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Association between the hypertriglyceridemic waist phenotype, prediabetes and diabetes mellitus among adults in Puerto Rico

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Abstract

Background—This study assessed the association of the hypertriglyceridemic waist (HTGW) phenotype with prediabetes and diabetes (DM) in a group of Hispanics.

Methods—Analysis of a cross-sectional study of 858 adults residing in Puerto Rico that collected data on blood pressure, biochemical, and anthropometric measurements was performed. HTGW phenotype was defined as elevated triglycerides and elevated waist circumference. Prediabetes was defined as a fasting glucose of 100–125 mg/dL and DM as a fasting glucose ≥ 126 mg/dL or prior diagnosis.

Results—Prevalence of HTGW, prediabetes and DM was 27.9%, 38.0% and 21.6%, respectively. Subjects with the HTGW phenotype had higher adjusted odds of prediabetes (POR=5.55; 95% CI=3.38–9.13) and DM (POR=7.28; 95% CI=3.63–14.63) compared to those without the phenotype. The association for prediabetes was stronger for women than among men.

Discussion—HTGW phenotype was strongly associated with prediabetes and DM, reinforcing the need to further assess its performance as a screening tool to identify at-risk individuals for cardiometabolic conditions.

Keywords

Hypertriglyceridemic waist phenotype; Prediabetes; Diabetes; Puerto Ricans; Hispanics

Introduction

Urbanization, population growth, and the increasing prevalence of obesity have been regarded as contributing factors to the global rise of diabetes mellitus (DM) (1). Estimates

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from the International Diabetes Federation showed that an estimated 371 million of adults are living with DM worldwide (2). Moreover, half of all DM cases worldwide are undiagnosed (2), highlighting the need for early diagnosis and management to prevent or delay complications.

Visceral adipose tissue has been independently associated with incident type 2 DM (3). Imaging studies using measurements of abdominal adiposity, such as magnetic resonance imaging (MRI) and computed tomography (CT) represent the gold standard for quantitative assessment of visceral adiposity; however, the costs and the exposure to radiation associated with these procedures constitute important barriers to their general use in research and clinical practice. Alternatively, waist circumference (WC) has been shown to be a good correlate of abdominal visceral adipose tissue accumulation (4). However, an increased WC alone is not sufficient to identify an abdominal obese person with excess visceral adipose tissue. Clinical markers of an altered metabolic risk profile, such as dyslipidemia, elevated blood pressure, and elevated fasting glucose, must also be present to suggest the presence of visceral obesity (5).

The concurrent measure of the accumulation of triglyceride-rich lipoproteins has been shown to offer advantages on discriminating visceral from subcutaneous adiposity among abdominal obese individuals (6). Lemieux and colleagues (7) showed that concurrent elevated triglycerides (men: 177 mg/dL, women: 133 mg/dL) and elevated WC (men: 36 inches, women: 34 inches), known as hypertriglyceridemic waist (HTGW) phenotype, could also predict metabolic abnormalities in people with an increased waist line. The usefulness of the HTGW is grounded on the concept that visceral adiposity and dyslipidemia are the pathogenic core of the metabolic syndrome (8), and are critical components for assessing subjects with insulin resistance and DM (3, 9, 10). Previous studies have demonstrated that the HTGW phenotype might be a stronger predictor of cardiovascular disease and DM than the metabolic syndrome (11–13). HTGW denotes an alternative tool to the metabolic syndrome as a simple and reliable phenotype indicator of metabolic risk associated with visceral obesity and an inexpensive surrogate marker of visceral adiposity itself. Considering the simplicity of the HTGW phenotype and its association with diabetogenic risk factors, the prevalence of the HTGW phenotype and its association with prediabetes and DM were assessed among adults living in Puerto Rico, a Hispanic subgroup that is disproportionately affected by DM compared to other ethnic groups in the US and in selected Latin American countries (14–16).

