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Characterization of Metabolic Syndrome among Diverse Hispanics/Latinos Living in the United States: Latent Class Analysis from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL)

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Abstract

Background/Objectives—Empirical investigation of the adequacy of metabolic syndrome (MetS) diagnostic criteria, and whether meaningful subtypes of MetS exist, is needed among Hispanics/Latinos.

Methods—In 15825 US Hispanics/Latinos from HCHS/SOL, latent class analysis of MetS components (waist circumference, systolic and diastolic blood pressure, HDL cholesterol, triglycerides, glucose, and antihypertensive, lipid- and glucose-lowering medication use) was used to investigate (1) whether distinct subtypes of MetS could be identified, and how component levels differed between them, and (2) how identified subtypes related to covariates and cardiovascular disease (CVD) prevalence.

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Conflicts of Interest: None

Results—Two latent clusters emerged in both men (n=6317) and women (n=9508): one characterized by relatively healthy mean levels (Non-MetS cluster, 77.1% of men and 67.1% of women) and the other by clinically elevated mean levels (MetS cluster, 22.9% of men and 32.9% of women) across most MetS components. These clusters showed expected associations with covariates and CVD prevalence. Notable results suggest that (1) HDL cholesterol may poorly differentiate between US Hispanics/Latinos with and without MetS (mean = 45.4 vs. 44.6 mg/dL for men and 51.3 vs. 52.0 mg/dL for women in the MetS vs. Non-MetS clusters, respectively) and (2) the NCEP-ATP III 88 cm waist circumference cutoff for US females may not optimize diagnosis among Hispanic/Latino women (MetS cluster mean waist circumference = 102.5 cm).

Conclusions—Beyond classification into having MetS or not, additional subtypes of MetS do not clearly emerge in US Hispanics/Latinos. Current diagnostic cutoffs for some components may not optimize MetS identification among this population.

Introduction

Although robust data indicate that metabolic syndrome (MetS; the clustering of obesity, hypertension, dyslipidemia, and hyperglycemia) increases cardiovascular disease (CVD) risk,[1, 2] debate ensues regarding current conceptualizations of the syndrome and its utility.[3] Cited concerns include (1) unclear etiology, despite postulations of insulin resistance and central adiposity as underlying pathologies, (2) lacking empirical support for the component cutoffs specified in diagnostic criteria, some of which differ between men and women (waist circumference and HDL cholesterol) and between select ethnic groups (waist circumference), and (3) unknown existence of distinct and meaningful subtypes of MetS – and their hierarchy of risk – despite findings that different MetS component combinations may confer differential risks for clinical and subclinical CVD.[3]

Additionally, MetS has been understudied in diverse US Hispanics/Latinos, who may be disproportionately affected compared to non-Hispanic/Latino whites and blacks.[4–6] Hispanics/Latinos represent the largest and fastest growing US minority population, whose burden of CVD and associated risk factors is projected to increase with their growth and aging.[6, 7] Yet cardiometabolic research on US Hispanics/Latinos has been limited and largely constrained to Mexican Americans and/or low socioeconomic groups, despite significant heterogeneity among this ethnic population.[8]

In an effort to address current knowledge gaps, data from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) were utilized to examine MetS presentation(s) via latent class analysis (LCA) of continuous MetS components. LCA allows for the identification of subgroups that differ not only in terms of which MetS components are elevated, but also the degree to which they are elevated.[9] Precluding the use of arbitrary cutoffs, working with continuous variables embraces the notion that the risk they confer is progressive, as opposed to purely absent or present. This study investigated 1) whether distinct subgroups of individuals could be identified based on their presenting levels of MetS components, and the extent to which MetS component levels differed among identified subgroups, 2) how identified MetS subgroups differed on various demographic, clinical,

socioeconomic, and behavioral characteristics, and 3) how identified MetS subgroups are associated with coronary heart (CHD) and cerebrovascular disease prevalence.

