Metabolic Syndrome and High-sensitivity C-reactive Protein in Cubans

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Objective: We investigated metabolic syndrome and its association with high-sensitivity C-reactive protein (hs-CRP) levels in Cuban Americans.

Methods: The study included 161 nondiabetic Cuban Americans (55 men and 106 women) aged ≥30 years living in South Florida. Metabolic syndrome was defined by using Adult Treatment Panel III criteria. Elevated hs-CRP level was defined as >3 mg/L.

Results: Metabolic syndrome was present in 41% of participants, and no differences were seen by sex. The most common components of metabolic syndrome for women were abdominal obesity and elevated blood pressure, whereas for men they were elevated blood pressure and high triglyceride levels. A higher percentage of women had abdominal obesity and low high-density lipoprotein cholesterol levels, whereas a higher percentage of men had high triglyceride levels and abnormal glucose metabolism. The odds of having elevated hs-CRP levels were ≈4 times higher in participants with metabolic syndrome than in those without it. Mean log hs-CRP increased as number of components of metabolic syndrome increased. Of the components of metabolic syndrome, only abdominal obesity was significantly associated with elevated hs-CRP.

Conclusions: Metabolic syndrome was highly prevalent in our population of Cuban Americans. Cuban Americans with metabolic syndrome had elevated hs-CRP levels that might be explained by their abdominal obesity, increasing the risk for type 2 diabetes and cardiovascular diseases. (*Ethn Dis*. 2009; 19:115–120)

Key Words: Metabolic Syndrome, High-sensitivity C-reactive Protein, Cuban, Abdominal Obesity

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Introduction

Metabolic syndrome is defined as the clustering of multiple metabolic risk factors that increase the risk of cardiovascular diseases, type 2 diabetes and all-cause mortality.[1–3] However, worldwide there is no accepted criterion for the diagnosis of metabolic syndrome. The National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) identifies various components of metabolic syndrome in adults and defines it as having three or more of the following: abdominal obesity (waist circumference >102 cm for men and >88 cm for women), triglyceride levels ≥150 mg/dL, high-density lipoprotein (HDL) cholesterol <40 mg/dL for men and <50 mg/dL for women, blood pressure ≥130/85 mm Hg, and fasting plasma glucose 100–125 mg/dL.[4] Other organizations, such as the World Health Organization,[5] the European Group for the Study of Insulin Resistance,[6] the American College of Endocrinology,[7] and the International Diabetes Federation,[8] have also proposed criteria for the diagnosis of the metabolic syndrome, keeping in common the general features of a combination of central obesity, elevated blood pressure, dyslipidemia, and impaired glucose metabolism.

Findings from the Hispanic Health and Nutrition Examination Survey (HHANES) show that the prevalence of obesity (defined as ≥95th percentile) among Cuban Americans aged ≥18 years is 15% for women and 9% for men.[9] Additionally, data from HHANES indicate that the prevalence of diabetes (including previously diagnosed and undiagnosed diabetes) in the 45- to 74-year age group is ≈16% among Cuban Americans, 1.3 times higher than the rate among non-Hispanic Whites.[10] Analysis of data from the National Vital Statistics System demonstrated that compared with other Hispanics, Cuban Americans had the highest percentage of diabetes-related deaths (44%), more than Puerto Ricans (39%) and Mexican Americans (37%).[11]

Metabolic syndrome is also considered a proinflammatory state,[4] and measurement of inflammatory markers like high-sensitivity C-reactive protein (hs-CRP)[12] might improve the prediction of cardiovascular disease and diabetes in patients with metabolic syndrome. Previous studies have shown that CRP is associated with components of metabolic syndrome,[13,14] including abdominal obesity. Cytokine production by adipocytes might mediate the elevation of CRP levels. Adipose tissue secretes a number of cytokines, among which is interleukin 6 (IL-6).[15] IL-6 regulates hepatic production of CRP.[16,17] Data are not available on the prevalence of metabolic syndrome in Cuban Americans, which is one of the fastest growing groups in the United States. Therefore, we investigated metabolic syndrome in Cuban Americans and its association with inflammation, as measured by hs-CRP levels.

Methods

Design

This was a data analysis of nondiabetic participants in a cross-sectional study conducted in Cuban Americans with and without type 2 diabetes.