Methods

Study design and Sample

This is a secondary analysis of the cross-sectional study entitled *Prevalence of the metabolic syndrome in San Juan, Puerto Rico*. The design and methods of the study have been described in detail previously (17). Briefly, the population of the parent study consisted of adults aged 21 to 79 years residing in the San Juan Metropolitan Area. A complex sampling design of households was used to randomly select the participants of the study. In the parent study, 1,200 individuals were identified as eligible to participate in the study, of which, 867 (72.3%) consented to participate in the study. A total of nine adults had incomplete data to

define the HTGW phenotype, thus the final analytic sample included 858 participants. They were instructed to fast for at least eight hours prior to attend their morning appointment in a mobile examination center located near their homes. Participants completed a face-to-face interview that ascertained socio-demographic characteristics, health behaviors, medical history, and current medication use. The physical examination included anthropometric and blood pressure measurements and blood draw for laboratory testing. The study was approved by the Institutional Review Board of the University of Puerto Rico Medical Sciences Campus, and written informed consent was given by all participants.

Study variables

Educational attainment was categorized as high school diploma or less, some college and college graduate or more, whereas annual household income from previous year was classified as <\$20,000 and \$20,000. Participants were classified into three categories according to their smoking habits: current smokers if they reported having smoked 100 cigarettes during their lifetime and were still smoking; former smokers if they had previously smoked at least 100 cigarettes in their lifetime and have stopped smoking; and all other participants were classified as never smokers. Respondents were classified as alcohol abstainers if they reported no alcohol consumption in their lifetime or who have abstained in the past 30 days. Light-to-moderate drinkers were men that consumed up to two drinks per day and women that consumed up to one drink per day. Individuals that reported an alcohol intake that exceeded the American Dietary Guidelines cutoff points were classified as heavy drinkers (more than two drinks per day in men and more than one drink per day in women) (18). Participants 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.

Anthropometric measurements were performed following the NHANES III Anthropometric Procedure Videos (19). WC was determined with a measuring tape at the high point of the iliac crest at minimal respiration. Current body weight in kilograms was assessed using a Cardinal Detecto digital scale (Cardinal/Detecto, Webb City, Mo), and a portable Seca stadiometer (Seca Corporation, Hanover, MD) was used to measure the height in meters. Body mass index (BMI) was classified as underweight (<18.5 kg/m²), normal weight (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²), and obese (≥ 30.0 kg/m²). Three blood pressure measurements were taken 10 minutes apart with an appropriate cuff size and a standard aneroid sphygmomanometer, and the three measurements were averaged. Fasting blood samples were collected to determine the concentrations of total cholesterol, triglycerides, HDL cholesterol, hemoglobin A1c and fasting plasma glucose using commercial enzymatic colorimetric kits (Bayer Diagnostics, Tarrytown, NY). LDL cholesterol levels were estimated indirectly by means of the Friedewald equation.

Definitions of prediabetes and DM

DM was defined as either having responded “yes” to the question "Have you ever been told by a doctor that you have diabetes?" or having a fasting plasma glucose level of at least 126

mg/dL (20, 21). Prediabetes was defined as fasting plasma glucose between 100 and 125 mg/dL (20, 21).

Definition of the HTGW phenotype

Participants were categorized into three phenotype groups as follows: (1) Normal waist-normal triglyceride (NWNT): normal WC (<36 inches for men and <34 inches for women) and normal serum triglyceride levels (<177 mg/dL for men and <133 mg/dL for women); (2) Enlarged waist-normal triglycerides/Normal waist-elevated triglycerides (EWNT/NWET): enlarged WC (≥36 inches for men and ≥34 inches for women) and normal serum triglyceride concentrations (<177 mg/dL for men and <133 mg/dL for women) and normal WC (<36 inches for men and <34 inches for women) and elevated serum triglyceride concentrations (≥177 mg/dL for men and ≥133 mg/dL for women); (3) Hypertriglyceridemic waist (HTGW): enlarged WC (≥36 inches for men and ≥34 inches for women) and elevated serum triglyceride concentrations (≥177 mg/dL for men and ≥133 mg/dL for women). Previous studies have shown that these cutoff points correspond to the values with the optimal sensitivity and specificity among Canadian men and women (7, 22, 23). To assess the possible influence of various diagnostic criteria proposed to define abdominal obesity and hypertriglyceridemia, we conducted sensitivity analyses in which we used ethnic- and gender-specific optimal cutoffs for WC in Latin America (≥36.4 inches in men and ≥37.6 inches in women) (24) and the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) criteria for elevated WC (≥40 inches in men and ≥35 inches in women) and elevated triglycerides (≥150 mg/dL) (25).