Methods

Study Sample

HCHS/SOL is an epidemiologic study of health and disease in diverse US Hispanic/Latino populations. Participants were recruited from 4 communities (the Bronx, NY; Chicago, IL; Miami, FL; and San Diego, CA), ensuring representation of persons from Mexican, Puerto Rican, Dominican, Cuban, and Central and South American origin. A detailed description of the study design and methods has been published.[10] At time of enrollment, participants had to self-identify as Hispanic/Latino and be between 18 and 74 years old. A two-stage area household probability sampling approach was employed, as described previously.[11] The institutional review board at each site approved the study protocol and all participants gave informed consent. This study included participants who attended the baseline exam. Participants who had missing data on Hispanic/Latino background group affiliation or who self-reported as “more than one heritage” or “other” were excluded (3.9% of men and 3.3% of women).

Measurement of MetS Components

Waist circumference (WC) was measured at the uppermost lateral border of the right ilium to the nearest 0.1 cm using a measuring tape. Systolic (SBP) and diastolic blood pressure (DBP) were measured 3 times in the right arm using an automatic sphygmomanometer after 5 minutes in the seated position; the average of the 3 readings was used. Fasting blood samples were collected for measurements of high-density lipoprotein cholesterol (HDL-C), triglycerides (TG), and glucose. Use of antihypertensive, lipid-lowering, and glucose-lowering medications during the month prior to baseline visit was assessed via standard questionnaire and interview, with ascertainment via scanning of Universal Product Code bar codes when available or centralized manual coding. Medication use was examined as dichotomized variables.

Measurement of Prevalent Cardiovascular Disease

A digital 12-lead electrocardiogram (ECG) was performed on each participant. Findings were electronically transmitted to a Central ECG Reading Center (EPICARE, Wake Forest University School of Medicine, Winston-Salem, NC). Ascertainment of old myocardial infarction (MI) was based on the Minnesota Code classification system[12]. A standard questionnaire and interview was used to collect self-reported information on angina, heart attack, coronary procedures (angioplasty, stent, or bypass surgery to the arteries of the heart), stroke, transient ischemic attack (TIA), and cerebrovascular procedures (balloon angioplasty or surgery to the arteries of the neck). Prevalent CHD was represented as a dichotomous variable that combined ECG reports of old MI as well as self-report of heart attack and coronary procedures. Prevalent CHD further including self-report of angina was also examined. Prevalent cerebrovascular disease was represented as a dichotomous variable that combined self-reported information on stroke, TIA, and cerebrovascular procedures.

Measurement of Covariates

Standard questionnaires and interviews were used to collect information on age, sex, Hispanic/Latino background group (characterized as Mexican, Puerto Rican, Cuban, Dominican, Central American, or South American, with Mexicans serving as the reference group), smoking (characterized as never, former, or current, with never serving as the reference group), family history of CHD and stroke in parents or siblings (each examined as a dichotomous variable), education (categorized as no, at most, or greater than a high school diploma/GED), and total gross family income (categorized as <$10,000, $10,000 to $15,000, >$15,000 to $20,000, >$20,000 to $25,000, >$25,000 to <$30,000, $30,000 to $40,000, > $40,000 to $50,000, >$50,000 to $75,000, >$75,000 to $100,000, or >$100,000).

Statistical Analyses

LCA was used to investigate the number and types of latent clusters underlying the associations among the following MetS components: WC, SBP, DBP, HDL-C, TG, glucose, and antihypertensive, lipid-lowering, and glucose-lowering medication use. TG and glucose values were log-transformed (due to having non-normal distributions) and multiplied by 100. Men and women were analyzed separately to allow for comparisons between MetS component estimates and currently specified gender-specific diagnostic cutoffs.

The traditional LCA assumptions of local independence (that the variables used to extract the latent clusters are independent and do not covary within each latent cluster) and homogeneity of variance (that although the different latent clusters may exhibit different mean levels in the variables used to extract them, the variability around those levels is the same in each latent cluster), often unrealistic with real-life data and research questions,[9, 13] were tested. Statistical indices suggested that the least restrictive model examined (where covariances between the two blood pressure variables and the two lipid variables were freely estimated along with cluster-dependent variances) fit the data best compared to more restrictive models (e.g., where the covariances between the two blood pressure and the two lipid variables were assumed to be zero within clusters, and the variance among variables were assumed to be equal between clusters), and was thus retained.

