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Cardiometabolic Health in Asians with Diabetes in the US

Andy Menke, PhD¹, Sarah Casagrande, PhD¹, and Catherine C Cowie, PhD²

¹Social & Scientific Systems, Silver Spring, Maryland ²National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health, Bethesda, Maryland

Abstract

Aims—Asians develop diabetes at lower levels of adiposity than people of other race/ethnicities. However, there is limited data investigating the health of US Asians with diabetes. We compared cardiovascular risk factors in US Asians to other race/ethnicities stratified by diabetes status.

Methods—Among 4,645 adults in the 2011–2014 National Health and Nutrition Examination Survey (NHANES), a cross-sectional survey of the US population, odds ratios were calculated for obesity, hypertension, and elevated low-density lipoprotein (LDL) cholesterol associated with race/ethnicity after adjustment for age, sex, income, education, smoking, alcohol consumption, and health insurance.

Results—Overall and stratified by diabetes status, non-Hispanic whites, non-Hispanic blacks, and Mexican-Americans were significantly more likely to be obese compared to non-Hispanic Asians after adjustment. Overall and stratified by diabetes status, adjusted levels of hypertension compared to non-Hispanic Asians was generally similar for non-Hispanic whites and Mexican-Americans and generally more common among non-Hispanic blacks; among those with diagnosed diabetes, the adjusted odds ratios (95% confidence interval) were 1.48 (0.79–2.77), 2.54 (1.49–4.30), and 1.38 (0.73–2.60) for non-Hispanic whites, non-Hispanic blacks, and Mexican-Americans, respectively. Overall and stratified by diabetes status, elevated LDL cholesterol levels were generally similar between non-Hispanic Asians and other race/ethnicities; among those with diagnosed diabetes, the adjusted odds ratios (95% confidence interval) were 0.88 (0.32–2.43), 0.58 (0.24–1.42), and 1.15 (0.29–4.58) for non-Hispanic whites, non-Hispanic blacks, and Mexican-Americans, respectively.

Conclusions—Although non-Hispanic Asians had lower levels of adiposity compared to other race/ethnicities with diabetes, their adjusted levels of hypertension and LDL cholesterol were generally more comparable.

Corresponding author: Andy Menke, Social & Scientific Systems, Inc. 8757 Georgia Avenue, 12th Floor, Silver Spring, MD, 20910, amenke@s-3.com, Phone: 301-628-0331.

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Keywords

Asians; body mass index; hypertension; LDL cholesterol; waist circumference; United States

1. Introduction

In the US, the prevalence of diabetes among Asians was 21% in 2011–2012, which was similar to non-Hispanic blacks and Hispanics and considerably higher than the 11% prevalence found among non-Hispanic whites [1]. The relatively high prevalence among Asians occurs despite a lower body mass index (BMI) compared to other race/ethnic groups. Similarly, previous research found that Asians have a higher prevalence of diabetes at a given waist circumference [2]. This may partly explain why Asians with diabetes in the US are more likely to be undiagnosed than other race/ethnicities, with approximately half unaware of their diabetes, compared to approximately one-third among non-Hispanic whites and non-Hispanic blacks [1]. Despite these substantial differences, there is limited data investigating other aspects of cardiometabolic health among Asians with diabetes in the US. In a study of Veterans Affairs patients with diabetes, Asians had lower levels of glucose control than whites, but there was no difference in cholesterol or blood pressure control [3]. In another study of patients with diabetes in public hospitals, Asian patients had lower levels of glucose control and cholesterol control than white patients [4].

We sought to characterize clinically important cardiovascular risk factors that are routinely assessed in basic medical examinations, including body mass index, blood pressure, and low-density lipoprotein (LDL) cholesterol in US Asians in the general population stratified by diabetes status, and to compare levels of these risk factors to other race/ethnicities. To do so, we used data from the 2011–2014 National Health and Nutrition Examination Survey (NHANES).

