Trends in the Prevalence of Type 2 Diabetes in Asians Versus Whites

Results from the United States National Health Interview Survey, 1997–2008

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OBJECTIVE—To examine trends in the prevalence of type 2 diabetes and related conditions in Asian Americans compared with non-Hispanic whites.

RESEARCH DESIGN AND METHODS—We analyzed data from the National Health Interview Survey (NHIS) from 1997 to 2008 to construct a nationally representative sample of 230,503 U.S. adults aged ≥18 years. Of these adults, 11,056 identified themselves as Asian Americans and 219,447 as non-Hispanic whites.

RESULTS—The age- and sex-adjusted prevalence of type 2 diabetes was higher in Asian Americans than in whites throughout the study period (4.3–8.2% vs. 3.8–6.0%), and there was a significant upward trend in both ethnic groups ($P < 0.01$). BMI also was increased in both groups, but age- and sex-adjusted BMI was consistently lower in Asian Americans. In fully adjusted logistic regression models, Asian Americans remained 30–50% more likely to have diabetes than their white counterparts. In addition, Asian Indians had the highest odds of prevalent type 2 diabetes, followed by Filipinos, other Asians, and Chinese.

CONCLUSIONS—Compared with their white counterparts, Asian Americans have a significantly higher risk for type 2 diabetes, despite having substantially lower BMI. Additional investigation of this disparity is warranted, with the aim of tailoring optimal diabetes prevention strategies to Asian Americans.

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Asian Americans are a fast-growing subpopulation in the U.S., accounting for 1.4% of the total U.S. population in 1980 and tripling to 4.2% (11.9 million people) in 2000 (1,2). However, apart from focused studies of Japanese immigrants in Hawaii and the West Coast (3,4), few data are available regarding diabetes in Asian Americans nationwide (5,6). We therefore analyzed data from the NHIS to examine trends in the prevalence of type 2 diabetes and related conditions in Asian Americans compared with non-Hispanic whites.

RESEARCH DESIGN AND METHODS

Data source

The National Health Interview Survey (NHIS) is an ongoing annual survey designed to collect health-related information on the noninstitutionalized civilian population of the U.S. Conducted by the National Center for Health Statistics (NCHS), the survey uses a three-stage stratified cluster-probability sampling design. All data are based on respondent self-report. There are no laboratory assays or physical assessments. Details regarding study design and procedures are available elsewhere (7).

Study population

We used data collected from a sample of 359,156 adult participants, aged ≥18 years, who were interviewed between 1997 and 2008. The 12-year average response rate was 71.8% (range 62.6–80.4). We excluded individuals based on any one of the following criteria (individuals can be excluded for more than one reason): missing age at diabetes diagnosis (n = 1,013); diabetes diagnosed before the age of 25 years (n = 2,567); missing data on height or weight (n = 15,097); or outliers for BMI defined as the upper and lower 0.5% of BMI values (n = 3,351). Thus, the final sample comprised 11,056 Asian American (henceforth Asian) and 219,447 non-Hispanic white (henceforth white) adults.

Race and ethnicity

Race/ethnicity was categorized using a combination of variables: "race coded to single/multiple race group," based on self-reported primary race and "Hispanic origin" in 1997–2005 and the predefined "race/ethnicity recode" in 2006–2008. Asian subgroups consisted of Chinese, Filipinos, Asian Indians, and other Asians (i.e., Korean, Japanese, Vietnamese, and other Asian subgroups). In 1997 and 1998, the NHIS included Pacific Islanders (i.e., Hawaiian, Samoan, Guamanian, and other Pacific Islander subgroups) as a part of the "other Asians" category. However, we were unable to differentiate Pacific Islanders from other Asians based on the public-use dataset.

Prevalent diabetes

Individuals were classified as having diabetes if they gave a positive response to any of the following three questions: *1*) "Have you ever been told by a doctor or health professional that you have diabetes or sugar diabetes?"; *2*)"Are you now taking insulin?"; or *3*) "Are you now taking

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diabetic pills to lower your blood sugar? These are sometimes called oral agents or oral hypoglycemic agents." Those who reported having been told they had borderline diabetes or prediabetes and women who reported having had diabetes only during pregnancy (gestational diabetes) were classified as nondiabetic in our analysis.