In line with common LCA practice, models systematically extracting an increasing number of latent clusters (e.g., from 1 to 20 latent clusters in our particular study) were specified, and each of these models was examined using various suggested indices to select the best-fitting model. These indices included (1) the Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), and sample size adjusted BIC (ABIC) (statistical parsimony criteria that consider how well the data fit a particular model, in which comparatively lower values indicate better fitting models), (2) entropy and posterior probabilities (statistical estimates of classification uncertainty, in which values greater than 0.80 and 0.90, respectively, indicate low uncertainty in classification and are considered adequate), as well as (3) cluster sizes and their theoretical/clinical meaningfulness (qualitative assessments that should always be considered along with statistical indices when determining the best model for the data, which should be consistent with prior theory and research). It is not uncommon for these various indices to disagree, and best practice advises careful consideration of each of these indices in combination when selecting a best-fitting model.[9]

After obtaining a final model, covariates were included as predictors of latent cluster assignment using logistic regression to examine MetS subgroup differences in these characteristics. Logistic regression was also used to examine MetS subgroup differences in each CVD prevalence outcome, controlling for covariates

Analyses were cross-sectional, used baseline data, and applied stratification, clustering, and sampling weights. Mplus software (version 6) was used.[14] Missing data were handled using full information maximum likelihood estimation.

Results

Table 1 presents baseline demographic, risk factor, and prevalent disease information.

Number of Latent Clusters

Fit indices for the models extracting increasing numbers of clusters are presented in Table 2 for men. Results were analogous for women (data not shown). AIC, BIC, and ABIC indices decreased as the number of clusters extracted increased, suggesting a greater number of clusters fit the data progressively better. However, the largest decreases occurred when comparing the two-cluster to the one-cluster model. This decrease was more than 4 times greater compared to the decreases observed across other models, which were smaller and expected given the extraction of increasing number of clusters and large sample size. Additionally, classification quality as indicated by entropy and posterior probabilities was best for the two-cluster model, and did not reach recommended thresholds for models that extracted more clusters. Detailed examination of models extracting three or more clusters revealed further – albeit less systematic and interpretable – re-classification of individuals within each of the two profiles identified in the two-cluster solution. Moreover, qualitative assessment of the two-cluster model suggested this model also reflected current theoretical and clinical conceptualizations of MetS. This model yielded adequate classification of individuals (entropy = 0.85 and 0.82 for men and women, respectively), further evidenced by elevated average posterior probabilities for cluster membership ranging from 0.93 to 0.97 for men and 0.94 to 0.96 for women, and very low cross-probabilities ranging from 0.03 to 0.07 for men and 0.04 to 0.07 for women.

Description of Latent Clusters

Table 3 presents the means of the MetS components in the two latent clusters.

The first cluster, named “Non-MetS,” described 81.2% of men and 73.2% of women, and was characterized by individuals exhibiting relatively healthy mean MetS component levels (with the exception of WC among women). Additionally, the proportion of individuals taking antihypertensive, lipid-lowering, and glucose-lowering medications was low (ranging from 0.1% to 3.6%).

The second cluster, named “MetS,” described 18.8% of men and 26.8% of women, and was characterized by individuals exhibiting clinically elevated mean levels across most MetS components. With the exception of DBP and HDL-C among men and women, and TG among women, mean MetS component values were above proposed diagnostic thresholds.

Additionally, the estimated proportion of individuals taking antihypertensive, lipid-lowering, and glucose-lowering medications was high (ranging from 30.8% to 46.2%).

Association of Covariates with Latent Cluster Membership

Table 3 also presents the parameter estimates including covariates (age, Hispanic/Latino background group, family history of CHD and stroke, smoking status, income, and education). Including covariates did not alter the cluster characteristics (i.e., estimated means and standard deviations were similar between models with and without covariates) but did change the proportion of individuals classified into each cluster (decreasing the proportion of individuals classified as Non-MetS and consequently increasing the proportion of individuals classified as MetS).

