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Asian Americans Have Greater Prevalence of Metabolic Syndrome Despite Lower Body Mass Index

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Abstract

Objective—To examine the relationship between body mass index and metabolic syndrome for Asian Americans and non-Hispanic Whites, given that evidence shows racial/ethnic heterogeneity exists in how body mass index predicts metabolic syndrome.

Research Design and Methods—Electronic health records of 43 507 primary care patients aged 35 years and older with self-identified race/ethnicity of interest (Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese, or non-Hispanic White) were analyzed in a mixed-payer, outpatient-focused healthcare organization in the San Francisco Bay Area.

Results—Metabolic syndrome prevalence is significantly higher in Asians compared to non-Hispanic Whites for every body mass index category. For women at the mean age of 55 and body mass index of 25 kg/m^2, the predicted prevalence of metabolic syndrome is 12% for non-Hispanic White women compared to 30% for Asians; similarly for men, the predicted prevalence of metabolic syndrome is 22% for non-Hispanic Whites compared to 43% of Asians. Compared to non-Hispanic White women and men with a body mass index of 25 kg/m^2, comparable prevalence of metabolic syndrome was seen at body mass index of 19.6 kg/m^2 for Asian women and 19.9 kg/m^2 for Asian men. A similar pattern was seen in disaggregated Asian subgroups.

Conclusions—Despite lower body mass index values and lower prevalence of overweight/obesity than non-Hispanic Whites, Asian Americans have higher rates of metabolic syndrome over the range of body mass index. Our results indicate that body mass index ranges for defining overweight/obesity in Asian populations should be lower than for non-Hispanic Whites.

Keywords

Obesity; Metabolic Syndrome; Racial Differences; Asian; Population Study

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Introduction

Metabolic syndrome is a constellation of multiple metabolic risk factors that greatly increases risk for cardiovascular mortality1 and Type 2 diabetes.2 Metabolic syndrome is currently defined by the National Cholesterol Education Program Expert Panel in Adult Treatment Panel III (NCEP ATP III) as the presence of three or more of the following factors: elevated fasting glucose (≥100 mg/dL), elevated blood pressure (≥130/85 mmHg), reduced high-density lipoprotein (HDL) (men <40 mg/dL, women <50 mg/dL), and elevated triglycerides (≥150 mg/dL), and an elevated waist circumference (≥40 inches for men, ≥35 inches for women).3 Prospective population studies of people with metabolic syndrome have shown a two-fold increase in relative risk for cardiovascular disease (CVD) events4 and a five-fold increase for developing diabetes compared to people without the syndrome.2 Therefore, the components of metabolic syndrome are important treatment targets for reducing CVD and diabetes.

The NCEP ATP III identifies overweight, obesity and physical inactivity, along with genetic factors that enhance insulin resistance, as the root causes of the metabolic syndrome.3 The San Antonio Heart Study and the Insulin Resistance Atherosclerosis Study, both population-based longitudinal studies, showed both body mass index (BMI) and waist circumference to be highly predictive of the onset of metabolic syndrome.5,6 Subjects with a baseline BMI >30 kg/m^2 were between 3 and 8 times more likely to develop metabolic syndrome than those with a BMI <25 kg/m^2.5 Thus, targeting obesity and obesity-related factors seems to be the most potent strategy to prevent or manage metabolic syndrome.

Currently, the Centers for Disease Control and Prevention (CDC) defines overweight as having a BMI ≥25 kg/m^2 and obese as having a BMI ≥30 kg/m^2. These BMI ranges serve to "assess someone's likelihood of developing overweight- or obesity-related diseases."7 However, there is evidence that BMI predicts metabolic syndrome differently across racial/ethnic groups.

