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Adiponectin levels in obese and non-obese middle-aged African-American women

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Abstract

Context—Adiponectin levels in African-Americans are poorly described.

Objective—To assess predictors of serum adiponectin levels in obese and non-obese middle-aged African-American women.

Methods—Serum adiponectin, testosterone (T), free androgen index (FAI), estradiol, dehydroepiandrosterone-sulfate (DHEAS), leptin, sex hormone binding globulin (SHBG), triglycerides and C-reactive protein (CRP) were measured in 142 obese and 102 non-obese, community-dwelling, African-American women in St. Louis, Missouri. Medical history, physical activity, anthropometry, medications and body composition were assessed.

Results—Adiponectin and SHBG levels were lower and leptin and CRP were higher in obese compared to non-obese women (P 's < 0.01). Overall, log-adiponectin was positively associated with age ($R = 0.13$) and log-SHBG ($R = 0.29$), and inversely associated with anthropometric measures (R 's = -0.17 to -0.36), serum androgens (R 's = -0.21 to -0.23), log-estradiol ($R = -0.21$), log-leptin ($R = -0.15$), log-triglycerides ($R = -0.33$) and log-CRP ($R = -0.29$). Overall, multivariate modelling significantly predicted 32% of variation in adiponectin level; the most significant factors were WHR ($\beta = -1.33$), SHBG ($\beta = 0.23$) and triglycerides ($\beta = -0.34$). In non-

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obese women, the model predicted 27% of variation in adiponectin level; no individual factor was independently associated. In obese women, the model predicted 30% of variation in adiponectin level; the most significant factors were WHR ($\beta = -1.49$), triglycerides ($\beta = -0.34$) and history of stroke ($\beta = -0.71$).

Conclusions—Adiponectin level in African-American women is predicted by WHR, SHBG, and triglycerides; stroke history adds predictive value in obese women.

Keywords

Adiponectin; African-American; obesity; women; stroke

Introduction

African-Americans have the highest age-adjusted prevalence of cardiac disease (American Heart Association, 2002) and the highest cardiac disease mortality rate of any ethnic group (Gillum, 1991). African-American women are especially more prone to have hypertension, type 2 diabetes mellitus and metabolic syndrome (Okosun et al., 2000). The reason for this discrepancy among ethnic groups is not clearly understood and has been partly attributed to obesity (Gensini, 1998). According to the Third National Health and Nutrition Examination Survey (NHANES 1999–2000) African-Americans have the highest proportion of obesity, with a near 40% prevalence (Flegal, 2002) compared to 30.5% in the general US population. However, the relation between this prominent risk factor and cardiovascular disease may not be as strong for African-American as for Caucasian women (Stevens, 1992). Other factors such as hereditary predisposition, dietary habits, smoking, educational level, physical activity and disparities in health care access (Park, 2003) may also be contributors.

Recently, a number of other risk factors, including adiponectin, have been identified to add independently to the prediction of diabetes and cardiovascular disease. Adiponectin is an adipokine that has been shown to improve insulin secretion and sensitivity, increase fatty acid oxidation, have anti-inflammatory actions and prevent atherosclerosis (Duncan, 2004). Adiponectin has also been shown to be lower in African-Americans than in Caucasians, even after adjustment for anthropometric measures (Ferris, 2005). Thus, a lower level of adiponectin may, at least in part, be a risk factor contributing to the higher prevalence of diabetes and cardiovascular disease in African Americans.

Little is known about the regulation of adiponectin, especially in African-Americans (Duncan, 2004) and most of the factors and mechanisms affecting adiponectin levels are poorly described. Understanding adiponectin regulation in African-Americans is important as it may permit the development of preventive approaches in this high-risk population. It is not yet established in interventional studies whether increased adiponectin levels prevent a dysregulated metabolic state. However, in a large prospective study, higher adiponectin levels have been reported to be independently associated with a lower incidence of diabetes (Duncan, 2004) and myocardial infarction (Pischon, 2004).