Table 4 presents the multivariate relationships between the covariates and the clusters. Being older (OR = 1.12 for men and 1.16 for women) and having a family history of CHD (OR = 1.32 for men and 1.29 for women) was associated with significantly higher odds of belonging to the MetS cluster compared to the Non-MetS cluster, while being of South American relative to Mexican descent was associated with significantly lower odds (OR = 0.46 for men and 0.61, at trend level, for women). In women, lower education level (OR = 0.77), lower income (OR = 0.87), never as opposed to current smoking (OR = 0.72), and being of Puerto Rican relative to Mexican descent (OR = 2.01) was also associated with significantly higher odds of being classified into the MetS cluster compared to the Non-MetS cluster. With the exception of smoking among women, these results are consistent with previous research on predictors of MetS,[15] suggesting adequate construct validity for the extracted clusters. Latent cluster classification was not significantly related to family history of stroke, former smoking relative to never smoking, or being of Cuban, Dominican, or Central/South American relative to Mexican descent.

Latent Cluster Membership and Prevalent Cardiovascular Disease

Inclusion of all outcomes (CHD without self-reported angina, CHD including selfreported angina, and cerebrovascular disease) in the gender-specific models also did not alter the cluster characteristics (data not shown).

Table 5 presents the relationships between the outcomes and the clusters, adjusted for age, Hispanic/Latino background group, family history of CHD and stroke, smoking status, income, and education. The odds of having CHD both without (OR = 1.11 for men and 1.05 for women) and with self-reported angina (OR = 1.13 for men and 1.07 for women), and cerebrovascular disease (OR = 1.05 for men and 1.03 for women), were significantly higher among individuals classified into the MetS cluster compared to the Non-MetS cluster. In general, these effects were stronger than those observed when MetS was defined using the NCEP-ATP III criteria (see Table 6).

Discussion

LCA revealed two distinct subgroups of MetS among US Hispanics/Latinos: Non- MetS and MetS. Additional subgroups were neither well-defined, clearly interpretable, nor possessed added empirical or clinical utility. This was contrary to initial hypotheses that additional,

meaningful subtypes of MetS (e.g., characterized by more specific patterns of elevated and/or non-elevated components) may exist.

Mean MetS component levels mostly fell within healthy ranges in the Non-MetS cluster. While significant variability was observed, suggesting certain individuals may have had clinical elevations in some components, the aggregate cluster profile was that of a healthy cardiometabolic group. The elevated mean WC among Hispanic/Latino women in this cluster may reflect the increased prevalence of overweight/obesity in this population,[15] which may not necessarily cluster with similar elevations across other MetS components.

Mean MetS component levels were noticeably more adverse in the MetS cluster compared to the Non-MetS cluster. This was not observed for HDL-C, mean levels of which were similar among individuals in the MetS vs. Non-MetS clusters (45.4 vs. 44.6 mg/dL in men and 51.3 vs. 52.0 mg/dL in women). This suggests that HDL-C may poorly differentiate between Hispanics/Latinos with and without MetS, and thus between those at increased or decreased CVD risk, and echoes a recent prospective cohort study showing that HDL-C was not predictive of MI among US Hispanics/Latinos despite being so among non-Hispanic/Latino whites and blacks.[16]

Compared to the Non-MetS cluster, the MetS cluster exhibited greater heterogeneity across most components (particularly glucose and SBP), suggesting variability in MetS presentation among affected persons and supporting current diagnostic criteria requiring elevations in only a subset of components. The Non-MetS cluster was most homogeneous with respect to non-elevated fasting glucose levels, supporting an etiologic role of insulin resistance.