2. Materials and Methods

2.1 Study Participants

NHANES is a series of stratified, multistage probability surveys designed to be representative of the US civilian, noninstitutionalized population [5]. NHANES continuously collects data in 2-year cycles since 1999. We limited our analysis to the 2011–2014 years because those were the only years that Asians were oversampled to provide sufficient sample size for precise estimates. The data are collected via an in-home interview and a visit to a mobile examination center. The response rate was 73% and 71% for the interview and 70% and 69% for the examination in 2011–2012 and 2013–2014, respectively. Participants were randomly selected to participate in a morning examination for which they were asked to fast or to an afternoon/evening examination. We used data from the morning sessions. Of 5,315 adults ≥20 years of age, we excluded pregnant women (n=6) and those who self-reported being ‘other race/ethnicity’ comprising subgroups with insufficient statistical power for analysis (n=664). The final sample for our analysis was 4,645 participants, including 2,095 non-Hispanic whites, 1,197 non-Hispanic blacks, 679 non-Hispanic Asians, and 674 Mexican-Americans.

The protocol for the 2011–2014 NHANES was approved by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention research ethics board. All participants gave written informed consent.

2.2 Data Collection

During the in-home interview, standardized questionnaires were used to collect information regarding age, race/ethnicity, sex, education, income, smoking status, alcohol consumption, health insurance, and medication use. A previous diagnosis of diabetes was determined based on a self-reported diagnosis by a doctor or other health professional.

During the examination, height and weight were measured and body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Obesity was defined as having a BMI ≥ 30 kg/m². Waist circumference was measured at the iliac crest and abdominal obesity was defined as a waist circumference >102 cm in men and >88 cm in women. Participants had their blood pressure measured up to three times and hypertension was defined as an average systolic blood pressure ≥ 140 mm Hg, or an average diastolic blood pressure ≥ 90 mm Hg, or current use of antihypertensive medication.

A trained phlebotomist obtained a blood sample according to a standardized protocol. Participants fasted overnight for at least 8 hours (they were excluded if they reported fasting for more than 24 hours). LDL cholesterol was estimated using the Friedewald equation [6] based on measured total cholesterol, high-density lipoprotein (HDL) cholesterol, and triglycerides. Elevated LDL cholesterol was defined as having LDL cholesterol ≥ 100 mg/dL or use of lipid-lowering medication.

A1c was measured using a Tosoh G7 Automated HPLC Analyzer or a Tosoh Automated Analyzer HLC-723G8 (Tosoh Medics, Inc, San Francisco, CA), which had a reportable range of 3.0–19.0% (9–184 mmol/mol) and 3.1–19.5% (10–190 mmol/mol), respectively. The interassay coefficient of variation ranged from 0.4% to 1.3%. Eligible participants were administered a 75 g (or a calibrated dose for participants weighing <94 pounds) glucose load (Trutol) oral glucose tolerance test (OGTT) and a blood sample was drawn 2 hours later. Fasting and 2-hour glucose were measured in plasma by a hexokinase method using a Roche Modular P Chemistry Analyzer or a Roche Cobas C Chemistry Analyzer (Roche Diagnostics, Indianapolis, IN). The interassay coefficient of variation ranged from 0.9% to 3.8%. Undiagnosed diabetes was defined as not having a previous diagnosis of diabetes and having either an A1c level of $\geq 6.5\%$ (48 mmol/mol), a fasting plasma glucose level of ≥ 126 mg/dL, or a 2-hour plasma glucose level of ≥ 200 mg/dL. Prediabetes was defined as not having diabetes and having an A1c level of 5.7–6.4% (39–47 mmol/mol), a fasting glucose level of 100–125 mg/dL, or a 2-hour glucose level of 140–199 mg/dL.

2.3 Statistical Methods

We calculated percentages (standard errors) of participant characteristics by race/ethnicity (non-Hispanic Asian, non-Hispanic white, non-Hispanic black, and Mexican-American). After stratifying by diabetes status and race/ethnicity, we used conditional margins to calculate the unadjusted and adjusted mean BMI and LDL cholesterol using linear regression and the percentage with hypertension using logistic regression. Adjustment

included age, sex, income, education, smoking, alcohol consumption, health insurance, and BMI (except for BMI analysis). We then calculated the odds ratios of obesity, hypertension, and elevated LDL cholesterol associated with race/ethnicity overall and stratified by diabetes status using adjustment as described above.

For all analyses, appropriate sample weights were used in all analyses so that the sum of the sample weights (MEC, fasting, and OGTT weights) added to the total civilian non-institutionalized US population; weights were used to account for unequal probabilities of selection and non-response and thus provide estimates representative of the non-institutionalized US population. Data analyses were done using SUDAAN (version 10.0.1; RTI International, Research Triangle Park, NC) accounting for the stratified, clustered sample design used by NHANES.

