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Prevalence of overweight and obesity and their cardiometabolic comorbidities in Hispanic adults living in Puerto Rico

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Abstract

This study characterized the prevalence of overweight and obesity and assessed their cardiometabolic comorbidities in the population aged 21–79 years living in the San Juan Metropolitan Area of Puerto Rico. We analyzed data from a household survey conducted in Puerto Rico between 2005 and 2007 that used a representative sample of 840 non-institutionalized adults living in the San Juan Metropolitan Area. Body mass index categories were classified as normal weight, overweight and obese. Poisson regression model with robust variance was used to estimate the prevalence ratio to assess the association of each cardiometabolic comorbidity (hypertension, dyslipidemia, diabetes, prediabetes, systemic inflammation, prothrombotic state, and coronary heart disease) with overweight and obesity. Age-standardized prevalence of overweight and obesity was 35.9% and 41.5%, respectively, figures higher than the combined prevalence for the U.S. adult population (68.8%) but similar to all mainland Hispanics (78.8%). Men were more likely to be overweight than women (40.4% versus 33.4%), whereas more women than men were obese (43.7% versus 37.6%). Prevalence of all cardiometabolic comorbidities was significantly ($p < 0.05$) higher among overweight and obese adults than those of normal weight after adjusting for age, sex, years of education, smoking status, alcohol consumption and physical activity. A considerable proportion of adults in this population are overweight or obese. In view of the wide-ranging effects that overweight and obesity have on health, preventive actions to avert the rise of excess body weight as well as the design of lifestyle interventions are largely needed in this population.

Keywords

Overweight; Obesity; Cardiometabolic Comorbidities; Hispanics

Conflict of interest

The authors have no commercial associations or sources of support that might pose a conflict of interest.

Introduction

The sharp rise in the prevalence of overweight and obesity poses a major public health challenge worldwide (1,2). After tobacco use, obesity represents the second leading preventable cause of disease and death in the United States (U.S.) (3). It substantially raises the risk of chronic conditions and other adverse health outcomes, including cardiovascular disease, stroke, type 2 diabetes, and selected types of cancer, health conditions that represent the leading causes of preventable deaths (4).

The 2009–2010 National Health and Nutrition Examination Survey (NHANES) found that the age-standardized prevalence of overweight and obesity in the U.S. population 20 years and over was 33.1% and 35.7%, respectively (5). Although there were no significant differences between racial and ethnic groups in the prevalence of obesity among men (38.8% African Americans, 37.0% Hispanics, and 36.2% non-Hispanic Whites), African-American (58.5%) and Hispanic (41.4%) women were significantly more likely to be obese than non-Hispanic White women (32.2%). Research suggests that racial/ethnic variations in the prevalence of obesity are partially explained by differences in lifestyle behaviors, economic disadvantage, and genetic or molecular factors (6).

Although achievement of health equity, elimination of health disparities, and health improvement in all groups are one of the overarching goals set forth in Healthy People 2020 (7), Hispanics, the current largest ethnic minority population in the U.S., still experience many health disparities (8). Compared to non-Hispanic Whites, Hispanics have more age-adjusted years of potential life lost before age 75 years per 100,000 population for stroke and diabetes (8). Hispanics are also disproportionately affected by overweight and obesity, and at each body mass index level (BMI), Hispanics had a higher prevalence of diabetes than non-Hispanic Whites (8).