Racial/ethnic differences in the relationship between BMI and metabolic syndrome have been documented among non-Hispanic Whites (NHWs), African Americans, and Hispanics. Non-obese African American women have higher levels of fasting glucose at the same BMI levels as non-obese NHW women.8,9 Overweight Hispanic women have higher levels of fasting glucose when compared to overweight NHW and African American women.9 Hispanic adults are also reported to have greater fasting insulin levels and resistance than NHWs after adjusting for age and BMI.10

The relationship between BMI and metabolic syndrome has not been explored in Asian Americans. Asians in general have been documented to have higher risk of cardiovascular disease and Type 2 diabetes at lower BMI than European populations. International studies conducted among different Asian subgroups in China, Korea, Philippines, Singapore, and Taiwan have shown this increased risk.11–20 Based on this evidence, a World Health Organization (WHO) expert consultation recommended lower BMI ranges for overweight and obese in Asian populations.21 Specifically, they recommended 23–27.4 kg/m^2 for overweight, and 27.5 kg/m^2 and higher for obese. However, Asians living in their countries

of origin may have very different nutritional and physical activity profiles than Asians who have immigrated to and are living in the US. Due to these important environmental differences, it is unclear whether these international guidelines for Asians are appropriate for Asian Americans. We sought to examine the relationship between BMI and metabolic syndrome for Asian Americans and NHWs in a large, ethnically diverse healthcare organization to evaluate whether there is evidence that ethnic-specific BMI ranges for overweight and obesity are more appropriate for Asian Americans than the CDC BMI ranges.

Patients and Methods

Setting

The Palo Alto Medical Foundation (PAMF) is a mixed-payer, outpatient-focused healthcare organization in the San Francisco bay area of northern California. PAMF has 30 clinics and provides care for approximately 600 000 active patients.

Inclusion/Exclusion

A cross-sectional sample of patient electronic health records from January 1, 2006 – December 31, 2008 was studied. A record was eligible for analysis if the patient: 1) had been seen at least once in a primary care department during the cross-sectional period; 2) was aged 35 years and older as of January 1, 2006; and 3) had a self-identified race/ethnicity22 of: Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese or NHWs. Additionally, patients with a distinctly high number of visits (>29 visits in 3 years, 1% of the population), and measurements taken during pregnancy (0.2%) were excluded. No patients were contacted for the study, which received approval from the Palo Alto Medical Foundation Institutional Review Board on August 14, 2008.

Clinical Definitions

The definition of metabolic syndrome was based on the NCEP ATP III guidelines.3 Waist circumference was not consistently available in the electronic health records, so BMI was used to define overweight (BMI: 25.0–29.9 kg/m^2) or obese (BMI ≥30.0 kg/m^2), as demonstrated in previous national studies.23–25 To avoid circularity when describing the association between BMI and metabolic syndrome, we excluded the BMI criterion from the five criteria and instead defined metabolic syndrome as any two of the remaining four criteria. The electronic health record data elements for the definition are shown in Table 1. Metabolic syndrome was additionally defined as having an ICD-9 code 277.7 (physician-diagnosed metabolic syndrome, which was present in only 2% of total participants with metabolic syndrome). While our redefinition of metabolic syndrome reduces the comparability of our prevalence rates to other studies, our focus is on the internal comparison between Asian Americans and NHWs, for whom it is similarly defined.

Statistical Analysis

Univariate—Patient demographics and characteristics were described using means and proportions. Means were compared using ANOVA and Tukey comparisons. Proportions of

individual metabolic syndrome components were calculated with binomial confidence intervals.

Multivariate—First, we sought to compare the age-adjusted prevalence rates of metabolic syndrome across different Asian subgroups and BMI categories compared to NHWs. Multiple anthropometric measures and laboratory results were available for each patient. To take advantage of all available measures, we needed to account for the correlation of repeated measures from the same patient. To address this, we used generalized estimating equations (GEE) with a logit link function and unstructured working correlation structure. Prevalence rates were calculated using the predicted probability from the GEE model and termed predicted prevalence rates. Models included age, age2, and racial/ethnic group. Terms including age were centered to the mean, and the age2 covariate was included to allow for non-linear contributions of age. We reported the age-adjusted prevalence rate for four separate BMI categories: normal (BMI: 18.5–24.9 kg/m^2), overweight (BMI: 25.0–29.9 kg/m^2), class I obesity (BMI: 30.0–34.9 kg/m^2) and class II obesity (BMI: 35.0–39.9 kg/m^2) (Figure 1).