Statistical Analysis

Differences in demographic, lifestyle and clinical data across the three phenotype groups were assessed using analysis of variance or Pearson's chi-square tests. To estimate the age-standardized prevalence of the HTGW phenotype according to the 2000 World Standard Population, the direct method of standardization was used (26). Separate logistic regression models were used to estimate the prevalence odds ratio (POR) for prediabetes and DM according to HTGW status after controlling for potential confounders selected a priori based on published associations and biological plausibility. Covariates in the adjusted model included age, physical activity, educational attainment, smoking, alcohol consumption, and family history of DM. Considering that the mechanisms by which visceral adiposity can lead to prediabetes and DM may be different in men and women, we tested for interactions between HTGW phenotype and sex within the fully adjusted model using the likelihood ratio test. A p value of less than 0.05 was considered to be statistically significant. All statistical analyses were performed with STATA software version 11 (StataCorp LP, College Station, TX).

Results

Characteristics of study population

Table 1 compares the baseline characteristics of participants according to the HTGW phenotype. Subjects with the HTGW phenotype were older and reported a lower frequency of heavy alcohol drinking, participation in moderate-intensity or vigorous-intensity physical

activity, and current smoking compared with subjects in the NWNT group ($P<.05$). They also had higher levels of general and abdominal obesity, systolic and diastolic blood pressures, HbA1c and blood glucose levels, and a deteriorated lipid profile ($P<0.001$). Prevalence of DM, cardiovascular disease, and hypertension was also higher in subjects with the HTGW phenotype (Table 1).

The age-standardized prevalence of the HTGW phenotype was 24.4%. Prevalence increased with age, and it peaked in women aged 60–79 years and in men aged 40–59 years. Overall prevalence of HTGW, based on ethnic- and gender-specific cutoff points for WC in Latin Americans (24), was 20.8%, whereas prevalence of HTGW, based on NCEP-ATP III criteria (25), was 20.1% (data not shown). Both criteria yielded prevalence estimates that were significantly higher among males than females ($P<0.05$) (data not shown).

The logistic regression models showed that after adjusting for age, education level, smoking, alcohol consumption, physical activity, and family history of DM, participants with the HTGW phenotype had 5.55 (95% CI: 3.38, 9.13) and 7.28 (95% CI: 3.63, 14.63) greater odds of prediabetes and DM, respectively, compared to subjects with NWNT (Table 3). Among subjects with isolated abdominal obesity or hypertriglyceridemia (EWNT/NWET), the strength of the associations for prediabetes (POR: 3.98; 95% CI: 2.55, 6.22) and DM (POR: 4.41; 95% CI: 2.23, 8.72) were attenuated but remained statistically significant (Table 3).

A significant sex-by-HTGW phenotype interaction was observed in the multivariable model for prediabetes only (Table 4). Men with the HTGW phenotype had a three-fold increased odds of prediabetes compared to men with NWNT (95% CI: 1.34, 7.10). However, women with the HTGW phenotype had a nearly eight-fold increased odds of prediabetes compared to women with NWNT (POR: 7.80; 95% CI: 4.05, 15.00).

When abdominal obesity was defined according to ethnic- and gender-specific cutoff points for Latin Americans, the HTGW remained significantly associated with DM (men: POR: 5.53; 95% CI: 1.93–15.91; women: POR: 4.64; 95% CI: 2.41–8.95) and prediabetes (men: POR: 2.77; 95% CI: 1.22–6.28; women: POR: 4.87; 95% CI: 2.64–8.96). Application of the NCEP-ATP III criteria to define abdominal obesity and hypertriglyceridemia indicated that the HTGW was also significantly associated with DM (men: POR: 4.35; 95% CI: 1.87–10.13; women: POR: 5.40; 95% CI: 2.68–10.90) and prediabetes (men: POR: 3.20; 95% CI: 1.39–7.39; women: POR: 6.47; 95% CI: 3.42–12.24) (Table 4).