In this cross-sectional study, we investigate the associations between adiponectin and anthropometric measures, hormones, C-reactive protein and lifestyle habits in women from

the African-American Health (AAH) study. Since many anthropometric measures are strongly associated with adiponectin levels, we hypothesized that predictors of adiponectin levels could be different between obese and non-obese. Then, this analysis aims to contrast the predictors of adiponectin between non-obese and obese women as defined by body mass index (BMI) of 30 kg/m² or greater.

Materials and Methods

Population

Data for this study were collected in the AAH study, a population-based longitudinal study of 998 African-American, recruited from two diverse socio-economic areas of St. Louis, Missouri, to address the issues of disparity in disabilities among middle-aged African-Americans. The sampling and data collection procedures have been previously described in detail (Miller, 2004; Miller, 2005). Participants were recruited and an in-home baseline assessment was conducted between 2000 and 2001.

To be included, participants had to self-report black or African-American race, to be born between 1936 and 1950, and to have a Mini-Mental Status Examination of 16 or greater. Among this population, 244 women agreed to participate in an additional study that included blood sampling. The sample population considered for the present study consisted of 142 obese and 102 non-obese women with a mean age of 56.9 ± 4.4 years (range 49–65) and BMI of 31.8 ± 6.9 kg/m² (range 15.7–55.2).

This study was approved by the Institutional Review Board (IRB) of St. Louis University and each participant provided written informed consent to participate in the study.

Protocol

A home-based physical examination and a health status questionnaire were used to record co-morbid disease. The questionnaire included age, environmental characteristics (city or suburbs) and income (< \$10,000; \$10,000 – \$25,000; > \$25,000). Chronic conditions (hypertension, diabetes, cardiovascular disease [angina, heart failure or coronary artery disease] or stroke) were assessed by asking the participant “did a doctor ever tell you that you have?” All medications, prescription and over-the-counter, were recorded by the interviewer during the in-home assessment. Medications were recorded as oral anti-diabetic, anti-hyperlipidemic, anti-hypertensive (angiotensin-converting enzyme inhibitor, angiotensin II receptor blocker, anti-adrenergic, beta-blocker, calcium channel blocker and diuretic), estrogen (hormonal replacement therapy [HRT]) and thyroxin. Present smoking was obtained by direct inquiry. Physical activity levels were assessed by the Yale Physical Activity Study (YPAS) scale summary index (Dipietro, 1993).

Hip circumference was determined using a tape measure at the level of the maximum posterior protrusion of the buttocks. Waist circumference was measured at the level of the largest horizontal circumference between the ribs and the iliac crest, and the waist-to-hip ratio (WHR) was calculated. BMI was calculated using self-reported height and weight, which was very highly correlated with measured height and weight but available for more

participants. Obesity was defined as BMI of 30 or greater. Women with a BMI below 30 were defined as non-obese.

Total body lean mass (LM), fat mass (FM) and the composition of appendicular skeletal mass (ASM) were evaluated by dual-energy x-ray absorptiometry (DEXA [Hologic QDR 4500 W]).

Laboratory Analyses

Blood was drawn for laboratory analyses at the time of the DEXA examination. Thus values are representative of neither morning nor fasting state. Hormonal and inflammatory marker measurements were performed by the Geriatrics Research Laboratory (St. Louis University). All these variables have been reported to contribute to the adiponectin level.

Adiponectin was determined using a commercially available RIA kit (Linco Research, St. Charles, MO, USA). In this laboratory, intra- and inter-assay coefficients of variation (CVs) were 5.3% and 8.1% respectively. Serum estradiol and leptin were measured using an RIA kit (Diagnostic Systems Laboratories, Webster, TX, USA). The intra- and inter-assay CVs were 6.5% and 9.7% for estradiol and 4.7% and 5% for leptin. Serum dehydroepiandrosterone sulfate (DHEAS) was measured using an RIA kit (Diagnostic Products Corp). The intra and inter-assay Cvs were 5.3% and 7.0% respectively. Testosterone (T) was measured using an RIA kit (ICN-Biomedicals) with intra and inter-assay CVs of 6.7% and 7.3%. Sex hormone binding globulin (SHBG) was determined using an RIA kit (Diagnostics Systems Lab Inc) with intra and inter-assay CVs of 3.7% and 10.2%. The free androgen index (FAI, T/SHBG) was calculated. Fructosamine and triglycerides were measured using a commercially available enzymatic kit from Roche Diagnostics (Indianapolis, IN). In this laboratory, fructosamine and triglycerides respectively, have intra-assay CV's of 1.7% and 1.1% and inter-assay CV's of 2.1% and 3.6%. CRP was measured using commercial available High Sensitivity Enzyme Immunoassay (hsCRP ELISA) kit from MP Biomedicals (Orangeburg, NY). The intra-assay and inter-assay CV's were 4.5% and 4.1% respectively. Serum glucose measurement was performed in a commercial clinical laboratory (Smith Kline-Beecham, St. Louis, MO).