3. Results

Non-Hispanic Asians (45.1 years) were younger than non-Hispanic whites (49.8 years) and older than Hispanics (41.4 years) (Supplement Table S1). Compared to other race/ethnicities, non-Hispanic Asians were generally more likely to be female, more likely to be born outside the US, less likely to have low income, more educated, less likely to currently smoke, less likely to consume alcohol, more likely to have health insurance (except compared to non-Hispanic whites), and had a lower mean BMI. In addition, while the percent of non-Hispanic Asians with diagnosed diabetes was similar or lower, the percent with undiagnosed diabetes was higher compared to other race/ethnicities (Supplement Table S1).

Among people with diagnosed diabetes, undiagnosed diabetes, prediabetes, and normal glucose levels, the multivariable adjusted mean BMI was lower for non-Hispanic Asians compared to other race/ethnicities (Figure 1 Panel A). For example, among people with undiagnosed diabetes, the mean (95% confidence interval) BMI was 27.1 kg/m² (25.8–28.4) for non-Hispanic Asians, 32.5 kg/m² (31.0–33.9) for non-Hispanic whites, 35.0 kg/m² (33.0–37.0) for non-Hispanic blacks, and 35.0 kg/m² (33.5–36.6) for Mexican-Americans. Results for waist circumference were similar; non-Hispanic Asians had a lower multivariable adjusted mean waist circumference than other race/ethnicities after stratification by diabetes status and sex (Supplement Figure S1). Among diabetes status categories, the multivariable adjusted percent with hypertension and mean LDL cholesterol was generally similar for non-Hispanic Asians compared to other race/ethnicities (Figure 1 Panels B and C). For example, among people with undiagnosed diabetes, the multivariable adjusted percent (95% confidence interval) with hypertension was 54.9% (35.4–73.0) for non-Hispanic Asians, 36.9% (27.6–47.3) for non-Hispanic whites, 46.9% (32.0–62.3) for non-Hispanic blacks, and 28.9% (10.8–57.8) for Mexican-Americans. Results for mean systolic blood pressure and diastolic blood pressure were generally similar; non-Hispanic Asians did not have consistently different multivariable adjusted mean blood pressure levels than other race/ethnicities after stratification by diabetes status (Supplement Figure S2). Among people with undiagnosed diabetes, the multivariable adjusted mean level of LDL cholesterol was 109.2 mg/dL (97.6–120.8) for non-Hispanic Asians, 108.5 mg/dL (100.5–

116.6) for non-Hispanic whites, 112.0 mg/dL (102.2–121.8) for non-Hispanic blacks, 114.3 mg/dL (97.3–131.2) for Mexican-Americans.

In the overall population and after stratification by diabetes status, non-Hispanic whites, non-Hispanic blacks, and Mexican-Americans were significantly more likely to be obese compared to non-Hispanic Asians in unadjusted and adjusted models (Table 1). For example, among those with diagnosed diabetes, the multivariable adjusted odds ratio (95% confidence interval) of obesity was 8.37 (4.74–14.80), 7.34 (3.90–13.81), and 7.14 (3.88–13.13) for non-Hispanic whites, non-Hispanic blacks, and Mexican-Americans, respectively, compared to non-Hispanic Asians. Results were similar when using a lower BMI cutpoint of 27.5 kg/m², which is the World Health Organization recommended cutpoint for obesity in Asian populations (Supplement Table S2) [7]. Results for abdominal obesity were also similar; after stratifying by sex, other race/ethnicities were more likely to have abdominal obesity compared to non-Hispanic Asians in unadjusted and adjusted models (Supplement Tables S3 and S4).