Recent data regarding the burden of cardiovascular risk factors and cardiovascular diseases across Hispanic subgroups born in the U.S. suggest that mainland Puerto Ricans experience high rates of individual cardiovascular risk factors (obesity: 40.9% men, 51.4% women; current smoking: 34.7% men, 31.7% women; hypercholesterolemia: 48.2% men, 41% women; hypertension: 27.4% men, 29.1% women; diabetes: 16.2% men, 19.4% women) and overall cardiovascular risk factor burden (25% had at least three risk factors) compared with other Hispanic subgroups (9). Consistent with these observations, the Boston Puerto Rican Health Study has documented a large prevalence of obesity, type 2 diabetes, and hypertension among Puerto Ricans aged 45–75 years than among non-Hispanic Whites (10). Although diabetes has disproportionately affected islander Puerto Ricans, with estimated prevalence of 12.4% in 2008 and annual-age adjusted incidence of 12.8 per 1,000 in 2005–2007 (11–12), current data on overweight and obesity and related comorbidities in Puerto Rico are scant (11–15). Burden of overweight and obesity in Puerto Rico has relied upon respondents' self-reports of diagnoses provided in the Behavioral Risk Factor Surveillance Survey (BRFSS) (11). In addition, data are sparse regarding related comorbidities in Puerto Rico, limiting the planning of prevention interventions and monitoring their effectiveness to control these conditions. Currently, population-based studies using anthropometric measures in the identification of overweight or obesity in adults are limited. For this study, we determined for the first time prevalence estimates of overweight and obesity and assessed their cardiometabolic comorbidities, using anthropometric and biochemical measurements, in a population-based sample of adults residing in the San Juan metropolitan area.

Methods

Study sample

The methods used in this study have been reported in detail in separate publications (16–20). Briefly, our study population consisted of non-institutionalized Puerto Ricans aged 21 to 79 years residing in the San Juan metropolitan area, who participated in the population-based cross-sectional study *Prevalence of the metabolic syndrome in San Juan, Puerto Rico* (16). The sampling frame was based on a three-stage cluster design for household surveys using the census tracts of the San Juan metropolitan area. Sample selection included random selection of census groups of blocks using a systematic design, followed by the random selection of a single block from each group, and finally the random selection of an area segment within each block. All individuals aged 21–79 years from each selected household were eligible to participate in the study and asked to undergo a personal interview, physical exam and biochemical measurements. We identified 1,200 eligible adults; of these, 867 (72.3%) participated in a face to face interview, physical examination and biochemical measurements. Subjects with incomplete data on any of the variables of interest (n=10) or those who were underweight (BMI<18.5 kg/m², n=17) were excluded, thus the final analytic sample used in the present study consisted of 840 participants.

Anthropometric measurements were taken in duplicate according to the NHANES III Anthropometry Procedures Manual (21), and the average of the two measures was used. A Cardinal Detecto digital scale (Cardinal/Detecto, Webb City, MO) was used to measure current body weight in kilograms, and a portable Seca stadiometer (Seca Corporation, Hanover, MD) was used to determine height in meters. BMI categories were defined as normal (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²), and obese (≥30.0 kg/m²). Waist circumference was determined with a measuring tape at the high point of the iliac crest at the end of the study participant normal expiration and was classified as follows: high risk ≥102 cm in men and ≥88 cm in women and low risk if below these levels (22). Hip circumference was determined using a measuring tape at the maximum extension of the buttocks at minimal respiration in centimeters. Waist-to-hip ratio (WHR), calculated as waist circumference divided by hip circumference, was classified as follows: high risk ≥0.90 in men and ≥0.85 in women and low risk if below these levels (23).

Three blood pressure measurements were taken 10 minutes apart with an appropriate cuff size and a standard aneroid sphygmomanometer. Blood pressure status was based on the average of the three measurements. Fasting blood samples were collected, and concentrations of total cholesterol, triglycerides, HDL cholesterol (HDL-C), fasting plasma glucose, and hemoglobin A1c were determined by using commercial enzymatic colorimetric kits (Bayer Diagnostics, Tarrytown, NY). Levels of LDL cholesterol (LDL-C) were estimated indirectly using the Friedewald equation. A two site immunoassay for measuring human fibrinogen in plasma was used (DiaPharma Group Inc., West Chester, OH). Plasminogen activator inhibitor 1 (PAI-1) levels were determined by the use of Imubind enzyme-linked immunosorbent assay (American Diagnostica Inc., Stamford, CT). The high-sensitive C reactive protein (hs-CRP) was measured using the ultrasensitive assay (Kamiya Biomedical, Seattle, WA). The study was approved by the Institutional Review Board of the University of Puerto Rico Medical Sciences Campus. Informed consent was obtained from all subjects prior to their participation in the study.

