacks than in whites (31,32). In addition, on examining these variables in reproductive-age Hispanic women, it was found that any given increase in total or trunk fat variables is a reflection of a greater rise in lipid levels in white and Hispanic women compared with black women. This may explain why white and Hispanic women had higher lipid levels than black women in the study despite having less body fat and trunk fat mass.

The present study also demonstrates a greater positive association between trunk fat versus TG and VLDL levels, and a stronger negative association between leg-to-total fat ratio versus TG and VLDL levels, in Hispanic compared with black women. Also, the proportions of fat between various fat sub-compartments - visceral, subcutaneous and intramuscular- differed by racial/ethnic groups and showed differential sensitivity to metabolic activity including insulin sensitivity (11,33). This finding supports the current view that similar amounts of total fat or trunk fat in women of different race/ethnicities may confer different degrees of CVD risk (34), and extends the observation to Hispanic women as well.

Recent studies have suggested that the AIP may be a more useful index of cardiovascular risk than are individual lipid levels. The AIP is reported to be more sensitive than either TG or HDL alone, while reflecting the balance between the atherogenic and protective lipoproteins (26, 35). In the present study, most relationships between AIP and fat distribution variables were stronger in white and Hispanic women compared with black women. With the inclusion of Hispanics as a separate analytical category, our study has added new information on racial/ethnic difference in the relationship between the newly introduced AIP and body fat distribution variables.

In spite of having a favorable lipid profile (low TG, high HDL and low AIP), the higher CVD and coronary heart disease (CHD) incidences at the national level in blacks compared with whites and Hispanics present a puzzling and poorly understood paradox (36). Indeed, it is still not known whether greater adiposity is needed in black women to attain a level of lipid risk similar to that of white and Hispanic women, or if the risk of CVD increases at a lower threshold of TG and higher threshold of HDL in blacks. Lower peripheral insulin sensitivity in black compared with white women could also account for the discrepancy (37,38). Other CVD risk factor indicators, such as BMI, blood pressure, and glycated hemoglobin, which tend to be higher among black than in white women, may also play a role (39). In addition, genetics, environmental factors, dietary habits, and physical activity may also play a crucial role in this regard, and need to be evaluated in future prospective longitudinal studies.

The present study has several limitations. First, results are based on a single fasting measurement of serum lipids, and so the known considerable within-individual variability of lipid profiles may have led to substantial deviation from the true values. Second, DXA does not provide data on visceral fat, subcutaneous fat and intramuscular fat separately, information that would have offered additional insight. Third, women were not included if they were unable to receive hormonal contraceptives containing estrogen or wished to become pregnant in ≤ 3 years, as the specific aims of the larger study addressed contraceptive use. These limitations could influence the overall generalizability of the present findings.

Despite these limitations, the racial/ethnic differences revealed in the present study have important implications for public-health efforts targeting CVD prevention. The stronger correlation of lipids with body fat in white and Hispanic women indicates that weight loss programs may be more effective in improving serum lipid levels in these women than in black women. Our findings also suggest that preventative and interventional campaigns focusing on the dangers of trunk obesity should include reproductive-age women and, particularly, white women. Finally, tailoring awareness materials to specific at-risk populations may also be warranted. Information specifically targeting Hispanic women, for example, could address the importance of reducing their trunk-to-limb fat ratio as a measure to prevent CVD and metabolic complications. In all instances, possible cultural differences and attitudes towards body images by race/ethnicity should also be taken into account.

In conclusion, it is imperative to understand how race/ethnicity affects the relationship between body fat and lipid levels, as the incidence of CVD is extremely high in the US. Our results clearly indicate that race/ethnicity significantly modifies the relationship between body fat distribution and lipid levels. Thus, data derived from white populations may be inadequate for identifying at-risk Hispanic and black women. Furthermore, the application of new information such as ours to modify the “one size fits all” approaches to health promotion programs should boost the efforts of the US to meet its Healthy People 2010 goal to eliminate disparities in health.