In unadjusted models, non-Hispanic whites and non-Hispanic blacks were generally more likely to have hypertension compared to non-Hispanic Asians, while Mexican-Americans had similar levels of hypertension as non-Hispanic Asians (Table 2). For example, among those with diagnosed diabetes, the unadjusted odds ratio (95% confidence interval) of hypertension was 2.26 (1.49–3.42), 3.05 (1.94–4.79), and 1.25 (0.69–2.28) for non-Hispanic whites, non-Hispanic blacks, and Mexican-Americans, respectively, compared to non-Hispanic Asians. After multivariable adjustment, non-Hispanic whites and Mexican-Americans generally had similar levels of hypertension as non-Hispanic Asians, while non-Hispanic blacks had similar or higher levels of hypertension compared to non-Hispanic Asians depending on the diabetes category. Among those with diagnosed diabetes, the multivariable adjusted odds ratio (95% confidence interval) of hypertension was 1.48 (0.79–2.77), 2.54 (1.49–4.30), and 1.38 (0.73–2.60) for non-Hispanic whites, non-Hispanic blacks, and Mexican-Americans, respectively, compared to non-Hispanic Asians. These comparisons were not consistent in all diabetes categories, as multivariable adjusted hypertension did not differ between non-Hispanic blacks and non-Hispanic Asians in the undiagnosed diabetes or prediabetes categories, while Mexican-Americans were less likely to have hypertension compared to non-Hispanic Asians in the overall and prediabetes categories only after multivariable adjustment including BMI.

In unadjusted models, non-Hispanic whites were more likely to have elevated LDL cholesterol in the overall population and those with prediabetes and normal glucose compared to non-Hispanic Asians, while non-Hispanic blacks and Mexican-Americans were less likely to have elevated LDL cholesterol compared to non-Hispanic Asians among those with undiagnosed diabetes (Table 3). Among those with diagnosed diabetes, the unadjusted odds ratio (95% confidence interval) of elevated LDL cholesterol was 1.19 (0.52–2.71), 0.82 (0.37–1.81), and 0.81 (0.31–2.13) for non-Hispanic whites, non-Hispanic blacks, and Mexican-Americans, respectively, compared to non-Hispanic Asians. After multivariable adjustment, in the overall population and after stratification by diabetes status, non-Hispanic Asians had similar levels of elevated LDL cholesterol as other race/ethnicities (except for non-Hispanic blacks in the overall population). Among those with diagnosed diabetes, the

multivariable adjusted odds ratio (95% confidence interval) of elevated LDL cholesterol was 0.88 (0.32–2.43), 0.58 (0.24–1.42), and 1.15 (0.29–4.58) for non-Hispanic whites, non-Hispanic blacks, and Mexican-Americans, respectively, compared to non-Hispanic Asians.

4. Discussion

In this representative study of the US general population, non-Hispanic Asians had substantially lower levels of BMI compared to people of other race/ethnicities in the overall population and after stratification by diabetes status. Unadjusted higher levels of hypertension in non-Hispanic whites and non-Hispanic blacks compared to non-Hispanic Asians were attenuated and no longer significant after multivariable adjustment, except among non-Hispanic blacks in the overall population and the diagnosed diabetes and normal glucose categories. Although there were some unadjusted differences in LDL cholesterol between non-Hispanic Asians and other race/ethnicities, the only significant difference after multivariable adjustment was higher levels of LDL cholesterol compared to non-Hispanic blacks in the overall population.

Our results are consistent with previous studies that found that Asian populations have a higher prevalence of diabetes at a given BMI and waist circumference than white and black populations [2]. One reason for this difference is that Asians tend to have a higher percent body fat and more visceral adipose tissue at a given level of BMI compared to other race/ethnicities [8]. As a result of these issues, the World Health Organization recommended a lower BMI cutpoint of 23 kg/m² instead of 25 kg/m² to indicate increased risk of diabetes and other health outcomes in Asian populations, and a BMI cutpoint of 27.5 kg/m² instead of 30 kg/m² to indicate higher risk of outcomes [7].

Although there was a difference in the prevalence of diabetes between the race/ethnic groups, there was no statistical difference in the prevalence of prediabetes. This is consistent with previous research conducted in NHANES [1]. It is not clear why the prevalence of prediabetes is similar between different race/ethnic groups while the prevalence of diabetes varies.

Previous studies in the overall general population comparing hypertension among Asians and whites have had inconsistent results [9, 10]. Among people with diabetes, studies generally found that Asians in the US have similar levels of hypertension as whites [11]. Similarly, our study found that non-Hispanic Asians had similar levels of hypertension as non-Hispanic whites and Mexican-Americans among those with and without diabetes. However, our study also found that non-Hispanic Asians were generally less likely to have hypertension than non-Hispanic blacks, which is consistent with previous studies that found non-Hispanic blacks are more likely to have hypertension than other race/ethnicities [12].