Statistical Analysis

Adiponectin level was available for 240 participants and presented a log normal distribution. Leptin, testosterone, SHBG, DHEAS, FAI, estradiol, triglycerides and CRP were also normalized by transformation into their natural logarithm. Continuous variables were compared between obese and non-obese women using independent-samples t-tests. Chi-square tests were used to compare groups for ordinal and dichotomous variables.

Linear regression (continuous variables), one-way analysis of variance (ANOVA) (ordered variables) or independent-samples t-tests (dichotomous variables) were used in the whole population and within obese and non-obese groups to detect potential predictors of adiponectin. Variables significantly associated with adiponectin at an alpha level of 0.05 were further included together in multiple regression predictive models (Models A1–3).

To further investigate the value and confounding effect of WHR on adiponectin level, the models were tested after excluding WHR from the independent variables (Models B1–3).

Results of multiple regression analyses were reported as the predictive value of the model (R^2) and associated P-value. The influence of individual factors within a model, were reported using β coefficients and associated P-values. Data analyses were performed using Intercooled Stata 7.0 (STATA Corporation, College Station, TX). Figures were generated using GraphPad Prism 4.0 (GraphPad Software Inc. San Diego, CA).

Results

Twenty-two percent of the women were current smokers. Hypertension was reported by 71%, diabetes by 31%, and cardiovascular disease by 26%. Twelve percent reported a history of stroke. Twenty-eight percent had a prescription for anti-diabetic, 19% for anti-hyperlipidemic and 62% for anti-hypertensive drugs. Nineteen percent were under hormonal replacement therapy (HRT) and 7% had a prescription of thyroxine.

Characteristics of the obese and the non-obese groups are compared in Table 1. Obese women were significantly younger, were more frequently treated for hypertension and were less frequently under HRT. Adiponectin and SHBG were significantly lower in obese women than non-obese women. Total testosterone, FAI, leptin and CRP were significantly higher in obese women than non-obese women. Obese women had greater FM than non-obese women and all anthropometric measurements were significantly higher, except for height which was significantly lower in obese women.

Log adiponectin was negatively correlated with WHR in obese but not in non-obese women (Figure 1). The power of the association in the obese sub-group translated to a significant association in the whole sample. The log values of testosterone, FAI, estradiol, triglycerides and CRP for the whole sample and for obese and non-obese women were negatively associated with log adiponectin. Log adiponectin was positively correlated with log SHBG for the whole sample and for obese and non-obese women. Age was positively and waist was negatively correlated with log adiponectin in the whole sample only. Weight and log leptin were negatively correlated with log adiponectin in the whole sample only. BMI and log DHEAS was negatively correlated with log adiponectin in the whole sample and in non-obese women, but not in obese women. Serum glucose was negatively correlated with log adiponectin in the non-obese only. In the obese group only, log adiponectin was lower in women who reported a history of stroke when compared to those with no history of stroke ($P = 0.02$, Figure 2a) and higher in women treated with anti-adrenergics compared to those without anti-adrenergic treatment ($P = 0.01$, Figure 2b). In the whole sample, log adiponectin levels were significantly lower in diabetic when compared with non-diabetic women ($P = 0.035$, Figure 2c) and there was a trend towards this same relation in the obese group (2.02 ± 0.06 v 1.83 ± 0.09 , $P = 0.079$). In the whole sample, there was also a trend toward lower log adiponectin levels in thyroxine treated women when compared to participants without thyroxine treatment (1.78 ± 0.69 v 2.06 ± 0.60 , $P = 0.067$). Height, fat mass, lean mass, ASM, Yale physical activity score, and fructosamine were not significantly correlated with adiponectin level.