While not widely employed in medical research,[17] LCA may be used to inform diagnostic cutoffs when, as in the present study, indicators appear to measure one underlying construct.[18] In fact, several consistencies between the MetS clusters' mean component estimates and NCEP-ATP III cutoffs[1] were observed in men (i.e., WC: 105 vs. 102 cm, SBP: 136 vs. 130 mm Hg, HDL-C: 45 vs. 40 mg/dL, and TG: 150 vs. 150 mg/dL) and women (i.e., SBP: 132 vs. 130 mm Hg, HDL-C: 51 vs. 50 mg/dL, and glucose: 112 vs. 110 mg/dL). However, differences were also noted, providing incipient evidence that current cutoffs for some components may not optimize MetS diagnosis among US Hispanics/Latinos. For example, the mean WC among women in the MetS cluster (102.5 cm) was markedly higher than the 88 cm NCEP-ATP III threshold for US females, suggesting this cutoff be raised for US Hispanic/Latino women. Although leading scientific organizations now advocate using ethnic-specific WC cutoffs, thresholds specific to Hispanics/Latinos have not been formally proposed.[19] Observed discrepancies between our study estimates and established guidelines may help guide future research investigating Hispanic/Latino-specific cutoffs. For instance, identified thresholds can be tested against current criteria to examine changes in sensitivity and specificity. This can also be carried out within an LCA framework without requiring a "gold" standard referent that, for MetS, has yet to be agreed upon.[17]

Consistent with national MetS prevalence estimates using NCEP-ATP III criteria, a higher proportion of women (32.9%) were classified into the MetS cluster compared to men

(22.9%). These estimates were slightly lower than those obtained using NCEPATP III criteria on the same sample of women (34.2%) and men (30.9%). While a high proportion of individuals in the MetS cluster also met NCEP-ATP III criteria (68.8% of women and 63.2% of men) compared to those in the Non-MetS cluster (16.8% of women and 20.9% of men), discordance between these two classifications is noted. Of note, while the effect sizes for the relationships observed between latent cluster membership and the CVD outcomes may appear small (e.g., OR < 1.5), those effects were actually stronger than those obtained using NCEP-ATP III criteria. These observations merit further investigation and may reflect the previously discussed adequacy or inadequacy of using currently established thresholds that are non-Hispanic/Latino specific.

The identified MetS clusters related to covariates and CVD prevalence in a manner consistent with previous research.[15] Specific to Hispanic/Latino background group differences, the observation that relative to Mexicans, South Americans had lower odds and Puerto Rican women had higher odds of being classified into the MetS cluster is consistent with prior findings.[20, 21] While Mexicans had the highest prevalence of MetS in MESA followed by Puerto Ricans, reported estimates were not gender-specific, and Hispanic/Latino background group differences in MetS prevalence may also vary as a function of gender.[21] This discrepancy might also have resulted from differences in generational status or length of US residence, factors that have been associated with obesity and poor cardiometabolic health.[22] The HCHS/SOL Puerto Rican sample, recruited mainly from New York communities, may have consisted of fewer immigrants and/or more acculturated individuals than the Mexican sample, and this warrants further investigation.

Examining how extracted latent clusters relate to multiple predictors and outcomes is the best-proposed method to verify the adequacy of selected models.[13, 23, 24] The convergence of observed relationships with previous empirical work, as well as the noted stability and unaltered qualitative nature of the MetS clusters across models both excluding and including multiple covariates and outcomes, strongly supports the validity of the extracted clusters. These observations are important and reassuring given the exploratory nature of our investigation that employed an alternative statistical approach to the study of MetS.

This study did not exclude diabetic persons. Excluding diabetic men (n = 1246) and women (n = 2031) in post-hoc analyses greatly altered the ability to identify distinct and meaningful MetS subgroups. Given that insulin resistance and obesity have been posited as major contributing factors in the development of both MetS and diabetes, and that diabetics may represent an important subsample of individuals with MetS in an advanced pathophysiologic state, these results should not be surprising. In fact, nearly all diabetics were classified into the MetS cluster (accounting for 53.0% of men and 44.0% of women in this cluster compared to only 3.2% of men and 2.4% of women in the Non-MetS cluster) in initial analyses. However, given the high variability in glucose level and glucose-lowering medication use among individuals classified into the MetS cluster, it appears diabetes status alone did not drive the formation of this group, but rather that diabetics also exhibited elevations in other MetS features that importantly influenced our ability to capture a valid picture of the syndrome as whole.