Discussion

The major finding of the current study is the higher prevalence odds of prediabetes and DM associated with the HTGW phenotype in this Puerto Rican population. This is the first study assessing the prevalence of the HTGW phenotype and its association with prediabetes and DM in this Hispanic subgroup. The association was strong and remained significant after controlling for the effect of sociodemographic characteristics, selected lifestyles and family history of DM. This finding is consistent with those of Pollex and colleagues who found that the HTGW phenotype was associated with type 2 DM in a Canadian aboriginal population

(OR: 4.96; 95% CI= 2.49–9.88) (27). Only one cohort study in Chinese adults has been performed to date, which assessed the association of the HTGW phenotype and prediabetes (11). The findings indicate that compared with subjects in the NWNT phenotype, only women with the HTGW phenotype were at higher risk for developing prediabetes (OR: 1.51; 95% CI= 1.04–2.19) and DM (OR: 4.64; 95% CI= 1.20–17.97). The findings of Okosun and Boltri (28) suggested that there is a gender and ethnic/racial difference regarding the association between the HTGW phenotype and type 2 DM, with Black men (OR: 3.94; 95% CI= 2.85–3.90) and women (OR: 5.62; 95% CI= 1.04–9.42) with the HTGW phenotype having higher odds of type 2 DM, compared to their White counterparts. In the current study, separate multivariable analysis for men and women indicated that the strength of the association of the HTGW phenotype and DM was similar in both sexes. However, the sex-specific analysis suggested a gender difference between HTGW and prediabetes.

The mechanism behind the strong association observed with the HTGW phenotype and both prediabetes and DM remains unclear. A central pattern of body fat distribution, particularly an increased amount of visceral fat, is an independent risk factor for type 2 DM. Subjects with a selective excess of intra-abdominal, or visceral adipose tissue are at substantially higher risk of being characterized by insulin resistance and by the features of the metabolic syndrome (29). Visceral adipocytes increase the release of free fatty acids into the portal vein which can inhibit glucose uptake. An increased secretion of insulin compensates temporarily for these alterations, but the continuous presence of these triggering conditions may promote the development of type 2 DM (30). The evidence up-to-date suggests that the HTGW phenotype offers advantages on discriminating visceral from subcutaneous adiposity among abdominal obese individuals (6). Moreover, in the current study higher prevalence of DM was more common among adults with HTGW irrespective of gender, while the HTGW phenotype was more strongly associated with prediabetes in women compared to men. Even though the explanation for these difference remain to be elucidated, it could be related to gender differences in the patterns of visceral fat accumulation as well as adipose tissue distribution (31). As a phenotype of visceral obesity associated with DM development in adults, in the clinical practice more attention should be paid to young adults with HTGW in order to prevent the premature incidence of DM and prediabetes among this population.

In agreement with previous studies, this study identified a high prevalence of the HTGW phenotype (27.9%), a figure consistent with the prevalence of the HTGW phenotype found in adults from the United Kingdom (30%) (32). The prevalence of HTGW phenotype for males observed in our study (25.4%) was higher than the figures reported among men from the Quebec Health Survey (19%) (23) and a cohort of French men (12.1%) (33). Despite the use of different cutoff points, the prevalence of this phenotype was also higher than that reported for men (13.1%) who participated in the 2003–2004 National Health and Nutrition Examination Survey (28). In females, the prevalence of the HTGW phenotype (29.1%) was lower in our study population compared to the prevalence observed by Blackburn and colleagues (2012) in a sample of women from Chicoutimi, Canada (40.6%) (12).