In the whole sample, the multivariate model (Model A1) predicted 30% of the variation in log adiponectin levels ($P < 0.001$) and showed that log adiponectin levels were predicted by WHR ($\beta = -1.70$, $P = 0.01$), log SHBG ($\beta = 0.26$, $P = 0.02$) and log triglycerides ($\beta = -0.34$, $P < 0.01$). In obese women (Model A2), the model predicted 29% of the variation in log adiponectin ($P < 0.001$). WHR ($\beta = -2.27$, $P < 0.01$), history of stroke ($\beta = -0.75$, $P < 0.01$) and log triglycerides ($\beta = -0.32$, $P = 0.03$) were independently associated with log adiponectin. There was a trend towards an independent association with anti-adrenergic treatment ($\beta = 0.49$, $P = 0.12$). In non-obese women (Model A3), the model predicted 30% of the variation in log adiponectin levels ($P < 0.001$). Log SHBG ($\beta = 0.27$, $P = 0.03$), Log estradiol ($\beta = -0.15$, $P = 0.01$), Log triglycerides ($\beta = -0.37$, $P < 0.01$) were independently associated with log adiponectin (Table 2).

When WHR was removed (Models B1–3), the models predicted 25%, 23% and 23% of the variation in log adiponectin levels in the whole population, obese and non-obese, respectively (All P 's < 0.0001). In the whole population and both subgroups, log estradiol (Whole: $\beta = -0.17$, $P < 0.001$; Obese: $\beta = -0.16$, $P = 0.01$; Non-obese: $\beta = -0.15$, $P = 0.01$) and log triglycerides (Whole: $\beta = -0.30$, $P < 0.001$; Obese: $\beta = -0.29$, $P = 0.003$; Non-obese: $\beta = -0.37$, $P = 0.001$) independently predicted log adiponectin levels. In both the whole population and in non-obese women, log SHBG (Whole: $\beta = 0.22$, $P = 0.004$; Non-obese: $\beta = 0.27$, $P = 0.03$) was independently associated with log adiponectin levels. In both the whole population and obese women, log CRP (Whole: $\beta = -0.11$, $P = 0.001$; Obese: $\beta = -0.11$, $P = 0.02$) was independently associated with log adiponectin. In obese women only, log adiponectin was additionally independently associated with diabetes ($\beta = -0.22$, $P = 0.03$) and anti-adrenergic use ($\beta = 0.48$, $P = 0.01$) and there was a trend towards an independent association with history of stroke ($\beta = -0.31$, $P = 0.05$) (Table 3).

Discussion

In this cross-sectional study on African-American women, WHR and triglycerides were associated with a lower adiponectin level, whereas SHBG was associated with a higher level of adiponectin. Across the categories of BMI, WHR remained, amongst the variables, the prominent factor in predicting adiponectin levels in obese and was the only predictor of adiponectin closed to significant in the non-obese women. In the obese women, predictors of adiponectin were WHR, triglyceride levels, anti-adrenergic treatment and history of stroke.

The mechanisms by which adiponectin is regulated are still to be elucidated. In the present study plasma adiponectin was consistently and negatively related to WHR. This result corroborates a previous study (Cnop, 2003) and suggests that regional adipose tissue distribution contribute to adiponectin level. The relation between plasma adiponectin and WHR was significantly stronger than that with BMI or any other anthropometric measure assessed, including fat mass. Waist circumference, a good predictor of visceral adiposity, was correlated with adiponectin in the whole sample only. The same correlation between abdominal obesity and metabolic disorders has been widely reported (Vanhala, 1998). Several explanations for this association between visceral adiposity and adiponectin levels have been proposed. Large visceral adipocytes with greater triglycerides stores may produce less adiponectin than small sub-cutaneous adipocytes, at least under culture conditions

(Motoshima, 2002) and visceral adipocytes may produce factors that reduce adiponectin synthesis (Halleux, 2001). For example, cytokines secreted by adipose tissue can reduce adiponectin secretion (Bruun, 2003; Engeli, 2003; Fasshauer, 2003). Alternatively, adiponectin can inhibit cytokine secretion (Spranger, 2006; Wulster, 2004). These actions together can explain the inverse relation between adiponectin and markers of obesity and inflammation.