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Table 1

Characteristics of study participants by race/ethnicity

	Black (n=204)	White (n=247)	Hispanic (n=257)	Group Difference*
Age in years, mean (SD)	23.6 (4.7)	24.6 (5.2)	24.5 (4.9)	NS
Parity, mean (SD)	1.12 (1.21)	0.96 (1.18)	1.40 (1.34)	H > W, B
DMP use in months (SD)	10.2 (18.7)	4.0 (10.3)	6.1 (15.4)	B > W, H
Body weight in kg; mean (SD)	78.5 (21.5)	70.5 (16.6)	70.0 (16.5)	B > W, H
Lean mass in kg; mean (SD)	48.1 (8.7)	43.4 (6.4)	42.1 (6.7)	B > W, H
Body Mass Index; mean (SD)	29.6 (7.7)	26.2 (6.2)	27.8 (6.1)	B > H > W
Alcohol, g/day; mean (SD)	0.93 (8.75)	2.45 (13.6)	1.52 (6.70)	NS
Smoker, current; %	16.2	39.3	24.9	W > H > B
Physical activity > 120 m/wk; %	33.8	32.4	44.9	NS
Total Fat mass in kg; mean (SD)	28.4 (13.5)	25.4 (11.2)	26.1 (10.3)	B > W
% Body Fat; mean (SD)	35.2 (8.4)	35.3 (8.1)	37.0 (6.9)	H > W
Total Trunk Fat in kg; mean (SD)	12.8 (7.1)	11.7 (6.3)	12.7 (6.0)	NS
Trunk-to-Limb Fat ratio; mean (SD)	0.83 (0.19)	0.87 (0.24)	0.99 (0.25)	H > W, B
Leg-to-Total Fat ratio; mean (SD)	0.42 (0.05)	0.41 (0.06)	0.38 (0.06)	B, W > H
Cholesterol in mg; mean (SD)	167.5 (33.0)	174.5 (29.5)	174.7 (31.3)	H > B
Triglyceride in mg; mean (SD)	77.4 (44.7)	100.3 (61.3)	109.6 (72.9)	W, H > B
HDL in mg; mean (SD)	47.6 (11.6)	46.1 (11.5)	44.2 (10.6)	B > H
LDL in mg; mean (SD)	104.6 (29.6)	108.2 (26.9)	109.4 (26.8)	NS
VLDL in mg; mean (SD)	15.5 (8.9)	20.1 (12.3)	21.9 (14.6)	W, H > B
TC-to-HDL ratio; mean (SD)	3.7 (0.95)	4.0 (1.15)	4.1 (1.05)	W, H > B
Atherogenic index of plasma (SD)	0.15 (0.31)	0.28 (0.30)	0.34 (0.29)	W, H > B

B=Black, W=White, H=Hispanic; NS = Non significant; SD= Standard Deviation

* significant difference at $P < 0.017$; One-way analysis of variances (ANOVA) with Bonferroni correction was used to examine "between group" differences for continuous variables and Chi-square tests were used to examine the differences for categorical variables.

Table 2

Pearson correlation Coefficients between body fat distribution variables and serum lipids for the total sample and by race/ethnicity

	TC	TG	HDL	LDL	VLDL	TC-to-HDL	AIP
Total Fat (kg) (FM_{total})							
All	0.21	0.26	-0.23	0.22	0.26	0.35	0.32
B	0.19	0.21	-0.17	0.21	0.21	0.29	0.25
W	0.27	0.37	-0.27	0.23	0.37	0.39	0.39
H	0.23	0.30	-0.31	0.23	0.30	0.45 [/]	0.43 [/]
% Body Fat (% FM_{total})							
All	0.25	0.25	-0.22	0.25	0.26	0.35	0.32
B	0.21	0.18	-0.16	0.25	0.17	0.30	0.22
W	0.26	0.30	-0.22	0.24	0.30	0.34	0.31
H	0.27	0.27	-0.26	0.26	0.26	0.41	0.40 [/]
Total Trunk fat (kg) (FM_{trunk})							
All	0.25	0.34	-0.27	0.24	0.33	0.42	0.39
B	0.20	0.26	-0.18	0.21	0.25	0.31	0.29
W	0.30	0.43 [*]	-0.32	0.27	0.43 [*]	0.46	0.45
H	0.26	0.36	-0.34	0.25	0.35	0.50 [/]	0.48 [/]
Trunk-to-Limb ratio (FMR_{trunk-to-limb})							
All	0.26	0.46	-0.33	0.23	0.46	0.49	0.49
B	0.20	0.36	-0.17	0.18	0.35	0.34	0.36
W	0.28	0.45	-0.36 [*]	0.27	0.45	0.51 [*]	0.48
H	0.26	0.45	-0.36 [/]	0.22	0.45	0.51 [/]	0.53 [/]
Leg-to-Total ratio (FMR_{leg-to-total})							
All	-0.24	-0.43	0.34	-0.22	-0.43	-0.49	-0.48
B	-0.15	-0.30	0.20	-0.15	-0.30	-0.31	-0.31
W	-0.26	-0.40	0.38 [*]	-0.25	-0.43	-0.51 [*]	-0.48 [*]
H	-0.26	-0.45	0.37 [/]	-0.23	-0.44	-0.53 [/]	-0.48 [/]