Because of the lack of diagnostic criteria for the HTGW phenotype, sensitivity analyses of the prevalence of the HTGW phenotype and its association with DM and prediabetes in our

population was carried out using the ethnic- and gender-specific cutoff points proposed for various Latin American and Caribbean countries (36.4 inches for males and 37.6 inches for females) (24) and NCEP-ATP III criteria (25). These analyses led to a reduction in the prevalence of the HTGW phenotype and in the strength of the association for both prediabetes and DM. These findings may be partially explained by differences in the strength of the association between obesity indicators and cardiometabolic risk across ethnic groups (34). Since commonly used cut-off points for WC have been based on studies conducted predominantly in populations of European origin (32), further research is needed to identify the most appropriate sex- and ethnicity-specific cutoff points for WC, allowing for a more accurate estimation of the prevalence of the HTGW phenotype across populations (35, 36).

Some limitations are noteworthy in the interpretation of results from this study. First, our study was restricted to the San Juan Metropolitan Area, thus caution should be exercised when generalizing the results to the overall population of Puerto Rico. Second, due to the cross-sectional design of this study, the association of HTGW and prediabetes and DM cannot be established as causal in nature. Detailed information on nutrient intake was not available, thus, the possibility of residual confounding due to measurement error cannot be excluded. However, results of the present study provide further evidence that the HTGW phenotype represents a simple and useful tool to identify individuals likely to be characterized with greatest metabolic risk, including prediabetes and DM. These limitations must be balanced against the strengths of this study, which include a random, population-based study of a Hispanic subgroup across a broad age range, a high response rate, precise methods used for assays and body composition measurements, extensive data from the face-to-face interview and biological plausibility with most of the findings.

Due the growing prevalence of overweight and obesity worldwide, public health efforts are focusing on developing indicators for early identification individuals at substantial risk to progress to DM and thereby enable better prevention, diagnosis, and treatment of its long-term cardiometabolic abnormalities (25). Based on the results observed in our study, HTGW phenotype may be a useful screening tool to detect early individuals at risk of prediabetes and DM. However, further prospective investigations are necessary to understand the predictive usefulness of the HTGW phenotype as a DM risk indicator.

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Table I

Baseline characteristics of study participants across HTGW phenotype groups, San Juan Metropolitan Area, Puerto Rico, 2005–2007 (n=858).

Characteristics	NWNT ^d (n=241)	EWNT/NWET ^e (n=378)	HTGW ^f (n=239)	P-value
Demographic data				
Age ^a (years)	42.1 ± 16.7	50.1 ± 15.7	54.5 ± 13.5	<0.001
Sex (%)				0.13
Male	31.5	38.1	31.4	
Female	68.5	61.9	68.6	
Health care coverage (%)				0.67
Private	39.8	39.0	44.1	
Public	50.2	50.9	48.3	
None	10.0	10.1	7.6	
Annual family income (%)				0.97
<20,000	66.7	67.1	67.8	
\$20,000	33.3	32.9	32.2	
Lifestyle data				
Current drinking (%)				0.006
None	15.3	8.7	7.1	
Light-to moderate	62.7	70.1	76.2	
Heavy	22.0	21.2	16.7	
Moderate/vigorous physical activity (%)				0.01
Yes	44.4	39.7	31.4	
No	55.6	60.3	68.6	
Tobacco use (%)				< 0.001
Never smoker	61.8	60.9	61.1	
Former smokers	10.8	21.0	23.4	
Current smokers	27.4	18.1	15.5	
Clinical data				
BMI ^a (kg/m ²)	24.1 ± 3.7	31.3 ± 6.2	32.7 ± 6.1	<0.001
Overweight (BMI: 25.0–29.9 kg/m ²) (%)	38.1	38.9	34.7	<0.001
Obesity (BMI ≥ 30.0 kg/m ²) (%)	4.9	51.3	60.3	<0.001
Waist circumference ^a (inches)	30.4 ± 2.9	38.6 ± 5.0	39.7 ± 4.3	<0.001
Waist-to-hip ratio ^a	0.80 ± 0.07	0.89 ± 0.09	0.91 ± 0.08	<0.001
Systolic blood pressure ^a (mm Hg)	108.9 ± 15.2	122.7 ± 22.5	127.2 ± 19.3	<0.001
Diastolic blood pressure ^a (mm Hg)	66.9 ± 9.1	74.1 ± 10.6	77.2 ± 11.1	<0.001
Hemoglobin A1c ^a (%)	5.7 ± 0.8	6.4 ± 1.6	6.9 ± 1.8	<0.001
Blood glucose ^a (mg/dl)	95.1 ± 23.4	112.9 ± 42.2	132.8 ± 65.5	<0.001