The fact that estradiol, CRP and diabetes did not remain statistically significant in simultaneous modeling of adiponectin levels after including WHR suggests that WHR provides an independent contribution to the adiponectin level. This result also suggests that WHR was a confounding factor for estradiol, CRP and diabetes. All these variables have been hypothesized to independently regulate adiponectin levels.

The finding that estradiol level was not correlated with adiponectin when the model was corrected for WHR is in accordance with the study of Gui et al (Gui, 2004). Sieminska et al. (Sieminska, 2004) also recently reported no association between estrogen levels and adiponectin after adjustment for WHR. It is likely in the present cohort of women aged 49 – 65, that the majority of circulating estrogen comes from exogenous sources. D'Eon et al. (2005) showed that estrogen treatment in ovariectomized (OVX) mice reduced adipocyte size through down-regulation of lipoprotein lipase and reduced uptake of fatty acids in comparison to pair-fed OVX mice treated with placebo. This coincided with a significant reduction in plasma adiponectin, resistin and leptin levels in estrogen treated mice (D'Eon, 2005), a finding that contradicts that of Motoshima et al. (Motoshima, 2002) that occurred under culture conditions. In addition, estrogen treatment reduced lipogenesis through down-regulation of acetyl-CoA carboxylase-1 and fatty acid synthase, and elevated catecholamine-stimulated lipolysis (D'Eon, 2005). Estradiol levels were not significantly different between obese and non-obese women in the present study.

Both higher CRP levels and diabetes were also associated with lower log adiponectin levels in the simple and stratified analyses, but did not remain significantly associated with adiponectin levels after adjustment for WHR. Increasing evidence suggests that obesity leads to an inflammatory state that may be causal in the development of disorders such as diabetes (Brancati, 2000). In the present study, diabetics had significantly greater WHR than non-diabetics (1.51 ± 0.02 vs. 1.42 ± 0.01 , $P = 0.0007$), however CRP levels were similar.

Triglycerides were associated with adiponectin levels independent of anthropometric measures, especially in obese women. Triglycerides were strongly associated with WHR ($R = 0.271$, $P = 0.003$). However, after adjustment for WHR, triglycerides remained inversely and significantly associated with adiponectin levels in the obese ($\beta = -0.34$, $P = 0.02$) and showed a trend ($\beta = -0.30$, $P = 0.07$) in the non-obese women. A negative association between adiponectin and triglycerides levels has been reported (Schulze, 2004). The present study cannot determine the causal mechanism for this association, although it is possibly related to adiponectin's effects on insulin sensitivity.

Low levels of SHBG have been linked to higher rates of diabetes (Goodman-Gruen, 1997) and cardiovascular disease events (Sutton-Tyrrell, 2005). Potential mechanisms to explain

these associations might be a direct effect of SHBG on lipid metabolism or SHBG might be just a marker of insulin resistance as insulin has a direct inhibitory effect on SHBG. Based on our results, we hypothesize that low levels of SHBG may, at least in part, be a risk factor contributing to the higher incidence of diabetes and cardiovascular disease through a decreasing level of adiponectin. Obese subjects usually have a lower level of adiponectin and lower level of SHBG (Ducluzeau, 2003). In the present study, SHBG was negatively and significantly correlated with BMI ($R = -0.265$, $P < 0.0001$) and with waist circumference ($R = -0.248$, $P = 0.007$). This confounding effect of obesity might explain our results. However, after adjustment for WHR, SHBG remained significantly and independently associated with adiponectin levels in the whole sample and the non-obese women. Another potential explanation could be an inverse correlation between levels of free testosterone and SHBG.