Next, we investigated the relationship of metabolic syndrome with BMI, by racial/ethnic group. Models included age, age2, BMI, racial/ethnic group, and BMI*racial/ethnic group. The interaction terms between BMI and each racial/ethnic group are included in the models so that we can examine whether the effect of BMI on the outcomes differs by race/ethnicity. For example, the additional effect if any of being Asian with high BMI values beyond being Asian or having high BMI values separately. The predicted prevalence was estimated at fixed values of age and plotted against BMI. Statistical significance was determined using the standardized difference in predicted prevalences between racial/ethnic groups on the logit scale. To investigate the relationship of metabolic syndrome and BMI at different ages, results were presented at the representative ages of 35 years, the mean age, and 65 years. We repeated this investigation on metabolic syndrome components.

Prevalence rates are presented with 95% confidence intervals or bands. Since 320 models were examined during this study, a Bonferroni type correction was applied and statistical significance was determined at $P<0.00016$. All statistical analyses were performed using SAS 9.2 (Cary, NC).

Results

Electronic health record data from 43 507 unique patients were included in the analyses (Table 2). The number of unique patients in each racial/ethnic group ranged from 413 in the Korean group to 32 406 in the NHW group. The proportion of women ranged from 46% in Asian Indians to 68% in Japanese. Asian patients as a group were younger than NHWs and had lower BMIs than NHWs. The exception was Filipinos who had BMIs similar to NHWs. The proportion overweight (BMI: 25–30 kg/m^2) among Asians was lower than for NHWs, with the exceptions of Asian Indians and Filipinos. The proportion obese (BMI ≥30 kg/m^2) was lower for all Asian groups than for NHWs. Type 2 diabetes or impaired fasting glucose (IFG), low HDL, and hypertriglyceridemia were all more common among Asians than NHWs.

Age-adjusted metabolic syndrome prevalence rates are presented for four BMI categories (Figure 1). Metabolic syndrome is higher in Asians overall than NHWs within every BMI category. The differences are particularly noteworthy in the overweight category where the rates are 25% for NHWs and 48% for Asians ($P<0.00016$). Among the Asian subgroups, Asian Indians and Filipinos have uniformly higher prevalence of metabolic syndrome for every BMI category.

Figure 2 shows predicted prevalence of metabolic syndrome in NHWs and all Asians over the continuum of BMI. Results were presented for the representative ages of 35 years, the mean age of 55, and 65 years. Compared to NHWs, the predicted prevalence of metabolic syndrome was higher for all Asians at every BMI level over a range of ages. These differences were more pronounced at BMI values 25–30 kg/m^2 but were still significantly different over BMI values from 18–35 kg/m^2.

For a fixed BMI value, the predicted prevalence of metabolic syndrome can be compared. At the mean ages, a BMI of 25 kg/m^2 in women corresponded to a predicted prevalence of metabolic syndrome of 12% for NHWs, compared to 30% for Asians. For men with a BMI of 25 kg/m^2, the probability of metabolic syndrome is 22% for NHWs compared to 43% for Asians. Additionally, for a fixed BMI value in NHWs, the corresponding predicted prevalence of metabolic syndrome has a different BMI value in Asians. Compared to NHWs with a BMI of 25 kg/m^2, comparable prevalence was seen at a BMI of 19.6 kg/m^2 for Asian women and 19.9 kg/m^2 for Asian men. At higher levels of obesity, the racial/ethnic differences are just as evident. Compared to NHWs with a BMI of 30 kg/m^2, Asian women with a BMI of 23.9 kg/m^2 and Asian men with a BMI of 24.3 kg/m^2 had comparable prevalences. Similar patterns were observed across all Asian subgroups (not shown).