Covariates

Other variables of interests included age, sex, educational attainment, incomes, nation of birth, current smoking and alcohol drinking status, leisure-time physical activity, and BMI. Leisure-time physical activity was dichotomized at the level of regular activity recommended by the American Heart Association (i.e., 20 min of vigorous activity three times per week or 30 min of light-to-moderate activity five times per week) (8). BMI was categorized for whites as underweight/normal weight, overweight, and obese (BMI <25, $25 \leq$ BMI < 30, BMI ≥ 30 kg/m^2) according to National Heart, Lung, and Blood Institute guidelines. For Asian Americans, we first applied the National Heart, Lung, and Blood Institute standard and then applied the Asian standard (BMI <23, $23 \leq$ BMI < 27.5, BMI ≥ 27.5 kg/m^2) (9), which accounts for the generally higher ratio of fat mass to lean body mass in Asians versus people of European ancestry at any given level of BMI.

Statistical analysis

We merged 12 years of data and created new design variables that incorporated stratum, primary sampling unit, and sampling weight in order to accommodate different sampling designs between 1997–2005 and 2006–2008 (7). All analyses accounted for complex sampling designs and weights developed by the NHIS to represent the U.S. adult population and were limited to Asians and whites using the Stata "subpop" command for correct variance estimation. Subsequent analyses were performed by pooling data into four 3-year periods (1997–1999, 2000–2002, 2003–2005, and 2006–2008) to enhance robustness.

Characteristics of Asians versus whites were compared over time. In each time period, *t* tests were used to compare continuous variables and χ^2 tests were used to compare categorical variables. To examine differences in diabetes prevalence between Asians and whites, we calculated age- and sex-adjusted rates using the 2000 U.S. Census data as the standard and displayed the rates as Lowess-smoothed lines. The mean difference of age- and sex-adjusted prevalence in Asians versus whites was examined using a linear regression model by period. We compared age- and sex-adjusted BMI in Asians overall and in Asian subgroups (Chinese, Filipinos, Asian Indians, and other Asians) versus whites by period. We constructed several multivariable logistic regression models to obtain adjusted odds ratios (ORs) of prevalent type 2 diabetes in Asians versus whites. To check for effect modification by sex, we conducted fully adjusted analyses stratified by sex. No interaction was detected (all $P > 0.05$); therefore, only pooled results were presented.

All tests of significance were two tailed, with α levels of 0.05. Nonparametric trend tests across calendar-years were used to conservatively test for secular trends and to account for different sampling designs in 1997–2005 versus 2006–2008 (10). Analyses were performed using Stata/SE (version 10.0; College Station, TX).

RESULTS—Table 1 presents the characteristics of 230,503 study participants by race/ethnicity and period. Over 12 years, the weighted proportion of Asians in the NHIS sample increased from 3.1 to 4.6%, and 12,943 adults reported having physician-diagnosed type 2 diabetes (554 Asians and 12,389 whites). Compared with whites, Asians were younger, were less likely to be born in the U.S., had higher educational attainment and higher incomes, and were less likely to be current smokers or drinkers (all $P < 0.05$, except for income in the period of 2000–2002: $P = 0.15$). During the study period, Asians were consistently less likely than whites to report engaging in American Heart Association–recommended levels of physical activity (26–30% vs. 33–34%; all $P < 0.001$).

As expected, Asians had lower BMI than whites (mean 24 vs. 26–27 kg/m^2) and were less likely to be overweight (24–30 vs. 35–36%) or obese (6–8 vs. 19–25%) according to Western standards (all $P < 0.0001$). After applying modified adiposity criteria for Asians, their excess prevalence of obesity persisted (13–17 vs. 19–25%; $P < 0.0001$), but the disparity in overweight was reversed (39–42 vs. 35–36%). There was no significant secular trend in any covariate shown in Table 1 in either Asians or whites using data in 1997–1999 as the reference (all $P > 0.05$; data not shown).

Trends in type 2 diabetes and BMI

Figure 1 displays secular trends in type 2 diabetes and BMI after adjusting for age