Indeed, testosterone has been reported to decrease adiponectin levels (Xu, 2005). In one polycystic ovarian syndrome study, the association between adiponectin and testosterone was confounded by impaired glucose tolerance (IGT) (Sieminska L, Marek B, Kos-Kudla B et al. 2004 Serum adiponectin in women with polycystic ovarian syndrome and its relation to clinical, metabolic and endocrine parameters. *J Endocrinol Invest* 27:528-34) which was not tested during our study. Both total testosterone and FAI were both significantly and negatively correlated with adiponectin levels in bivariate regression in the present study. However, total testosterone and FAI did not remain significant predictors of adiponectin levels in multiple regression models. Thus, it is concluded that low levels of SHBG are consistently associated with low adiponectin levels.

Our results suggest an association between anti-adrenergic treatment and higher adiponectin levels. It is impossible to assign causation in a cross-sectional study such as this and these results must be interpreted carefully as only 11 participants were treated with this medication. However, increased activity of the sympathetic nervous system may contribute to the development of insulin resistance and the stress-induced atherosclerosis. Adrenergic agents have been reported to decrease adiponectin production (Fasshauer, 2001). Whether anti-adrenergic treatment results in higher adiponectin levels requires further investigation.

Experimental studies have indicated that adiponectin has potential anti-atherogenic and antiinflammatory properties (8). If so, patients with low adiponectin may be more vulnerable to the development of a stroke. Adiponectin levels were lower in obese women who reported a history of stroke. In multiple regression analysis, a history of stroke remained an independent and significant predictor of adiponectin levels in obese women. This result is in accordance with a recent cross-sectional study reporting a significantly lower level of adiponectin in patients with ischemic cerebrovascular disease, even after adjustment for BMI, WHR, age, lipid profile, diabetes and CRP (Chen, 2005). However, in one previous study, adiponectin levels did not predict stroke (Soderberg, 2004). The fact that only the obese had this association in the present study population suggests that additional factors may increase the risk factor associated with low adiponectin in obese women. Longitudinal studies to examine the role of low adiponectin levels in the development of stroke in African-Americans will be needed to confirm this hypothesis.

This study has several limitations. Related to the study design, the causal nature of associations between adiponectin and the different variables could not be addressed and our results may not be generalized to men or other ethnic or healthier populations. Our findings might have also differed with multimeric, globular or C-terminal adiponectin assays. More particularly, adiponectin may cross talk with other hormones (such as insulin, thyroxin and cortisol) not measured in the present study or be modulated by other lifestyle habits (such as nutrient and alcohol intake) not assessed here. Moreover, the validity of the YPAS scale summary index could be reconsidered in this middle-aged African-American population as surprisingly no difference was found between the score of the YPAS of the obese and the non-obese women. However, this cross-sectional study provides background information on factors associated with adiponectin levels in a poorly described, high-risk population. The strength of this study is the novelty of the group studied alone and its representativeness. Our results suggest that WHR is the main predictor of adiponectin levels in both obese and non-obese women. Clinical investigations to determine whether loss of visceral adiposity improves risk factors, such as low adiponectin, and reduce vascular events are warranted. In obese women, adiponectin was also associated with triglycerides levels, anti-adrenergic treatment and history of stroke. In conclusion, these findings show that in obese and non-obese African American women, adiponectin level is predicted by several independent and modifiable risk factors for cardiovascular morbidity and mortality.

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Association of WHR and ln Adiponectin in Obese and Non-Obese African American Women

Figure 1.

Association of WHR and log adiponectin in obese and non-obese African American women.

WHR = waist-hip-ratio. In obese women (open circles/broken line): $R = -0.339$, $P = 0.005$; in non-obese women (closed circles/solid line) $R = -0.199$, $P = 0.171$.

Figure 2.

The effect of (A) history of stroke in obese women only, (B) anti-adrenergic medication in obese women only and (C) diabetes in the whole sample. Log adiponectin levels were significantly lower in obese women with a history of stroke when compared to women without stroke history (A) and in all women with diabetes when compared to non-diabetics (C). Log adiponectin levels were significantly higher in obese women taking anti-adrenergic medication when compared with non anti-adrenergic treated women (B).

Table 1

A comparison of characteristics between obese and non-obese middle-aged African American women.