Study variables

The socio-demographic variables examined were sex, age group in years (21–39, 40–59, 60–79), and educational attainment (less than high school, high school graduate or some college, college graduate or more). Participants were considered current smokers if they

reported having smoked 100 cigarettes during their lifetime and were still smoking. Former smokers were defined as those who had previously smoked at least 100 cigarettes in their lifetime and have stopped smoking. The remaining participants were classified as never smokers. Participants who reported no alcohol consumption in their lifetimes or who had abstained in the past 30 days were defined as alcohol abstainers. Women consuming no more than one drink per day and men consuming no more than two drinks per day were classified as light-to-moderate alcohol consumers. Those individuals reporting number of drinks that exceeded the American Dietary Guidelines cutoff points were classified as heavy consumers. Respondents were classified as meeting national guidelines on physical activity if they indicated participation in moderate-intensity activities for a minimum of 30 minutes on five days per week or vigorous-intensity activity for a minimum of 20 minutes on three days per week.

Hypertension was defined as a systolic blood pressure 140 mm Hg, diastolic blood pressure 90 mm Hg or self-reported current antihypertensive treatment. High total cholesterol was defined as a serum total cholesterol 200 mg/dL, reduced HDL-C was defined as a level <40 mg/dL in men and <50 mg/dL in women, and LDL-C as 160 mg/dL. Elevated triglycerides were defined as 150 mg/dL, whereas diabetes was defined as a fasting blood glucose 126 mg/dL or self-reported diagnosis of diabetes. The number of metabolic syndrome abnormalities was defined using the American Heart Association/National Heart, Lung, and Blood Institute revised definition of the NCEP-ATP III report (24). Upper quartiles were used to define high levels of hs-CRP (>0.66 mg/L), PAI-1 (>18 ng/L) and fibrinogen (>365 mg/L). Self-reported information on physician-diagnosed hypertension, diabetes and coronary heart disease and their treatment regimens were collected.

Statistical Analysis

Weighted prevalence was estimated taking into account differential probabilities of selection and the complex sampling design. The prevalence of overweight and obesity was age-adjusted by the direct method to the 2000 U.S. Census population using age groups 21–39 years, 40–59 years, and 60–79 years. Differences in the distribution of socio-demographic, lifestyle and cardiometabolic comorbidities across BMI categories (normal, overweight, obese) were made using Pearson's chi-square test or analysis of variance. In view of the elevated prevalence of overweight and obesity, the association between BMI categories and each cardiovascular risk factor was assessed individually with the prevalence ratio (PR). Age- and multivariate-adjusted Poisson regression models with robust error variance were used to estimate the PR (25). To assess confounding, covariates were entered into each model one at a time and compared unadjusted and adjusted estimates. Those covariates that altered the unadjusted PR by at least 10% were retained in the multivariable model. All statistical analyses were performed using Stata for Windows release 11.0 (StataCorp, College Station, Texas).

Results

Age-standardized prevalence of overweight and obesity were 35.9% and 41.5%, respectively (Table 1). Men were significantly ($p<0.05$) more likely to be overweight than women (40.4% versus 33.4%), whereas more women than men were significantly ($p<0.05$) obese (43.7% versus 37.6%). Across age groups, prevalence of overweight was higher among adults aged 60–79 years, whereas prevalence of obesity was higher among those aged 40–59 years. Age-specific prevalence of overweight and obesity did not vary between men and women.

Overweight and obese individuals were significantly ($p<0.05$) more likely to be older and to report light to moderate alcohol consumption (Table 2). These groups also had significantly ($p<0.01$) higher levels of waist circumference, waist-to-hip ratio, systolic and diastolic blood pressures, total cholesterol, LDL-C, triglycerides, fasting plasma glucose, hemoglobin A1c, hs-CRP, fibrinogen, and PAI-1 but significantly lower levels of HDL-C. Compared to normal weight individuals, significant ($p<0.05$) higher proportions of overweight and obese individuals had hypertension, diabetes, metabolic syndrome abnormalities, and diagnosed coronary heart disease.