Strengths and limitations of this study should be noted. Utilizing community-based data from the most comprehensive study to date on US Hispanics/Latinos allowed for improved inference regarding the cardiometabolic health of this understudied population, but given this sample was not nationally representative, inferences cannot be extended to the US Hispanic/Latino community at-large.[10] Our approach to studying MetS allowed corresponding components to be analyzed as continuous rather than dichotomous variables, addressing a major criticism of previous and ongoing MetS investigations, and permitted detailed evaluation of component levels within identified clusters. Since this study relied on cross-sectional data, conclusions regarding the directionality of observed relationships cannot be made. HCHS/SOL's prospective design will present future opportunities to address this and similar issues in subsequent analyses. Given that HCHS/SOL did not include a non-Hispanic/Latino cohort, obtained results could not be compared to non-Hispanic/Latino populations. Future research may examine this indirectly using data from other epidemiologic cohorts (e.g., NHANES, MESA, etc.).

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Highlights

- We examined metabolic syndrome presentation in Hispanics using latent cluster analysis
- 2 clusters emerged in men and women: metabolic syndrome and no metabolic syndrome
- HDL cholesterol may not differentiate Hispanics with and without metabolic syndrome
- Current criteria may not optimize metabolic syndrome diagnosis among U.S. Hispanics

Table 1

Baseline demographic, risk factor, and prevalent disease information for analyzed participants of the Hispanic Community Health Study/Study of Latinos enrolled between March 2008 and June 2011.

	Men (n = 6317)	Women (n = 9508)
Variable	**Mean (SD) or proportion**	**Mean (SD) or proportion**
Age (years)	40.6 (14.8)	42.1 (15.1)
Hispanic/Latino background group		
Mexican	38.2%	39.7%
Puerto Rican	17.8%	16.0%
Cuban	22.8%	19.1%
Dominican	8.6%	12.0%
Central American	7.6%	7.8%
South American	5.0%	5.4%
Education < High school/GED	32.5%	33.5%
Income		
< $10K	11.9%	18.2%
$10K – $20K	30.1%	34.5%
> $20K – $40K	34.6%	31.6%
> $40K – $75K	16.0%	12.0%
> $75K	7.4%	3.7%
Family history of CHD	25.6%	31.5%
Family history of stroke	11.2%	14.1%
Smoking status		
Never	51.1%	70.9%
Former	22.1%	13.0%
Current	26.8%	16.1%
Waist circumference (cm)	98.3 (14.1)	96.6 (14.8)
Systolic blood pressure (mm Hg)	123.5 (15.1)	116.8 (18.5)
Diastolic blood pressure (mm Hg)	73.6 (10.9)	70.9 (10.7)
HDL cholesterol (mg/dL)	44.8 (11.4)	51.8 (12.9)
Triglycerides (mg/dL)	149.0 (150.6)	119.9 (76.9)
Glucose (mg/dL)	104.6 (34.5)	99.6 (32.1)
Antihypertensive medication use	12.3%	13.7%
Lipid-lowering medication use	8.6%	9.9%
Glucose-lowering medication use	7.9%	8.8%
CHD	5.7%	3.6%
CHD, including self-reported angina	6.7%	5.3%
Cerebrovascular disease	1.8%	1.1%

Abbreviations: CHD, coronary heart disease; GED, general educational development; HDL, high-density lipoprotein; K, thousand; SD, standard deviation.

Table 2

Fit indices for the retained latent class model* extracting increasing numbers of clusters (conducted on men, n = 6317).