A meta-analysis of studies in the general population found no difference in LDL cholesterol levels between Asians and whites [9]. There are limited data available among people with diabetes, with studies showing similar [3] or higher [4] levels of LDL cholesterol in Asians compared to whites. In our study, adjusted LDL cholesterol levels were similar by race/

ethnicity among people with and without diabetes, except that non-Hispanic Asians had higher levels than non-Hispanic blacks.

A major limitation of our study is that NHANES does not have more precise data on Asian heritage. Therefore, we were unable to explore differences by Asian subgroups (e.g., East Asian compared to South Asian). However, previous studies have found considerable differences in US Asian subgroups [13–15]. In a study using National Health Interview Survey (NHIS) data, based on a nationally representative sample of the US population, self-reporting multiple chronic health conditions (hypertension, coronary heart disease, stroke, diabetes, cancer, arthritis, hepatitis, kidney disease, asthma, or emphysema) was highest among adults identifying as Filipino descent, followed by Asian Indian, Japanese, Vietnamese, Korean, and lowest in those of Chinese descent [14]. In another study using NHIS data, Filipino adults were more likely to self-report being obese (14%) and a diagnosis of hypertension (27%) than other Asian subgroups including Japanese, Asian Indians, Vietnamese, Chinese, and Koreans, in which obesity ranged from 3% to 9% and hypertension ranged from 17% to 25% [13]. In that study, however, Asian Indians were most likely to report heart disease (9%) and diabetes (14%), whereas Vietnamese and Koreans were least likely to report heart disease (both 4%) and Koreans were least likely to report diabetes (4%).

Our study has a number of important strengths including use of NHANES data, which were designed to be representative of the US noninstitutionalized, civilian population. NHANES used a rigorous study protocol to collect data, including thorough quality-control procedures and the use of technicians trained and certified in data collection. Also, the large NHANES sample allowed us to stratify results by race/ethnicity and diabetes status.

Despite having lower levels of adiposity, non-Hispanic Asians in the US have a relatively high prevalence of diabetes compared to other race/ethnicities. In addition, non-Hispanic Asians with diabetes have generally similar adjusted levels of cardiovascular risk factors, which is particularly concerning consider they are less likely to have their diabetes diagnosed. These findings agree with previous studies in suggesting that BMI levels in non-Hispanic Asians can underestimate cardiometabolic disease risk if clinicians use cutpoints based on studies of other race/ethnic populations [7]. Our findings highlight the importance of screening and treating non-Hispanic Asians in the US for diabetes at lower levels of BMI and waist circumference than other race/ethnicities.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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References