Study Sample

Participants were recruited randomly from 2 mailing lists of Cuban Americans living in Miami-Dade and Broward Counties, Florida. During a 1-year period, ≈10,000 letters (5000

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from list of diabetics and 5000 from the list of nondiabetics) outlining the study were mailed to Cuban American residents, aged ≥30 years. Letters were sent in English and Spanish and included an invitation flyer that interested participants could respond to. Three percent (n = 300) of the letters were returned because of unknown addresses. From the remaining delivered mail, 4% (n = 388) responded. Interested participants were initially interviewed on the phone, at which time the study purpose was explained, and age and sex of the responders were determined. To ascertain diabetes status, each participant was asked for the age at diagnosis and initial treatment modalities. Only 18 potential participants did not qualify for the study because they were not Cuban American (n = 2), were aged <30 years (n = 9), or had other chronic illness (n = 7). If a person was determined to be eligible, then their participation was requested at the Human Nutrition Laboratory at Florida International University (FIU). Participants were instructed to refrain from smoking, eating or drinking anything except water, and any unusual exercise for at least 8 hours before blood collection. Nondiabetic participants were matched for age and sex with diabetic participants. The informed consent was presented to eligible participants in Spanish or English according to their preference, and signatures were obtained. For this study, we only included data from nondiabetic participants (n = 187). Of the 187 nondiabetic Cuban Americans, 26 were excluded, 7 were reclassified as diabetic, and 19 had missing values needed to determine metabolic syndrome. Statistical analysis was based on the remaining 161 participants.

Study Variables

A sociodemographic questionnaire was given to each participant to complete; it included questions related to age, sex, smoking status, family history of diabetes and heart diseases, and cholesterol and antiinflammatory medication. Metabolic syndrome was defined by using the NCEP-ATP III criteria.[4] Blood pressure was measured twice and averaged. Waist circumference was measured at a level midway between the lower rib margin and the iliac crest and was reported in centimeters. Weight and height were also measured to calculate body mass index (BMI).

Blood Collection

A 20-mL venous blood sample was collected from each participant after an overnight fast (≥8 hours) by a certified phlebotomist who used standard laboratory techniques. Blood samples were collected into a Vacutainer serum separator tube (SST) for analysis of lipids and glucose. After complete coagulation (30–45 minutes), the SST was centrifuged at 2500 RPM for 30 minutes. The serum was transferred from the spun SST into 3 labeled plastic tubes: the first tube was used for glucose analysis, the second for lipid panel, and the third tube was stored at −70°C to be used later for hs-CRP. Glucose levels were measured by hexokinase enzymatic methods, and lipid panel was assayed by enzymatic methods by Laboratory Corporation of America, Miami, Florida. hs-CRP was analyzed at the Vascular Disease Intervention and Research Laboratory, Edmond, Oklahoma, by using the Immulite method.[18] Based on abundant epidemiologic studies, the Centers for Disease Control and Prevention (CDC) and the American Heart Association (AHA), issued guidelines to use hs-CRP as an adjunct measurement of global risk assessment for CVD. In addition, the CDC and AHA indicate a cutoff point of hs-CRP >3mg/L as a predictor of high relative risk for CVD.[19,20]

Data Analysis

All analyses were performed by using SPSS version 15 (SPSS Inc, Chicago, Ill). hs-CRP and BMI were log-transformed to achieve normality. Analyses included descriptive statistics, χ^2 tests, independent sample t test, nonparametric test, analysis of covariance (ANCOVA), and logistic regression. Age, sex, BMI, smoking, cholesterol medication, antiinflammatory medication, family history of diabetes, and family history of heart diseases were controlled in ANCOVA and logistic regression analyses. Differences were considered significant at $P < .05$.

RESULTS

The study included 161 nondiabetic Cuban Americans (55 men and 106 women) (Table 1). More men were former or current smokers or were currently smoking. The most prevalent components of metabolic syndrome differed significantly by sex; for women, the common components were abdominal obesity and elevated blood pressure, and for men, they were elevated blood pressure and high triglyceride level. A significantly higher proportion of women had abdominal obesity and low HDL-cholesterol levels, whereas a higher proportion of men had significantly higher triglyceride level and abnormal glucose metabolism. No significant differences by sex were found for elevated blood pressure.

Metabolic syndrome was present in 41% (95% confidence interval 33.7–48.7) of the entire sample. Participants with metabolic syndrome were significantly older than were those without it and had a significantly higher mean

Table 1. Characteristics, by sex, of 161 nondiabetic Cuban Americans in Miami-Dade and Broward Counties, Florida

Characteristic	Women *n* = 106	Men *n* = 55	*P* value
Age (years) (mean ± SD)	62.1 ± 11.8	62.8 ± 11.4	.73
BMI (kg/m^2) [mean rank (rank sum)]*	83.5 (8858.0)	76.0 (4183.0)	.33
hs-CRP (mg/L) [mean rank (rank sum)]†	85.6 (9075.0)	72.1 (3966.0)	.08
	%		
Family history of diabetes	32.1	23.6	.26
Family history of heart diseases	25.5	16.4	.19
Smoking:			
Never	64.1	38.2	
Former	20.8	40.0	
Current	15.1	21.8	.006
Cholesterol medication	16.0	21.8	.37
Antiinflammatory medication	52.8	43.6	.27
Metabolic syndrome	42.5	38.2	.60
Metabolic syndrome components‡			
Abdominal obesity	80.2	41.8	<.001
High triglyceride level	31.1	50.9	.01
Low HDL cholesterol level	30.2	12.7	.01
Elevated blood pressure	66.0	63.6	.76
Abnormal glucose metabolism	23.6	47.3	.002
hs-CRP >3 mg/L	51.9	41.8	.23