Number of clusters extracted	# parameters	AIC	BIC	ABIC	Entropy	Posterior probabilities
One	17	309194.5	309309.3	309255.3	Na	Na
Two	35	297894.4	298130.7	298019.5	0.852	0.93 – 0.97
Three	53	295254.2	295612.0	295443.5	0.745	0.85 – 0.93
Four	71	294000.5	294479.8	294254.2	0.733	0.79 – 0.94
Five	89	293415.9	294016.7	293733.9	0.702	0.77 – 0.93
Six						
Seven	107	292878.0	293600.3	293260.3	0.726	0.77 – 0.90
Eight	125	292561.7	293405.6	293008.4	0.679	0.72 – 0.89
Nine	143	292332.4	293297.8	292843.4	0.671	0.72 – 0.88
…	161	292103.3	293190.2	292678.6	0.678	0.62 – 0.88
Twenty	359	291167.8	293591.4	292450.6	0.670	0.00 – 0.98

Abbreviations: ABIC, sample size adjusted Bayesian information criteria; AIC, Akaike information criteria; BIC, Bayesian information criteria.

*This model freely estimated covariances between the two blood pressure variables and the two lipid variables, and freely estimated cluster-dependent variances.

Table 3

Metabolic syndrome component means and standard deviations (or proportions) by latent cluster membership.

	Model without covariates		Model with covariates*	
	Latent cluster 1: Non-MetS	Latent cluster 2: MetS	Latent cluster 1: Non-MetS	Latent cluster 2: MetS
	Men: 81.2%	*Men: 18.8%*	*Men: 77.1%*	*Men: 22.9%*
	Women: 73.2%	*Women: 26.8%*	*Women: 67.1%*	*Women: 32.9%*
MetS component	**Mean (SD) or proportion**	**Mean (SD) or proportion**	**Mean (SD) or proportion**	**Mean (SD) or proportion**
Men (n = 6317)				
WC (cm)	96.1 (12.8)	106.7 (15.9)	96.1 (13.3)	105.1 (14.5)
SBP (mm Hg)	120.4 (11.3)	136.1 (20.6)	119.7 (10.7)	135.7 (19.7)
DBP (mm Hg)	72.2 (9.8)	79.2 (13.3)	71.9 (9.7)	79.0 (12.8)
HDL-C (mg/dL)	44.7 (10.5)	45.2 (14.5)	44.6 (10.5)	45.4 (14.1)
Triglycerides (transformed)	206.0 (25.3)	218.5 (26.0)	205.7 (25.5)	217.6 (25.3)
Triglycerides (mg/dL)	114.8 (----)	153.1 (----)	114.0 (----)	150.0 (----)
Glucose (transformed)	197.8 (3.5)	211.7 (16.0)	197.7 (3.5)	210.0 (15.4)
Glucose (mg/dL)	95.1 (----)	130.9 (----)	94.8 (----)	125.9 (----)
Antihypertensive med use	3.6%	46.2%	1.9%	45.3%
Lipid-lowering med use	2.1%	34.3%	1.0%	32.7%
Glucose-lowering med use	0.2%	38.2%	0.2%	32.3%
Women (n = 9508)				
WC (cm)	93.7 (13.6)	103.8 (15.2)	93.5 (14.0)	102.5 (14.5)
SBP (mm Hg)	110.5 (12.6)	133.1 (21.0)	109.0 (11.5)	132.4 (19.8)
DBP (mm Hg)	68.9 (9.7)	76.2 (11.4)	68.4 (9.5)	76.0 (11.1)
HDL-C (mg/dL)	52.4 (13.1)	50.1 (12.2)	52.0 (12.9)	51.3 (12.8)
Triglycerides (transformed)	196.4 (21.6)	214.7 (20.9)	195.5 (21.5)	213.5 (20.8)
Triglycerides (mg/dL)	92.0 (----)	140.3 (----)	90.2 (----)	136.5 (----)
Glucose (transformed)	195.6 (3.3)	206.2 (14.0)	195.5 (3.3)	204.8 (13.3)
Glucose (mg/dL)	90.4 (----)	115.3 (----)	90.2 (----)	111.7 (----)
Antihypertensive med use	2.3%	43.2%	0.8%	39.3%
Lipid-lowering med use	1.9%	30.8%	0.7%	28.3%
Glucose-lowering med use	0.1%	31.3%	0.2%	25.9%

Abbreviations: DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; MetS, metabolic syndrome; SBP, systolic blood pressure; SD, standard deviation; WC, waist circumference.