1. Menke A, Casagrande S, Geiss L, Cowie CC. Prevalence of and Trends in Diabetes Among Adults in the United States, 1988–2012. *JAMA*. 2015; 314(10):1021–9. [PubMed: 26348752]
2. Ntuk UE, Gill JM, Mackay DF, Sattar N, Pell JP. Ethnic-Specific Obesity Cutoffs for Diabetes Risk: Cross-sectional Study of 490,288 UK Biobank Participants. *Diabetes Care*. 2014
3. Jackson GL, Edelman D, Weinberger M. Simultaneous control of intermediate diabetes outcomes among Veterans Affairs primary care patients. *J Gen Intern Med*. 2006; 21(10):1050–6. [PubMed: 16970554]
4. Chew LD, Schillinger D, Maynard C, Lessler DS. Glycemic and lipid control among patients with diabetes at six U.S. public hospitals. *J Health Care Poor Underserved*. 2008; 19(4):1060–75. [PubMed: 19029737]
5. Zipf G, Chiappa M, Porter KS, Ostchega Y, Lewis BG, Dostal J. National Health and Nutrition Examination Survey: Plan and operations, 1999–2010. National Center for Health Statistics. *Vital Health Stat*. 2013; 1(56)
6. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clin Chem*. 1972; 18(6):499–502. [PubMed: 4337382]
7. World Health Organization Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet*. 2004; 363(9403): 157–63. [PubMed: 14726171]
8. Lear SA, Humphries KH, Kohli S, Birmingham CL. The use of BMI and waist circumference as surrogates of body fat differs by ethnicity. *Obesity (Silver Spring)*. 2007; 15(11):2817–24. [PubMed: 18070773]
9. Rana A, de Souza RJ, Kandasamy S, Lear SA, Anand SS. Cardiovascular risk among South Asians living in Canada: a systematic review and meta-analysis. *CMAJ Open*. 2014; 2(3):E183–91.
10. Tsai CF, Anderson N, Thomas B, Sudlow CL. Risk factors for ischemic stroke and its subtypes in Chinese vs. Caucasians: Systematic review and meta-analysis. *Int J Stroke*. 2015; 10(4):485–93. [PubMed: 25907735]
11. Watson RE, Karnchanasorn R, Gossain VV. Hypertension in Asian/Pacific Island Americans. *J Clin Hypertens (Greenwich)*. 2009; 11(3):148–52. [PubMed: 19302427]
12. Gasevic D, Ross ES, Lear SA. Ethnic Differences in Cardiovascular Disease Risk Factors: A Systematic Review of North American Evidence. *Can J Cardiol*. 2015; 31(9):1169–79. [PubMed: 26239006]
13. Barnes PM, Adams PF, Powell-Griner E. Health characteristics of the Asian adult population: United States, 2004–2006. *Adv Data*. 2008; 394:1–22.
14. Black LI, Bloom B. Health of Non-Hispanic Asian Adults: United States, 2010–2014. *NCHS Data Brief*. 2016; (247):1–8.
15. Ye J, Rust G, Baltrus P, Daniels E. Cardiovascular risk factors among Asian Americans: results from a National Health Survey. *Ann Epidemiol*. 2009; 19(10):718–23. [PubMed: 19560369]

Highlights

- Non-Hispanic Asians had lower levels of adiposity compared to other race/ethnicities
- Non-Hispanic Asians had similar adjusted levels of hypertension and LDL cholesterol
- Body mass index levels in Asians can underestimate cardiometabolic disease risk

Figure 1.

Adjusted mean body mass index (Panel A), percent with hypertension (Panel B), and mean LDL cholesterol (Panel C) by race-ethnicity and diabetes status. Adjustment included age, sex, income, education, health insurance, physical activity, smoking, alcohol consumption, lipid-lowering medication (Panel C only), and body mass index (except Panel A). Error bars represent 95% confidence intervals. LDL, low-density lipoprotein.

Table 1

Odds Ratios (95% Confidence Intervals) of Obesity[§] Associated with Race/Ethnicity, Overall and by Diabetes Status

	Non-Hispanic Asian	Non-Hispanic white	Non-Hispanic black	Mexican-American
Overall				
Unadjusted	reference	5.17 (3.81–7.03)	7.93 (5.75–10.93)	8.07 (6.06–10.75)
Adjusted Model 1 [*]	reference	4.94 (3.56–6.88)	7.65 (5.43–10.78)	7.74 (5.43–11.06)
Adjusted Model 2 [†]	reference	5.86 (4.00–8.58)	8.77 (5.80–13.28)	8.35 (5.36–12.99)
Adjusted Model 3 [‡]	reference	7.19 (5.01–10.32)	9.44 (6.34–14.06)	8.98 (5.81–13.86)
Diagnosed diabetes				
Unadjusted	reference	7.50 (4.67–12.04)	6.22 (3.72–10.42)	6.41 (3.91–10.50)
Adjusted Model 1 [*]	reference	8.81 (5.12–15.16)	6.87 (3.76–12.56)	6.70 (3.66–12.25)
Adjusted Model 2 [†]	reference	8.37 (4.74–14.80)	7.34 (3.90–13.81)	7.14 (3.88–13.13)
Undiagnosed diabetes				
Unadjusted	reference	9.98 (4.24–23.48)	18.55 (8.21–41.90)	26.91 (9.96–72.71)
Adjusted Model 1 [*]	reference	16.29 (5.45–48.70)	22.27 (8.67–57.19)	25.30 (9.20–69.52)
Adjusted Model 2 [†]	reference	15.82 (4.66–53.76)	22.77 (7.50–69.15)	42.02 (12.98–136.07)
Prediabetes				
Unadjusted	reference	4.42 (2.71–7.21)	6.31 (3.75–10.61)	6.60 (4.35–10.03)
Adjusted Model 1 [*]	reference	4.97 (2.96–8.32)	6.64 (3.81–11.57)	6.93 (4.02–11.92)
Adjusted Model 2 [†]	reference	6.50 (3.29–12.83)	8.61 (4.27–17.37)	8.39 (4.10–17.17)
Normal				
Unadjusted	reference	7.23 (3.29–15.87)	11.68 (5.45–25.03)	11.92 (5.85–24.29)
Adjusted Model 1 [*]	reference	6.90 (3.07–15.54)	10.54 (4.99–22.27)	10.72 (5.33–21.57)
Adjusted Model 2 [†]	reference	7.19 (3.20–16.14)	10.44 (4.77–22.86)	9.28 (4.48–19.21)