B= Black, W= White, H= Hispanic

Overall Coefficients (All) for all race/ethnicities combined were significant

* significant difference between blacks and whites at $P<0.05$

[/] significant difference between blacks and Hispanics at $P<0.05$

Table 3

Regression Coefficients between body fat distribution variables and lipid profile for total sample and by race/ethnicity

	TC	P value	TG	P value	HDL	P value	LDL	P value	VLDL	P value	TC-to-HDL	P value	AIP	P value
Total Fat (kg) (FM_{total})														
All	0.81	<0.001	0.90	0.006	-0.12	0.03	0.73	<0.001	0.18	0.006	0.020	<0.001	<0.001	<0.001
B	0.33	0.28	0.13	0.74	-0.18	0.08	0.49	0.07	0.03	0.71	0.027	0.048	<0.001	0.27
W	0.93	<0.001	1.38	0.005*	-0.12	0.21	0.75	0.001	0.28	0.005*	0.029	0.004*	<0.001	0.006*
H	1.14	<0.001	1.02	0.17**	-0.05	0.64**	0.86	0.002	0.21	0.16**	0.030	0.01**	<0.001	0.003**
% Body Fat (%FM_{total})														
All	0.89	<0.001	1.02	0.004	-0.18	0.005	0.83	<0.001	0.20	0.004	0.031	<0.001	0.69	<0.001
B	0.48	0.17	0.26	0.58	-0.26	0.03	0.69	0.03	0.05	0.56	0.026	0.007	0.43	0.16
W	0.89	0.001	1.22	0.02*	-0.15	0.14	0.78	0.002	0.24	0.02*	0.029	0.003	0.61	0.018
H	1.22	<0.001	1.39	0.08**	-0.11	0.29	0.93	0.002	0.28	0.08**	0.032	0.002**	1.14	<0.001**
Total Trunk fat (kg) (FM_{trunk})														
All	1.72	<0.001	3.02	<0.001	-0.32	<0.001	1.45	<0.001	0.61	<0.001	0.06	<0.001	0.02	<0.001
B	0.80	0.16	1.13	0.14	-0.38	0.06	0.97	0.06	0.23	0.13	0.04	0.01	0.01	0.035
W	1.96	<0.001	3.53	<0.001*	-0.41	0.01*	1.64	<0.001	0.71	<0.001*	0.07	<0.001*	0.02	<0.001*
H	2.18	<0.001	3.71	0.003**	-0.23	0.18**	1.49	0.002	0.74	0.003**	0.06	<0.001**	0.02	<0.001**
Trunk-to-Limb ratio (FMR_{trunk-to-limb})														
All	28.58	<0.001	104.68	<0.001	-12.50	<0.001	22.13	<0.001	20.90	<0.001	1.83	<0.001	0.52	<0.001
B	25.67	0.08	75.56	<0.001	-9.53	0.07	20.13	0.13	14.96	<0.001	1.48	<0.001	0.51	<0.001
W	32.98	<0.001	89.71	<0.001	-14.40	<0.001*	31.99	<0.001	18.00	<0.001	2.11	<0.001*	0.48	<0.001
H	25.99	0.006	119.23	<0.001**	-9.83	0.001	13.77	0.10	23.72	<0.001**	1.51	<0.001	0.51	<0.001
Leg-to-Total ratio (FMR_{leg-to-total})														
All	-98.94	<0.001	-352.46	<0.001	46.58	<0.001	-80.66	<0.001	-70.59	<0.001	-6.59	<0.001	-1.83	<0.001
B	-68.13	0.18	-191.01	0.004	28.72	0.10	-59.40	0.19	-38.23	0.004	-3.93	0.005	-1.27	0.003
W	-107.68	0.001	-301.19	<0.001	53.88	<0.001*	-107.95	0.001	-60.54	<0.001	-7.49	<0.001*	-1.74	<0.001
H	-111.00	0.002	-466.74	<0.001**	39.68	<0.001	-63.26	0.05	-93.03	<0.001**	-6.39	<0.001**	-2.07	<0.001**

Regression coefficient was generated by full model with all race together and race-specific model; B= Black, W= White, H=Hispanics

* = Difference between blacks and whites at $P<0.05$ ** = Difference between blacks and Hispanics at $P<0.05$

Adjusted for age, lean mass, alcohol, smoking, physical activity, parity and previous use of DMP injection

P values for racial differences were generated by putting interaction term between race and body fat variable in the full model with all race together