Characteristics	NWNT ^d (n=241)	EWNT/NWET ^e (n=378)	HTGW ^f (n=239)	P-value
Blood glucose level (%)				<0.001
Normal (< 100 mg/dl)	82.5	44.7	31.0	
Pre-diabetes (100 – 125 mg/dl)	14.5	37.6	38.9	
Diabetes (≥ 126 mg/dl)	3.0	17.7	30.1	
Total blood cholesterol (mg/dl)	173.2 ± 34.0	188.4 ± 40.2	214.0 ± 47.7	<0.001
HDL cholesterol ^a (mg/dl)	52.9 ± 15.0	49.5 ± 12.3	45.5 ± 10.7	<0.001
LDL cholesterol ^a (mg/dl)	103.5 ± 27.4	118.6 ± 39.3	130.2 ± 44.2	<0.001
Triglycerides ^a (mg/dl)	84.1 ± 29.7	120.8 ± 101.2	233.2 ± 106.2	<0.001
DM ^b (%)	4.6	24.1	34.7	<0.001
History of cardiovascular disease ^c (%)	2.1	4.8	7.1	0.03
History of hypertension ^c (%)	15.0	45.0	54.6	<0.001

Abbreviations: BMI, body mass index; hemoglobin A1c; NWNT, normal waist normal triglyceride; EWNT/NWET, enlarged waist normal triglyceride or normal waist elevated triglyceride; HTGW, hypertriglyceridemic waist phenotype.

^a Mean ± SD

^b Based on self-reported diagnosis and fasting glucose levels.

^c Based on self-reported diagnosis.

^d NWNT (normal waist-normal triglycerides) was defined as normal waist (<36 inches for men and <34 inches for women) and normal triglycerides (<177 mg/dL for men and <133 mg/dL for women).

^e EWNT/NWET (enlarged waist-normal triglycerides/normal waist-elevated triglycerides) was defined as enlarged waist (≥ 36 inches for men and ≥ 34 inches for women) and normal triglycerides (<177 mg/dL for men and <133 mg/dL for women); normal waist (<36 inches for men and <34 inches for women) and elevated triglycerides (≥ 177 mg/dL for men and ≥ 133 mg/dL for women).

^f HTGW (hypertriglyceridemic waist) was defined as enlarged waist (≥ 36 inches for men and ≥ 34 inches for women) and elevated triglycerides (≥ 177 mg/dL for men and ≥ 133 mg/dL for women).

Table II

Prevalence of the HTGW phenotype by sex on a sample of 858 Puerto Rican adults living in the San Juan metropolitan area.

Category	Total	Men	Women
	Prevalence (%)	Prevalence (%)	Prevalence (%)
Overall	27.9	25.4	29.1
Age-standardized	24.4	23.7	24.8
Age-specific			
21–39 years	13.8	17.8	11.8
40–59 years	33.2	29.8	34.9
60–79 years	35.4	27.7	39.9

Table III

Prevalence odds ratio (POR) between prediabetes and DM and the HTGW phenotype among Puerto Rican adults living in the San Juan Metropolitan Area (n=858).

Phenotype	Age-adjusted model		Multivariable model ^a	
	POR (95% CI)	P-Value	POR (95% CI)	P-Value
Prediabetes				
NWNT ^{bc}	1.00		1.00	
EWNT/NWET ^d	4.24 (2.74–6.55)	<0.001	3.98 (2.55–6.22)	<0.001
HTGW ^e	5.67 (3.50–9.22)	<0.001	5.55 (3.38–9.13)	<0.001
Diabetes				
NWNT ^{bc}	1.00		1.00	
EWNT/NWET ^d	5.13 (2.63–10.03)	<0.001	4.41 (2.23–8.72)	<0.001
HTGW ^e	7.45 (3.76–14.76)	<0.001	7.28 (3.63–14.63)	<0.001

Abbreviations: NWNT, normal waist normal triglyceride; EWNT/NWET, enlarged waist normal triglyceride or normal waist elevated triglyceride; HTGW, hypertriglyceridemic waist phenotype.