Figure 3 shows the predicted prevalence of individual metabolic syndrome components for NHWs and all Asians, over the continuum of BMI and at the mean age. For diabetes or IFG, Asians had uniformly higher predicted prevalence than NHWs across all BMI values in women and men. For high blood pressure, Asians had higher predicted prevalence than NHWs for BMI values greater than 25 kg/m^2 in women and men. For both low HDL and hypertriglyceridemia, Asian women had uniformly higher predicted prevalence for BMI less than 36 kg/m^2 and Asian men had higher predicted prevalence than NHWs for BMIs less than 31 kg/m^2.

Discussion

Obesity, as measured by BMI, is a well-known risk factor for metabolic syndrome. There are many studies that question the validity of BMI as a marker of obesity in Asian populations, given data suggesting higher adiposity at similar levels of BMI.17,26,27 While more precise measures of adiposity such as waist circumference, CT scans, and DEXA scans may be preferable to BMI to define obesity, BMI is without question the most cost-effective approach. Waist circumference commonly uses four body sites for measurement, and no consensus exists on the optimum site for measurement, especially since it may differ by sex. 28–30 Another study in which both waist circumference and BMI are available for all participants shows that BMI and waist circumference are highly correlated in specific racial/

ethnic populations (NHWs, African Americans, and Hispanics), although Asians or Asian subgroups were not examined.31 CT scans and DEXA scans have been used in research settings, but are too expensive to be routinely employed in clinical or public health settings. BMI has proved to be a reliable measure of adiposity, or total body fat, irrespective of height.26,32–34 Moreover, the National Institutes of Health35 and the World Health Organization36 have proposed using BMI as a method for defining overweight and obesity. Given the expense, difficulty, and debatable additional utility of more specialized measures of obesity, it may be preferable to customize BMI ranges to better define overweight/obesity for specific subpopulations than propose more accurate measurement approaches.

Racial/ethnic differences in the relationship between BMI and metabolic syndrome risk have previously been documented among African Americans and Hispanics in the US.8,9,37–39 Our study is the first to examine the relationship between BMI and metabolic syndrome in Asian Americans, and in Asian subgroups in the US. Given the heterogeneity of the Asian American population, future studies of Asians in the US should strive to disaggregate these diverse populations. International studies conducted among different Asian national populations in China, Korea, Philippines, Singapore, and Taiwan have shown increased risk of Type 2 diabetes and cardiovascular disease at lower BMI than European populations.11–20 Other international societies, such as the International Diabetes Federation,40 suggest population-specific cut points for obesity, recognizing increased metabolic risk for some populations (Japanese and South Asians) despite similar levels of obesity. Our findings in Asian populations in the US corroborate this increased disease risk for metabolic syndrome at lower BMI. While there is limited sample size to make robust comparisons among the Asian American subgroups, our data strongly suggest heterogeneity among Asian American subgroups. For example, Japanese patients in our population have higher HDL than the other Asian subgroups. Confirming the contrasts among Asian populations that we observe in other study groups would advance our understanding of this apparent heterogeneity.

A strength of our study is that the subgroups examined have similar healthcare access, socioeconomic status, and geographic location. The distribution of Asian subgroups in the PAMF population is approximately equal to the proportions observed in the US.41 Previous work in the PAMF population has shown sufficient validity of the electronic health records42 to provide accurate disease estimates. Limitations of this study include it being conducted a single geographic area with somewhat limited sample size in the smaller Asian subgroups (i.e. Korean and Vietnamese populations). The PAMF population is insured (30% PPO, 60% HMO, 10% Medicare), and thus under-represents the medically underserved. However, these limitations that affect the generalizability of the sample also minimize unmeasured confounding and therefore improve the internal validity of our comparisons; any racial/ethnic differences observed in the PAMF clinical population will likely only be magnified in the general population.

We found that Asian Americans generally have lower mean BMI values and lower prevalence of overweight and obesity than NHWs when using traditional BMI ranges in our population of insured northern Californians. However, despite lower BMI, Asian Americans have higher rates of metabolic syndrome for each BMI category (normal, overweight, class I obesity, class II obesity). Over the BMI continuum, Asians are more likely to manifest

metabolic syndrome than NHWs. This is true for most of the components of the metabolic syndrome as well. These findings support the WHO recommendation for lower BMI ranges for defining overweight and obesity in Asian populations, including Asian Americans, than for NHWs. Using lower BMI ranges for Asian Americans would allow for earlier and more appropriate screening for the components of metabolic syndrome and may improve preventive efforts.