^{*} Adjustment included age, sex, income, education, and health insurance

[†] Adjustment included age, sex, income, education, health insurance, physical activity, smoking, and alcohol consumption

[‡] Adjustment included age, sex, income, education, health insurance, physical activity, smoking, alcohol consumption, and diabetes status

[§] Obesity defined as a body mass index ≥ 30 kg/m²

Table 2

Odds Ratios (95% Confidence Intervals) of Hypertension Associated with Race/Ethnicity, Overall and by Diabetes Status

	Non-Hispanic Asian	Non-Hispanic white	Non-Hispanic black	Mexican-American
Overall				
Unadjusted	reference	1.70 (1.33–2.18)	2.40 (1.83–3.14)	0.78 (0.53–1.15)
Adjusted Model 1 [*]	reference	1.32 (0.99–1.76)	3.04 (2.21–4.19)	1.13 (0.78–1.64)
Adjusted Model 2 [†]	reference	1.21 (0.87–1.69)	2.88 (2.03–4.09)	1.07 (0.71–1.60)
Adjusted Model 3 [‡]	reference	0.82 (0.57–1.18)	1.71 (1.16–2.52)	0.61 (0.40–0.92)
Diagnosed diabetes				
Unadjusted	reference	2.26 (1.49–3.42)	3.05 (1.94–4.79)	1.25 (0.69–2.28)
Adjusted Model 1 [*]	reference	2.02 (1.29–3.16)	3.31 (2.08–5.28)	1.74 (1.02–2.95)
Adjusted Model 2 [†]	reference	2.26 (1.32–3.88)	3.64 (2.19–6.03)	1.99 (1.10–3.63)
Adjusted Model 3 [‡]	reference	1.48 (0.79–2.77)	2.54 (1.49–4.30)	1.38 (0.73–2.60)
Undiagnosed diabetes				
Unadjusted	reference	2.06 (1.01–4.21)	1.97 (0.96–4.03)	0.63 (0.27–1.48)
Adjusted Model 1 [*]	reference	1.60 (0.73–3.52)	2.04 (0.88–4.73)	0.80 (0.34–1.89)
Adjusted Model 2 [†]	reference	1.10 (0.47–2.55)	1.89 (0.81–4.41)	0.77 (0.29–1.99)
Adjusted Model 3 [‡]	reference	1.00 (0.41–2.41)	1.68 (0.72–3.95)	0.64 (0.22–1.89)
Prediabetes				
Unadjusted	reference	1.58 (1.07–2.33)	2.12 (1.42–3.15)	0.54 (0.28–1.04)
Adjusted Model 1 [*]	reference	1.16 (0.73–1.84)	2.60 (1.68–4.01)	0.82 (0.42–1.58)
Adjusted Model 2 [†]	reference	0.96 (0.55–1.68)	2.27 (1.36–3.78)	0.69 (0.35–1.39)
Adjusted Model 3 [‡]	reference	0.56 (0.29–1.06)	1.26 (0.68–2.34)	0.39 (0.18–0.87)
Normal				
Unadjusted	reference	2.93 (1.59–5.40)	3.61 (2.15–6.06)	0.99 (0.49–2.03)
Adjusted Model 1 [*]	reference	2.18 (1.12–4.25)	4.72 (2.56–8.71)	1.44 (0.60–3.41)
Adjusted Model 2 [†]	reference	2.14 (0.99–4.61)	4.74 (2.46–9.13)	1.39 (0.52–3.69)
Adjusted Model 3 [‡]	reference	1.29 (0.57–2.87)	2.68 (1.29–5.54)	0.84 (0.33–2.16)