In age-adjusted analyses, the prevalence of hypertension, diabetes, prediabetes, hypercholesterolemia, elevated triglycerides, reduced HDL-C, elevated LDL-C, elevated hs-CRP, and elevated PAI-1 was significantly ($p<0.05$) higher for overweight than for those of normal weight (Table 3). However, individuals who were obese had significantly ($p<0.05$) higher prevalence of all cardiometabolic comorbidities compared to normal weight individuals. The associations of overweight and obesity with all cardiometabolic comorbidities remained significant in multivariable analysis after further adjustment for sex, years of education, smoking status, alcohol consumption and physical activity.

Discussion

In this cross-sectional study, we assessed the prevalence of overweight and obesity and their associations with cardiometabolic comorbidities in a probabilistic sample of adults living in the SJMA of Puerto Rico. The data show that a considerable proportion (77.4%) of adults in this population is overweight or obese. This combined prevalence of overweight and obesity exceeded the self-reported prevalence of the 2007 BRFSS survey conducted in Puerto Rico (64.9%) (11). The age-adjusted prevalence was also higher than the U.S. estimate for the adult population (68.8%) but similar to the prevalence for all Hispanics (78.8%) in the mainland (5).

Gender-specific disparities in the prevalence of overweight and obesity have been documented worldwide (26,27). These studies indicate that differences in sedentary behaviors, genetics, and sociocultural and economic factors may account for some of these disparities (28). In our study, the prevalence of obesity was higher among lower-income and non-smoking women. In agreement with the literature, individuals with lower socioeconomic level are more likely to buy cheaper, energy-dense foods, whereas smoking has been associated with a higher metabolic rate and to a different dietary intake relative to non-smokers (29,30). However, further research is needed to understand the gender disparities in the distribution of obesity.

Compared with normal weight adults, those who were overweight and obese had significantly higher prevalence of an adverse cardiometabolic risk profile. These findings are in line with published evidence that has shown that obesity increases cardiometabolic risk through risk factors such as dyslipidemia, elevated blood glucose and blood pressure – all components of the metabolic syndrome (24,31). In agreement with previous studies, both overweight and obesity were also significantly associated with higher levels of hs-CRP, fibrinogen, and PAI-1, additional components of the metabolic syndrome (24,32,33). CRP, a biomarker of low grade inflammation, is a predictor of incident cardiovascular disease and correlates with several metabolic syndrome components, particularly with obesity (24). Increasing evidence suggests that this chronic, low-grade inflammation induced by adipocyte-secreted cytokines may be one of the underlying mechanisms of the metabolic syndrome, type 2 diabetes, and cardiovascular disease (33). On the other hand, coagulation products, such as PAI-1 and fibrinogen, have been found elevated in individuals with the metabolic syndrome, especially those who are obese or diagnosed with atherosclerosis and

type 2 diabetes (34). Although the mechanisms underlying the metabolic syndrome are not fully understood, obesity and insulin resistance are considered to be important links between adiposity and the associated risks of metabolic syndrome, type 2 diabetes, cardiovascular disease, and some types of cancer (32). Current study findings along with our previous observations from our group showing an elevated prevalence of the metabolic syndrome in the San Juan metropolitan area of Puerto Rico (16,20) underscore the need to implement public health initiatives that promote increased physical activity, healthful diets and healthy weight. These strategies could potentially help prevent or delay the development of comorbidities and markedly improve the health of individuals at risk.

Our study has several limitations. First, the cross-sectional design does not allow any inference to be drawn with respect to the causal relationship among variables. Second, the study sample is only representative of adults living in the San Juan metropolitan area, and thus findings may not be generalizable to the adult population of Puerto Rico. Furthermore, detailed information on dietary variables was not available and could have attenuated our associations. Finally, the small sample sizes available in some subgroup analyses reduced the statistical power to detect significant associations. Notwithstanding these limitations, our study provides useful data on the prevalence of overweight and obesity using measured height and weight and their cardiometabolic comorbidities among adults aged 21–79 years. In addition, we were able to control for several socio-demographic and lifestyle variables in order to assess the independent effects of overweight and obesity on cardiometabolic risks, results that were consistent with previous reports and supported by biological plausibility.