Asian Americans have higher prevalence of metabolic syndrome than NHWs at each level of BMI. Accurate and early diagnosis of overweight and obesity in Asian Americans is critical to stem the rising tide of metabolic syndrome and Type 2 diabetes in this rapidly growing population within the US. Our work adds to the growing body of evidence that population-specific BMI ranges are necessary for accurate, timely diagnosis of overweight and obesity to prevent metabolic diseases.

Acknowledgments

All research conducted for this study was approved by the Palo Alto Medical Foundation Institutional Review Board. This material has not been published previously (either in print or electronically) and is not under consideration for publication elsewhere. The study was presented as an abstract at the American Heart Association Joint Conference for Cardiovascular Disease Epidemiology and Prevention and Nutrition, Physical Activity and Metabolism, March 10–14, 2009. This study is supported by the American Heart Association 0885049N: Asian American Heart Study; and NIDDK/NIH 1 R01 DK081371-01A1: Identifying Disparities in Type 2 Diabetes Among Asian Americans: The Pan Asian Cohort Study.

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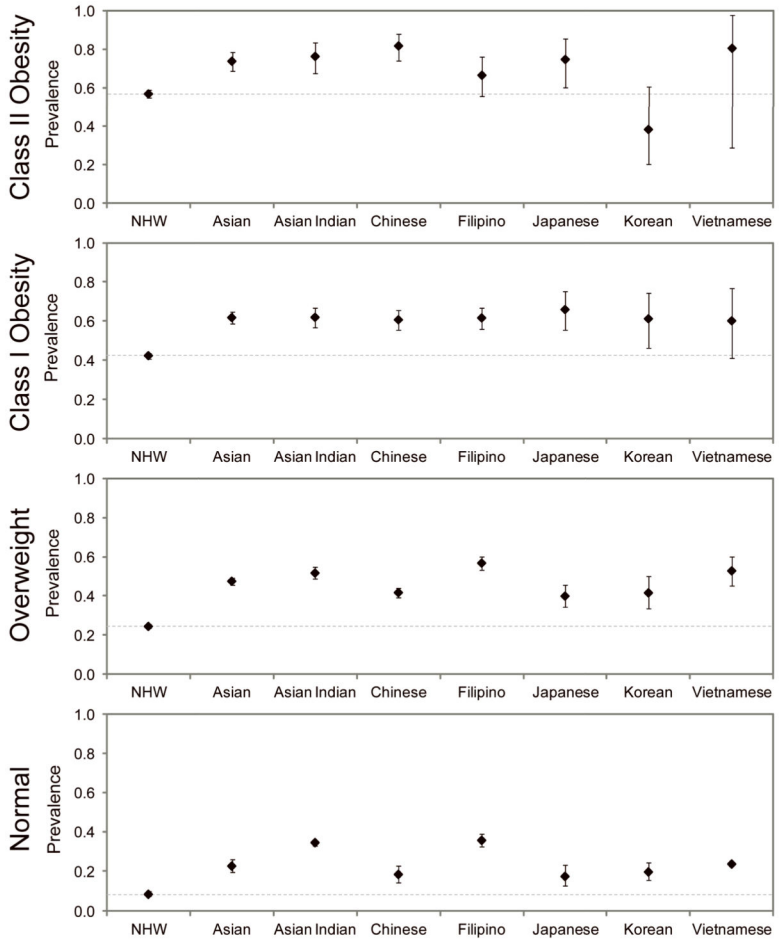

Figure 1. Age-Adjusted Prevalence of Metabolic Syndrome for Separate BMI Categories by Racial/Ethnic Subgroup

Normal (BMI: 18.5–24.9 kg/m^2), Overweight (BMI: 25.0–29.9 kg/m^2), Class I Obesity (BMI: 30.0–34.9 kg/m^2), Class II Obesity (BMI: 35.0–39.9 kg/m^2). The 95% confidence intervals are included.