^{*} Adjustment included age, sex, income, education, and health insurance

[†] Adjustment included age, sex, income, education, health insurance, physical activity, smoking, and alcohol consumption

[‡] Adjustment included age, sex, income, education, health insurance, physical activity, smoking, alcohol consumption, body mass index, and diabetes status (for the overall model)

[§] Hypertension defined as systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg, or use blood pressure medication

Table 3

Odds Ratios (95% Confidence Intervals) of Elevated LDL cholesterol[§] Associated with Race/Ethnicity, Overall and by Diabetes Status

	Non-Hispanic Asian	Non-Hispanic white	Non-Hispanic black	Mexican-American
Overall				
Unadjusted	reference	1.42 (1.10–1.84)	0.92 (0.71–1.18)	0.82 (0.57–1.19)
Adjusted Model 1 [*]	reference	1.15 (0.89–1.48)	0.90 (0.67–1.22)	1.03 (0.68–1.56)
Adjusted Model 2 [†]	reference	1.11 (0.87–1.42)	0.84 (0.61–1.15)	1.07 (0.70–1.65)
Adjusted Model 3 [‡]	reference	1.03 (0.79–1.35)	0.70 (0.49–0.98)	0.92 (0.59–1.46)
Diagnosed diabetes				
Unadjusted	reference	1.19 (0.52–2.71)	0.82 (0.37–1.81)	0.81 (0.31–2.13)
Adjusted Model 1 [*]	reference	1.04 (0.42–2.56)	0.72 (0.30–1.72)	1.43 (0.46–4.39)
Adjusted Model 2 [†]	reference	0.83 (0.33–2.09)	0.53 (0.23–1.20)	1.08 (0.30–3.93)
Adjusted Model 3 [‡]	reference	0.88 (0.32–2.43)	0.58 (0.24–1.42)	1.15 (0.29–4.58)
Undiagnosed diabetes				
Unadjusted	reference	0.65 (0.24–1.76)	0.29 (0.10–0.84)	0.30 (0.11–0.85)
Adjusted Model 1 [*]	reference	0.55 (0.17–1.79)	0.33 (0.08–1.26)	0.42 (0.13–1.33)
Adjusted Model 2 [†]	reference	0.75 (0.21–2.67)	0.41 (0.09–1.83)	0.64 (0.17–2.42)
Adjusted Model 3 [‡]	reference	1.00 (0.28–3.61)	0.58 (0.11–3.06)	0.84 (0.21–3.42)
Prediabetes				
Unadjusted	reference	1.60 (1.02–2.50)	0.84 (0.53–1.35)	0.70 (0.42–1.16)
Adjusted Model 1 [*]	reference	1.23 (0.74–2.02)	0.79 (0.42–1.48)	0.79 (0.39–1.61)
Adjusted Model 2 [†]	reference	1.03 (0.58–1.82)	0.65 (0.33–1.30)	0.72 (0.33–1.58)
Adjusted Model 3 [‡]	reference	0.90 (0.49–1.63)	0.56 (0.27–1.14)	0.62 (0.28–1.41)
Normal				
Unadjusted	reference	1.76 (1.27–2.46)	1.06 (0.76–1.46)	1.07 (0.74–1.55)
Adjusted Model 1 [*]	reference	1.41 (1.07–1.87)	1.15 (0.83–1.58)	1.31 (0.95–1.80)
Adjusted Model 2 [†]	reference	1.45 (1.06–1.98)	1.09 (0.81–1.47)	1.51 (1.14–2.00)
Adjusted Model 3 [‡]	reference	1.19 (0.86–1.64)	0.85 (0.61–1.17)	1.23 (0.88–1.73)

LDL, low-density lipoprotein

^{*} Adjustment included age, sex, income, education, and health insurance

[†] Adjustment included age, sex, income, education, health insurance, physical activity, smoking, and alcohol consumption

[‡] Adjustment included age, sex, income, education, health insurance, physical activity, smoking, alcohol consumption, body mass index, and diabetes status (for the overall model)

[§] Elevated LDL cholesterol defined as LDL ≥ 100 mg/dL or use of cholesterol medication