In conclusion, our data show that adults in the San Juan metropolitan area of Puerto Rico have a high prevalence of overweight and obesity and exhibit an unfavorable cardiometabolic risk profile. In view of the wide-ranging effects that overweight and obesity have on health, preventive actions to avert the rise of excess body weight as well as the design of lifestyle interventions are largely needed. Future research is needed to understand the biological mechanisms that link excess body weight with these cardiometabolic risk factors.

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Table 1

Prevalence (95% CI) of overweight and obesity across sex and age groups, San Juan Metropolitan Area, Puerto Rico (n=840)

	Both sexes		Females		Males	
	Overweight	Obesity	Overweight	Obesity	Overweight	Obesity
Weighted *	37.5 (34.2–40.8)	41.5 (38.2–44.9)	34.9 (30.9–38.9)	44.4 (40.3–48.6)	42.3 (36.6–48.0)	36.2 (30.7–41.7)
Age-standardized †	35.9 (32.5–39.2)	41.5 (38.1–45.0)	33.4 (29.3–37.5)	43.7 (39.4–48.0)	40.4 (34.6–46.3)	37.6 (31.8–43.4)
Age-specific						
21–39 years	32.4 (26.7–38.2)	35.9 (30.0–41.8)	29.0 (22.1–35.9)	37.3 (29.9–44.6)	38.9 (23.5–43.2)	33.3 (23.5–43.2)
40–59 years	35.2 (29.8–40.5)	49.7 (44.1–55.3)	34.3 (27.8–40.8)	50.7 (43.9–57.6)	36.9 (27.5–46.3)	47.6 (37.8–57.3)
60–79 years	45.0 (39.1–51.0)	37.6 (31.9–43.4)	41.5 (34.1–48.9)	43.9 (36.4–51.3)	51.0 (41.1–60.9)	27.0 (18.2–35.8)

* Weighted prevalence was estimated taking into account differential probabilities of selection and the complex sampling design.

† Using the direct method to the 2000 U.S. Census population using age groups 21–39 years, 40–59 years, and 60–79 years.

Table 2

Characteristics of Survey Respondents, San Juan Metropolitan Area, Puerto Rico, 2005–2007 (n = 840)

	Normal (n = 176)	Overweight (n = 315)	Obese (n = 349)	P value
Female gender, %	64.2	60.6	69.6	0.05
Mean age, years *	45.3±17.8	51.8±15.9	49.8±14.8	<0.01
Years of education, %				
16	23.9	19.4	18.1	0.45
12–15	25.6	28.9	25.8	
<12	50.6	51.8	56.2	
Smoking status, %				
Never smokers	61.1	60.8	61.6	0.07
Former smokers	13.1	21.3	20.3	
Current smokers	25.7	17.8	18.1	
Alcohol consumption, %				
Never	15.9	9.2	8.0	0.03
Light-to-moderate	63.1	68.6	73.6	
Heavy	21.0	22.2	18.3	
Not engaged in weekly moderate or vigorous physical activity, %	56.3	60.0	65.3	0.11
Daily consumption of 5 portions of fruits and vegetables, %	8.5	6.1	5.7	0.44
Weekly frequency of fast food restaurant visits	19.3	17.8	22.1	0.38
Mean waist circumference, in *	31.1±3.2	35.3±3.0	41.2±4.9	<0.01
Elevated WC, %	3.4	30.2	90.5	<0.01
Mean waist-to-hip ratio *	0.83±0.08	0.87±0.09	0.89±0.09	<0.01
Elevated WHR, %	23.9	53.7	63.9	<0.01
Mean SBP, mm Hg *	112.4±23.8	120.9±19.7	124.1±19.7	<0.01
Mean DBP, mm Hg *	67.1±10.1	73.1±10.9	76.3±10.4	<0.01
Hypertension, %	19.3	41.3	49.0	<0.01
Mean total cholesterol, mg/dL *	180.8±38.5	193.7±43.4	195.4±45.8	<0.01
Total cholesterol 200 mg/dL, %	28.4	40.6	39.5	0.02
Mean HDL-C, mg/dL *	51.9±14.0	49.7±13.3	47.2±10.9	<0.01
HDL-C<40 mg/dL in men and <50 mg/dL in women, %	35.8	42.2	54.7	<0.01
Mean LDL-C, mg/dL *	108.6±31.4	120.0±41.7	120.9±39.8	<0.01
LDL-C 160 mg/dL, %	6.8	14.3	14.6	0.03
Mean triglycerides, mg/dL *	111.7±91.2	148.7±99.0	154.3±99.8	<0.01
Triglycerides 150 mg/dL, %	15.9	32.7	39.0	<0.01
Mean fasting plasma glucose, mg/dL *	95.9±26.8	112.4±42.0	124.4±58.9	<0.01
Mean hemoglobin A1c, % *	5.7±0.8	6.4±1.6	6.6±1.7	<0.01