^a Adjusted for age, sex, physical activity, education level, smoking, alcohol consumption, and family history of DM. First-order interaction terms in the adjusted models were not significant (p>0.05).

^b Reference group.

^c NWNT (normal waist-normal triglycerides) was defined as normal waist (<36 inches for men and <34 inches for women) and normal triglycerides (<177 mg/dL for men and <133 mg/dL for women).

^d EWNT/NWET (enlarged waist-normal triglycerides/normal waist-elevated triglycerides) was defined as enlarged waist (≥36 inches for men and ≥34 inches for women) and normal triglycerides (<177 mg/dL for men and <133 mg/dL for women); normal waist (<36 inches for men and <34 inches for women) and elevated triglycerides (≥177 mg/dL for men and ≥133 mg/dL for women).

^e HTGW (hypertriglyceridemic waist) was defined as enlarged waist (≥36 inches for men and ≥34 inches for women) and elevated triglycerides (≥177 mg/dL for men and ≥133 mg/dL for women).

Table IV

Prevalence odds ratio (POR) between prediabetes and DM and the HTGW phenotype among Puerto Rican men and women living in the San Juan Metropolitan Area using different cutoff points for HTGW (n=858).

Phenotype	Model 1 ^{ac} POR (95%CI)	Model 2 ^{ad} POR (95%CI)	Model 3 ^{ae} POR (95%CI)
Prediabetes			
Men			
NWNT ^b	1.00	1.00	1.00
EWNT/NWET	3.56 (1.77–7.17)	3.48 (1.75–6.89)	2.32 (1.23–4.38)
HTGW	3.08 (1.34–7.10)	2.77 (1.22–6.28)	3.20 (1.39–7.39)
Women			
NWNT ^b	1.00	1.00	1.00
EWNT/NWET	4.79 (2.60–8.84)	2.87 (1.78–4.63)	3.64 (2.19–6.05)
HTGW	7.80 (4.05–15.00)	4.87 (2.64–8.96)	6.47 (3.42–12.24)
Diabetes			
Men			
NWNT ^b	1.00	1.00	1.00
EWNT/NWET	5.87 (1.88–18.34)	4.10 (1.54–10.93)	2.69 (1.28–5.65)
HTGW	7.68 (2.30–25.61)	5.53 (1.93–15.91)	4.35 (1.87–10.13)
Women			
NWNT ^b	1.00	1.00	1.00
EWNT/NWET	3.58 (1.54–8.36)	2.38 (1.30–4.36)	2.53 (1.31–4.88)
HTGW	6.99 (2.99–16.34)	4.64 (2.41–8.95)	5.40 (2.68–10.90)

Abbreviations: NWNT, normal waist normal triglyceride; EWNT/NWET, enlarged waist normal triglyceride or normal waist elevated triglyceride; HTGW, hypertriglyceridemic waist phenotype.

^a Adjusted for age, physical activity, education level, smoking, alcohol consumption, and family history of DM.

^b Reference group.

^c HTGW (hypertriglyceridemic waist) phenotype was defined as waist circumference ≥ 36 inches for men and ≥ 34 inches for women and elevated serum triglyceride concentrations ≥ 177 mg/dL for men and ≥ 133 mg/dL for women.

^d HTGW (hypertriglyceridemic waist) phenotype was defined using ethnic- and gender-specific cutoffs points for elevated WC among Latin Americans (≥ 36.4 inches in men and ≥ 37.6 inches in women) and elevated serum triglyceride concentrations ≥ 177 mg/dL for men and ≥ 133 mg/dL for women.

^e HTGW (hypertriglyceridemic waist) phenotype was defined using NCEP-ATP III criteria for elevated WC (≥ 40 inches in men and ≥ 35 inches in women) and elevated triglycerides concentrations (≥ 150 mg/dL).