SD = standard deviation, BMI = body mass index, hs-CRP = high-sensitivity C-reactive protein, HDL = high-density lipoprotein.
* Percentiles female: 25th (27.0), 50th (29.8), and 75th (32.6), Percentiles male: 25th (25.7), 50th (29.0), and 75th (32.2).
† Percentiles female: 25th (1.3), 50th (3.2) and 75th (7.0) Percentiles male: 25th (.9), 50th (1.7) and 75th (4.3).
‡ According to the Adult Treatment Panel III criteria.

BMI and hs-CRP (Table 2). After controlling for age, sex, log BMI, smoking, cholesterol medication, antiinflammatory medication, and family history of diabetes and heart diseases, the odds of having hs-CRP levels >3 mg/L were ≈4 times as high in participants with metabolic syndrome as in those without it (odds ratio 3.9, 95% confidence interval 1.6–9.0, P = .002). We also explored the odds of having elevated hs-CRP depending on each of the different components of metabolic syndrome (Table 3). Only participants with abdominal obesity had higher odds of having elevated hs-CRP. Although BMI is not a component of metabolic syndrome as defined by NCEP-ATP III, we analyzed the odds of having hs-CRP >3 mg/L with obesity (BMI >30 kg/m^2) and found that the odds of having elevated hs-CRP were 4.6 times higher in obese subjects (95% confidence interval 2.3–9.3, P = .001) than in nonobese participants (data not shown).

In general, mean log hs-CRP increased as the number of components of metabolic syndrome increased, (F (1, 149) = 4.43, P = .005). Mean log hs-CRP was .20 (standard error [SE] .14) for participants with 0 components of metabolic syndrome, .25 (SE .07) for those with 1 component, .37 (SE .07) for those with 2 components, and .58 (SE .06) for those with 3 or more components (data not shown). Using the Holm modified Bonferroni method to correct for multiple contrasts and after controlling for age, sex, log BMI, smoking, cholesterol medication, antiinflammatory medication, and family history of diabetes and heart diseases, mean log hs-CRP was significantly higher for participants with ≥3 components of metabolic syndrome than among participants with 1 component (P < .001).

Table 2. Characteristics, by presence of metabolic syndrome, of 161 nondiabetic Cuban Americans in Miami-Dade and Broward Counties, Florida

	Metabolic Syndrome		
Characteristic	No *n* = 95	Yes *n* = 66	*P* value
Age (years) (mean ± SD)	60.6 ± 12.7	65.0 ± 9.5	.02
BMI (kg/m^2) [mean rank (rank sum)]*	62.1 (5908.5)	108.0 (7132.5)	<.001
hs-CRP (mg/L) [mean rank (rank sum)]†	63.5 (6032.5)	106.1 (7008.5)	<.001
	%		
Family history of diabetes	25.3	34.8	.19
Family history of heart diseases	23.2	21.2	.77
Smoking:			
Never	61.1	47.0	
Former	23.1	33.3	
Current	15.8	19.7	.20
Cholesterol medication	52.6	45.5	.37
Antiinflammatory medication	16.8	19.7	.64
hs-CRP >3 mg/L	31.6	72.7	<.001

SD = standard deviation, BMI = body mass index, hs-CRP = high-sensitivity C-reactive protein.
* Percentiles without metabolic syndrome: 25th (24.8), 50th (28.0), and 75th (30.2), Percentiles with metabolic syndrome: 25th (29.8), 50th (31.6), and 75th (34.8).
† Percentiles without metabolic syndrome: 25th (.8), 50th (1.6) and 75th (4.1) Percentiles with metabolic syndrome: 25th (2.7), 50th (4.7) and 75th (8.7).

Table 3. Odds of having elevated hs-CRP (>3 mg/L) by individual components of metabolic syndrome among 161 nondiabetic Cuban Americans in Miami-Dade and Broward Counties, Florida

Metabolic syndrome component*	OR	95% CI	*P* value
Abdominal obesity	4.85	(1.73–13.59)	.003
High triglyceride level	1.76	(.81–3.84)	.15
Low HDL cholesterol level	1.73	(.72–4.12)	.22
Elevated blood pressure	1.61	(.68–3.80)	.28
Abnormal glucose metabolism	1.10	(.49–2.47)	.82

OR = odds ratio, CI = confidence interval, HDL = high-density lipoprotein.