	Normal (n = 176)	Overweight (n = 315)	Obese (n = 349)	P value
Diabetes, %	5.7	22.5	28.7	<0.01
Prediabetes, %	18.2	32.1	39.0	<0.01
Number of metabolic syndrome abnormalities, %				
0	36.4	14.9	2.0	<0.01
1	38.6	24.8	10.3	
2	14.8	23.2	20.9	
3	10.2	37.1	66.8	
hs-CRP>0.66 mg/L, % ^{†‡}	27.3	45.4	70.8	<0.01
Fibrinogen>365 mg/L, % [†]	40.3	48.3	55.3	0.01
PAI-1>18 ng/L ^{†‡}	22.2	52.7	66.5	<0.01
Diagnosed coronary heart disease, %	1.7	5.7	8.6	<0.01

* Mean±Standard Deviation

[†] Values represent the 75th percentiles of the sample distribution

[‡] hs-CRP=high-sensitive C reactive protein; PAI-1=Plasminogen activator inhibitor 1

Table 3

Age-adjusted and multivariable-adjusted prevalence ratio (PR) for cardiometabolic risk factors by BMI status

	Overweight*		Obese*	
	Age-adjusted PR (95% CI)	Multivariate-adjusted PR (95% CI) [†]	Age-adjusted PR (95% CI)	Multivariate-adjusted PR (95% CI) [†]
Hypertension	1.29 (1.11–1.50)	1.29 (1.11–1.51)	1.51 (1.32–1.72)	1.51 (1.31–1.73)
Diabetes	1.35 (1.18–1.54)	1.37 (1.20–1.58)	1.47 (1.32–1.64)	1.48 (1.32–1.65)
Prediabetes	1.22 (1.07–1.38)	1.21 (1.07–1.38)	1.32 (1.18–1.48)	1.34 (1.19–1.49)
Elevated triglycerides	1.26 (1.11–1.43)	1.26 (1.11–1.43)	1.37 (1.22–1.53)	1.38 (1.23–1.54)
Elevated total cholesterol	1.17 (1.01–1.37)	1.17 (1.00–1.37)	1.18 (1.02–1.37)	1.17 (1.01–1.36)
Reduced HDL-C	1.15 (1.01–1.32)	1.17 (1.02–1.33)	1.32 (1.17–1.49)	1.29 (1.14–1.46)
Elevated LDL-C	1.20 (1.03–1.41)	1.19 (1.02–1.40)	1.23 (1.06–1.41)	1.24 (1.07–1.43)
Elevated hs-CRP	1.19 (1.02–1.38)	1.22 (1.05–1.42)	1.55 (1.40–1.72)	1.54 (1.38–1.71)
Elevated fibrinogen	1.06 (0.92–1.22)	1.08 (0.94–1.24)	1.22 (1.08–1.37)	1.19 (1.05–1.34)
Elevated PAI-1	1.38 (1.22–1.55)	1.39 (1.23–1.56)	1.54 (1.38–1.70)	1.55 (1.40–1.72)
Diagnosed coronary heart disease	1.20 (0.98–1.46)	1.20 (0.98–1.46)	1.32 (1.16–1.51)	1.32 (1.14–1.52)

* Normal weight individuals used as the reference category

[†] Adjusted for age, sex, years of education, smoking status, alcohol consumption, and physical activity