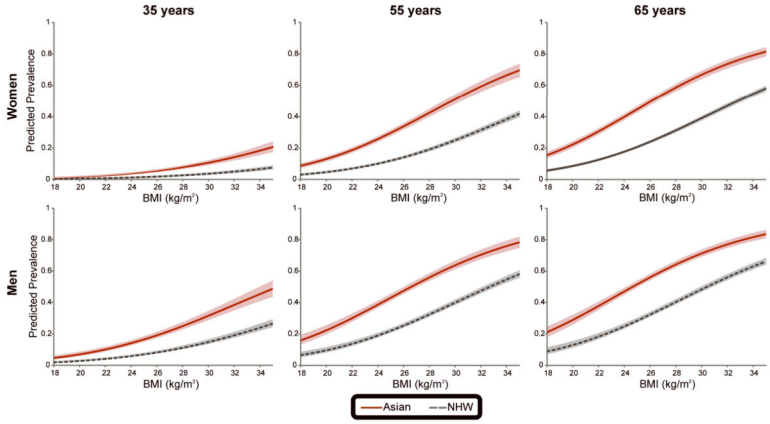

Figure 2. Predicted Prevalence of Metabolic Syndrome by BMI

Asians are compared to NHWs (women, men) for ages 35, 55, and 65 years. The 95% confidence bands are included.

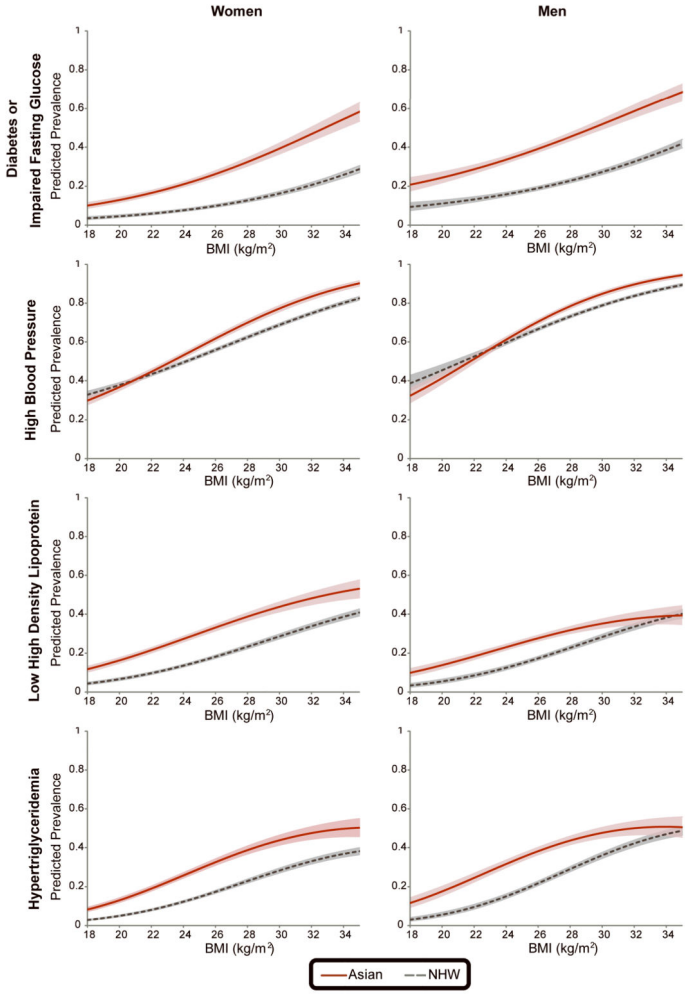

Figure 3. Predicted Prevalence of Metabolic Syndrome Components by BMI

Diabetes or IFG, high blood pressure, low high density lipoprotein, and hypertriglyceridemia are compared in Asians and NHWs. The 95% confidence bands are included.