*Adjusted for age, Hispanic/Latino background group, family history of CHD and stroke, smoking status, income, and education.

Table 4

Results from the multivariate logistic regression evaluating the associations between covariates and metabolic syndrome latent cluster membership.*

Covariate	Odds ratio (95% CI)	*p value*
Men (n = 6317)		
Age	1.12 (1.11–1.13)	< 0.001
Hispanic/Latino background group (relative to Mexicans)		
Puerto Rican	0.90 (0.62–1.30)	0.559
Cuban	0.70 (0.43–1.14)	0.149
Dominican	1.15 (0.69–1.91)	0.599
Central American	0.83 (0.56–1.23)	0.356
South American	0.46 (0.28–0.75)	0.002
Education	0.97 (0.86–1.10)	0.643
Income	0.97 (0.93–1.02)	0.247
Family history of CHD	1.32 (1.06–1.64)	0.013
Family history of stroke	1.34 (0.97–1.84)	0.073
Smoking status (relative to never smoking)		
Former	1.23 (0.97–1.56)	0.089
Current	0.97 (0.72–1.31)	0.837
Women (n = 9508)		
Age	1.16 (1.15–1.18)	< 0.001
Hispanic/Latino background group (relative to Mexicans)		
Puerto Rican	2.01 (1.20–3.38)	0.008
Cuban	1.16 (0.69–1.96)	0.581
Dominican	0.92 (0.49–1.70)	0.782
Central American	1.13 (0.69–1.84)	0.630
South American	0.61 (0.37–1.00)	0.051
Education	0.77 (0.68–0.88)	< 0.001
Income	0.87 (0.83–0.91)	< 0.001
Family history of CHD	1.29 (1.05–1.58)	0.017
Family history of stroke	1.08 (0.86–1.35)	0.515
Smoking status (relative to never smoking)		
Former	1.11 (0.86–1.44)	0.426
Current	0.72 (0.55–0.93)	0.013

Abbreviations: CHD, coronary heart disease.

*Adjusted for study site.

Table 5

Results from the logistic regression evaluating the association between metabolic syndrome latent cluster membership and prevalent cardiovascular disease, adjusting for covariates.[*] [†]

Prevalent CVD outcome	Odds ratio (95% CI)	*p value*
Men (n = 6317)		
CHD	1.11 (1.05–1.18)	<0.001
CHD, including self-reported angina	1.13 (1.07–1.20)	<0.001
Cerebrovascular disease	1.05 (1.01–1.09)	0.028
Women (n = 9508)		
CHD	1.05 (1.02–1.09)	0.005
CHD, including self-reported angina	1.07 (1.03–1.11)	<0.001
Cerebrovascular disease	1.03 (1.00–1.05)	0.018

Abbreviations: CHD, coronary heart disease; CVD, cardiovascular disease.

[*] Adjusted for age, Hispanic/Latino background group, family history of CHD and stroke, smoking status, income, and education.

[†] Results for the sample aged 45 and older were in the same direction.

Table 6

Results from the logistic regression evaluating the association between metabolic syndrome defined using NCEP-ATP III criteria and prevalent cardiovascular disease, adjusting for covariates.*

Prevalent CVD outcome	Odds ratio (95% CI)	*p value*
Men (n = 6317)		
CHD	1.04 (1.01–1.06)	0.001
CHD, including self-reported angina	1.04 (1.02–1.07)	<0.001
Cerebrovascular disease	1.01 (1.00–1.03)	0.042
Women (n = 9508)		
CHD	1.04 (1.02–1.06)	<0.001
CHD, including self-reported angina	1.05 (1.03–1.07)	<0.001
Cerebrovascular disease	1.01 (0.99–1.02)	0.061

Abbreviations: CHD, coronary heart disease; CVD, cardiovascular disease.

*Adjusted for age, Hispanic/Latino background group, family history of CHD and stroke, smoking status, income, and education.