* Metabolic syndrome defined according to Adult Treatment Panel III criteria. Analyses controlled for age, sex, log body mass index, smoking, cholesterol medication, antiinflammatory medication, family history of diabetes, and family history of heart diseases.

DISCUSSION

This study investigated metabolic syndrome and its association with hs-CRP levels in nondiabetic Cuban Americans. By using ATP III criteria, we estimated that 41% of the participants had metabolic syndrome, which is similar to the prevalence of 43.5 % among US adults aged 60–69 years from NHANES III.[21] When we analyzed our sample by sex, 38.2% of the men and 42.5% of the women had metabolic syndrome. These percentages are lower than the prevalence rates reported for Mexican American men and women of same age group (≈48% and ≈58%, respectively).[22] As in other studies,[21,22] we found no differences in the prevalence of metabolic syndrome by sex; however, a recent study of Peruvian Andean Hispanics found that metabolic syndrome was more prevalent in women than in men.[23] Given the trend in the increased prevalence of obesity reported[24] since the collection of NHANES III data, the subsequent increase in percentage of people who might be diagnosed with metabolic syndrome is anticipated.

Our study also showed a high percentage of single components of metabolic syndrome; abdominal obesity was the most prevalent component in women and elevated blood pressure was the most prevalent component in men. Sex differences were found for abdominal obesity, hypertriglyceridemia, low HDL cholesterol levels, and abnormal glucose metabolism. Men have a greater amount of abdominal fat than women,[25,26] but we found that abdominal obesity and low HDL cholesterol levels were more prevalent in women, while high triglyceride levels were more prevalent in men.

Research has shown that the prevalence of obesity differs among Hispanic subgroups; the 2000 National Health Interview Survey, Sample Adult File showed that obesity was more prevalent among Mexican Americans (25.3%) than among Cuban Americans (20.2%).[27] Data from HHANES also showed that prevalence of diabetes is higher in Mexican Americans (23.8%) than in Cuban Americans (15.8%).[10] However, a more recent study analyzing data from 1996 and 1997 indicates that the percentage of diabetes-related deaths was higher among Cuban Americans (44%) than among Puerto Ricans (39%) and Mexican Americans (37%).[11]

Inflammation has been associated with metabolic syndrome and its individual components.[28–30] We found that participants with metabolic syndrome had significantly higher log hs-CRP and greater prevalence of elevated hs-CRP >3 mg/L than did those without metabolic syndrome. In addition, hs-CRP levels increased as the number of components of metabolic syndrome increased. Our findings agree with results from previous studies, although in some of them CRP levels were not adjusted for meaningful covariates.[31,32] Of all the individual components of metabolic syndrome, only abdominal obesity was significantly associated with elevated levels of hs-CRP. Among 628 healthy Japanese participants (aged 19–85 years), waist circumference was the strongest determinant of high CRP levels.[33]

Several mechanisms have been suggested for the association between metabolic syndrome and CRP levels. A recent study evaluated the correlations between adiposity, tumor necrosis factor alpha (TNF-α), IL-6, adiponectin, and CRP levels in obese and nonobese healthy participants and obese and nonobese type 2 diabetic patients.[34] The authors found that TNF-α, IL-6, and CRP levels were positively associated with adipocyte size, whereas adiponectin was negatively correlated. We did not determine cytokine or adiponectin levels in our study. In addition, most of our participants were overweight or obese, and we could not determine whether abdominal obesity or overall obesity mediated elevation of hs-CRP. Future studies to determine possible associations between cytokine production and hs-CRP levels in obese people are warranted.

Limitations of the study include the small sample size (n = 161) and the low response rate (4%). However, to our knowledge, this is the first study of nondiabetic Cuban Americans that investigated metabolic syndrome and its relation to hs-CRP. Although data may not be generalizable to all Cuban Americans, it establishes a baseline for this understudied Hispanic subgroup. These findings need to be confirmed in a larger sample size and in a prospective manner.

In conclusion, this cross-sectional study demonstrates that metabolic syndrome affects a high percentage of Cuban American men and women in South Florida, which has the largest population of Cuban Americans in the

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United States. The study also indicates that Cuban Americans with metabolic syndrome have higher levels of hs-CRP that might be explained by abdominal obesity. Preventive programs that address weight and abdominal obesity might help manage metabolic syndrome before diabetes or cardiovascular disease develops in this population.

ACKNOWLEDGMENTS

This research was funded by a grant from NIH/MBRS/SCORE AC#124401529/42. We thank Michele Swink, Jenny Estevez, Lizabeth Nonell, and Gabriella Brissi for assistance with data collection and data entry.

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