	Obese BMI ≥ 30 N = 142	Non Obese BMI < 30 N = 102	P
Age (years)	56.4 (4.4)	57.6 (4.4)	0.02
Anthropometric measures			
Weight (kg)	94.98 (14.87)	69.44 (10.31)	<0.001
Height (m)	162.08 (8.18)	164.90 (6.70)	0.005
BMI * (kg/m ²)	36.40 (5.27)	25.72 (3.36)	<0.001
Waist (cm)	119.03 (1.69)	97.02 (1.60)	<0.001
Waist-to-hip ratio	0.978 (0.011)	0.940 (0.011)	0.03
Fat Mass _{DEXA} (kg)	41.13 (8.38)	25.25 (7.71)	<0.001
Lean Mass _{DEXA} (kg)	50.79 (6.48)	41.13 (4.96)	<0.001
ASM (lean) [†] _{DEXA} (kg)	23.09 (3.24)	18.06 (2.68)	<0.001
Lifestyle habits			
YPAS [‡] (range: 0 to 127)	31.10 (17.31)	31.19 (18.87)	0.96
Current smoker (%)	21.83	23.53	0.75
City/Suburbs (%)	48/52	40/60	0.18
Income (%)			
< \$10,000	18.84	21.65	
\$10,000-\$25,000	58.70	51.55	0.03
\$25,000	22.46	26.80	
Comorbidities (%)			
Hypertension	75.35	63.73	0.12
Diabetes	35.21	25.49	0.10
Cardiovascular Disease	13.38	17.65	0.36
Stroke	9.86	14.71	0.25
Treatments (%)			
Anti-Diabetic	30.99	23.53	0.20
Anti-Hyperlipidemic	19.72	17.65	0.68
Anti-Hypertensive	69.01	51.96	0.007
ACEI [§]	23.2	21.6	0.62
ARB	4.9	2.9	0.43
AA ^{adr} **	5.6	2.9	0.31
Beta-Blocker	14.8	11.7	0.49
Calcium Channel Blocker	33.8	24.5	0.11
Diuretic	38.0	27.4	0.08
Estrogen	13.38	28.43	0.004
Thyroxin	8.45	4.90	0.28
Hormones			
Adiponectin (µg/ml)	8.45 (5.95)	10.47 (6.16)	0.01

	Obese BMI ≥ 30 N = 142	Non Obese BMI < 30 N = 102	P
Leptin (ng/ml)	88.85 (30.70)	47.90 (28.97)	<0.001
Testosterone (ng/dl)	13.98 (11.62)	11.42 (12.07)	0.09
SHBG ^{††} (nmol/l)	41.98 (25.87)	57.66 (31.50)	<0.001
FAI ^{††}	0.49 (0.50)	0.33 (0.45)	0.01
DHEAS ^{§§} (μg/dl)	70.50 (42.68)	70.34 (51.00)	0.97
Estradiol (pg/ml)	19.59 (17.61)	20.82 (22.99)	0.63
Glycemic level			
Glucose (mg/dl)	125.30 (58.43)	131.78 (93.10)	0.46
Fructosamine (mmol/l)	256.30(53.23)	284.17(86.45)	0.51
Lipids			
Triglycerides (mg/dl)	149.84 (75.32)	141.79 (93.08)	0.23
Inflammatory markers			
CRP (mg/l)	10.06 (8.02)	5.84 (6.46)	<0.001

Notes: Data presented are means (± S.E.) and P value from either two-tailed t-test (continuous variables) or chi-squared tests (ordinal/dichotomous variables);

* BMI, Body Mass Index;

[†] ASM, Appendicular Skeletal muscle Mass;

[‡] YPAS, Yale Physical Activity Score (an increasing correspond to an increase level of physical activity);

[§] ACEI, angiotensin-converting enzyme inhibitor;

// ARB, angiotensin II receptor blocker;

** AAdr, anti-adrenergic;

^{††} SHBG, Sex Hormone Binding Globulin;

^{††} FAI, Free androgen index (T/SHBG);

^{§§} DHEAS, dehydroepiandrosterone sulfate;

|||| CRP, C-Reactive Protein.

Table 2

Multivariate linear regression models predicting log adiponectin levels in the whole sample and in obese and non-obese middle-aged African American women (Models A1–3).