Table 1

Definition of Metabolic Syndrome

Metabolic Syndrome Component	Definition	
Diabetes or Impaired fasting glucose (IFG)	ICD-9 250.X, 250.X0, 250.X2, 790.21;	-OR- ICD-9 277.7
	Fasting glucose ≥100 mg/dL;	
	Random glucose ≥200 mg/dL; OR	
	Use of hypoglycemic medications	
High blood pressure	ICD-9 401.0, 401.1, 401.9, 796.2;	
	At least one blood pressure ≥130/85 mmHg; OR	
	Use of blood pressure medications	
Low high-density lipoprotein cholesterol (HDL)	At least one HDL <50 mg/dL (women) or <40 mg/dL (men)	
Hypertriglyceridemia	At least one triglyceride ≥150 mg/dL	
Obesity*	Overweight (BMI: 25.0–29.9 kg/m^2) or obese (BMI ≥30 kg/m^2)	

* Obesity is excluded from metabolic syndrome criteria when examining association between BMI and metabolic syndrome

Table 2

Patient Characteristics

Characteristics	NHW	Asian (all)	Asian Indian	Chinese	Filipino	Japanese	Korean	Vietnamese
Sample size	32,406	11,101	2,679	5,310	1,379	837	413	483
Women, (%)	58%	58%	46% +*	60%	65% +	68% +*	68% +	64%
Age, mean (SD), y	57 (13.4)	50 (12.0) +	46 (10.1) +*	51 (12.3) +*	50 (11.0) +	56 (14.1) *	47 (11.2) +	48 (10.5) +
BMI, mean (SD), kg/m2	26.5 (4.6)	24.6 (3.8) +	25.8 (3.7) +*	23.8 (3.3) +*	26.5 (4.1) *	24.4 (4.1) +	24.0 (3.7) +	23.5 (3.2) +*
Prop. of Overweight (%)	49%	43% +	53% *	36% +*	54% *	42%	37% +	37% +
Prop. of Obese (%)	26%	12% +	17% +*	7% +*	24% *	14% +	8% +	6% +*
BP-Sys, mean (SD), mmHg	124 (14)	119 (14) +	118 (13) +	118 (14) +*	124 (13) *	123 (14) *	117 (14) +	116 (13) +
BP-Dia, mean (SD), mmHg	74 (8)	73 (9) +	74 (8) +	72 (9) +*	76 (8) +*	74 (9)	73 (9)	73 (8) +
Prop. of High BP (%)	69%	54% +	52% +	50% +*	74% *	65% *	53% +	46% +
Glucose (fasting), mean (SD), mg/dL	97 (17)	97 (16)	97 (18)	96 (14)	102 (22) +*	97 (12)	98 (15)	94 (13)
Glucose (random), mean (SD), mg/dL	99 (21)	101 (23) +	101 (25) +	99 (18)	107 (31) +*	101 (20)	99 (18)	97 (18)
Prop. of Diabetes or IFG (%)	19%	24% +	26% +	21%	35% +*	25%	20%	20%
Total Cholesterol, mean (SD), mg/dL	193 (35)	187 (34) +	183 (32) +*	186 (32) +	193 (37) *	196 (35) *	188 (32)	194 (34)
HDL, mean (SD), mg/dL	58 (16)	53 (14) +	47 (12) +*	55 (14) +*	54 (14) +	61 (16) +*	57 (15)	54 (13)
LDL, mean (SD), mg/dL	114 (30)	110 (29) +	110 (28) +	108 (29) +	112 (32)	111 (30)	109 (27)	115 (29)
Prop. of low HDL (%)	25%	35% +	51% +	29% +*	37% +	21% *	28%	36% +
Triglycerides, mean (SD), mg/dL	110 (66)	124 (76) +	133 (77) +*	117 (72) +*	133 (79) +	126 (85) +	117 (80)	127 (74) +
Prop. of Hypertriglyceridemia (%)	25%	34% +	39% +	30% +	41% +	36% +	30%	34%

+ Statistically Significant with NHW at p<0.00016

* Statistically Significant with Asian (all) at p<0.00016