	Whole Sample N=111 Adj. R ² = 0.30 P < 0.001			Obese N=66 Adj. R ² = 0.29 P < 0.001			Non-Obese N=97 Adj. R ² = 0.30 P < 0.001		
	β	SE	P	β	SE	P	β	SE	P
Age	0.02	0.01	0.082	-	-	-	-	-	-
Anthropometric measures									
Waist-to-hip ratio	-1.70	0.65	0.01	-2.27	0.80	0.006	-	-	-
BMI*	0.007	0.01	0.47	-	-	-	-	-	-
Comorbidities									
Diabetes	0.08	0.13	0.53	0.13	0.15	0.39	-	-	-
Stroke	-	-	-	-0.75	0.28	0.009	-	-	-
Treatments									
Diuretics	-0.12	0.12	0.30	-	-	-	-	-	-
Anti-adrenergics	-	-	-	0.49	0.31	0.12	-	-	-
Thyroxine	0.17	0.21	0.44	-	-	-	-	-	-
Hormones									
Log Leptin	0.02	0.10	0.83	-	-	-	-	-	-
Log Testosterone	-0.07	0.07	0.27	0.05	0.11	0.64	-0.05	0.06	0.42
Log SHBG [†]	0.26	0.11	0.02	0.19	0.14	0.17	0.27	0.13	0.033
Log DHEAS [‡]	-	-	-	-	-	-	-0.10	0.07	0.19
Log Estradiol	-0.12	0.06	0.05	-0.11	0.10	0.26	-0.15	0.06	0.01
Glycemic level									
Glucose	-	-	-	-	-	-	-0.0001	0.0007	0.85
Lipids profiles									
Log Triglycerides	-0.34	0.11	0.002	-0.32	0.15	0.034	-0.37	0.11	0.001
Inflammatory markers									
Log CRP [§]	-0.08	0.05	0.13	-0.10	0.07	0.16	0.06	0.05	0.18

Notes: Data presented are adjusted R² values and associated P values for each model. β coefficients ($\pm$ S.E.) and associated P values are presented for each factor within the models;

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* BMI, Body Mass Index;
† SHBG, Sex Hormone Binding Globulin;
‡ DHEAS, dehydroepiandrosterone sulfate;
§ CRP, C-Reactive Protein.

Table 3

Multivariate linear regression models predicting log adiponectin levels in the whole sample and in obese middle-aged African American women, excluding the effects of WHR (Models B1-2).

	Whole Sample N=233 Adj. R ² = 0.25 P < 0.0001			Obese N=138 Adj. R ² = 0.23 P < 0.0001		
	β	SE	P	β	SE	P
Age	0.01	0.008	0.10	-	-	-
Anthropometric measures						
BMI*	0.002	0.007	0.74	-	-	-
Comorbidities						
Diabetes	-0.11	0.08	0.21	-0.22	0.10	0.034
Stroke	-	-	-	-0.31	0.16	0.051
Treatments						
Diuretics	-0.07	0.08	0.39	-	-	-
Anti-adrenergics	-	-	-	0.48	0.20	0.017
Thyroxin	-0.06	0.14	0.66	-	-	-
Hormones						
Log Leptin	0.05	0.08	0.48	-	-	-
Log Testosterone	-0.05	0.04	0.24	-0.01	0.06	0.80
Log SHBG [‡]	0.22	0.08	0.004	0.14	0.09	0.13
Log DHEAS [‡]	-	-	-	-	-	-
Log Estradiol	-0.17	0.05	<0.001	-0.16	0.07	0.018
Glycemic level						
Glucose	-	-	-	-	-	-
Lipids profiles						
Log Triglycerides	-0.30	0.07	<0.001	-0.29	0.09	0.003
Inflammatory markers						
Log CRP [§]	-0.11	0.03	0.001	-0.11	0.05	0.024

Notes: Data presented are adjusted R² values and associated P values for each model. β coefficients ($\pm$ S.E.) and associated P values are presented for each factor within the models;

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* BMI, Body Mass Index;
† SHBG, Sex Hormone Binding Globulin;
‡ DHEAS, dehydroepiandrosterone sulfate;
§ CRP, C-Reactive Protein.