Table 1—*Characteristics of Asian and white adults in the U.S., NHIS 1997–2008**

	1997–1999		2000–2002		2003–2005		2006–2008	
	Asians	Whites	Asians	Whites	Asians	Whites	Asians	Whites
N	2,409	63,490	2,498	59,929	2,587	57,112	3,562	38,946
Age (years)								
Mean	40.4	46.1	40.7	46.5	42.0	47.2	42.9	47.5
≥65 (%)	9.0	18.4	8.7	18.3	10.2	18.5	11.5	18.7
Female (%)	51.6	50.9	47.9	50.7	50.1	50.8	51.9	50.4
Education (some college or college graduate) (%)†	68.3	54.2	71.6	56.2	68.7	58.2	72.8	59.7
Incomes (<$20,000) (%)‡	25.1	21.7	17.4	18.0	13.9	16.0	13.2	15.9
U.S. born (%)§	18.2	95.6	17.4	95.4	19.1	95.3	23.1	95.5
Current smoking (%)	15.4	24.9	13.5	24.1	12.5	22.5	10.2	22.0
Current alcohol drinking (%)	46.3	66.7	48.1	66.6	43.8	65.2	46.7	66.8
Physically active (%)‖	25.9	33.2	29.6	34.0	29.1	33.6	30.1	33.9
BMI (kg/m^2)								
Mean	23.6	26.1	23.8	26.5	24.0	26.8	24.3	27.1
Overweight (%)**	38.8	35.4	39.8	35.5	41.5	35.8	42.2	35.2
Obese (%)††	12.7	18.7	14.3	21.0	14.2	22.7	17.0	25.1

All characteristics of Asians are significantly different from those in whites ($P < 0.05$), except the proportion of female subjects in 1997–1999, 2003–2005, and 2006–2008 and the proportion of higher education in 2000–2002. *Data are weighted means or proportions, SEs for mean age were <1, for mean BMI were <0.2, and for other variables were <0.03. †Some college or college graduate. ‡Previous-year individuals' total incomes including hourly wages, salaries, tips, and commissions. §Born in the U.S. (50 states or the District of Columbia) excluding U.S. territories. ‖Percent met the recommended leisure-time physical activities: 20 min of vigorous activity three times per week or 30 min of light to moderate activity five times per week. **23 ≤ BMI < 27.5 kg/m^2 for Asians, 25 ≤ BMI < 30 kg/m^2 for whites. ††BMI ≥27.5 kg/m^2 for Asians, BMI ≥30 kg/m^2 for whites.

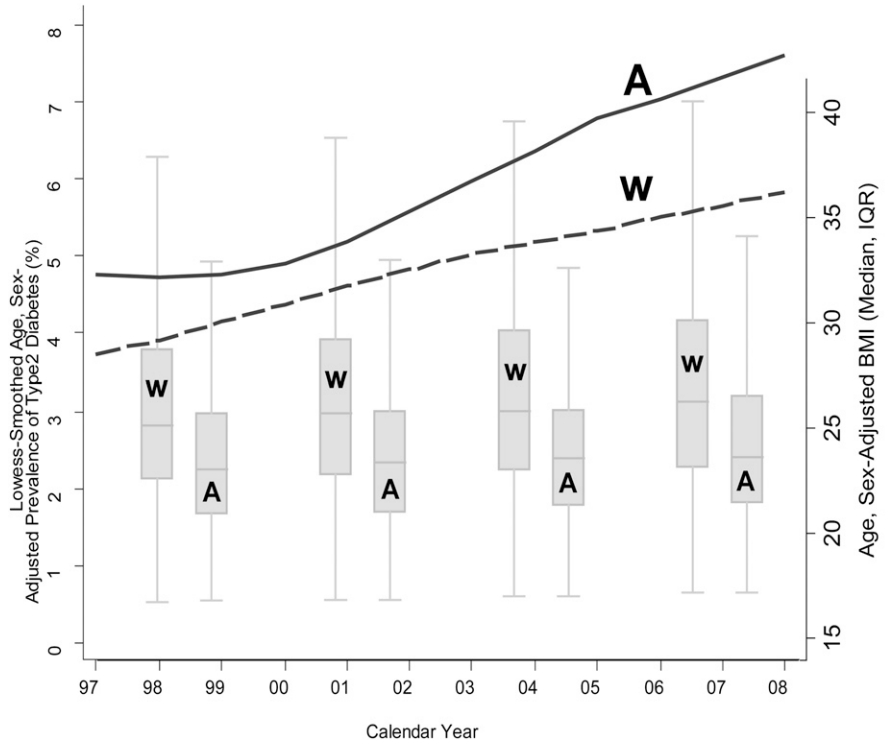

Figure 1—*Lowess-smoothed line curves represent age- and sex-standardized prevalence rates of type 2 diabetes in 1997–2008, after accounting for sampling weight. The solid line represents Asians (A) and the dotted line represents whites (W). P for trends: Asians = 0.028 and whites = 0.009. Box-plot reveals age- and sex-standardized BMI in each period (1997–1999, 2000–2002, 2003–2005, and 2006–2008) and draw at the midpoint of each period.*

and sex. Prevalent type 2 diabetes was substantially more common in Asians than in whites throughout the interval (4.7–7.3 vs. 3.8–5.6%; all $P < 0.05$), and both groups showed significant upward trends in prevalence. On the contrary, BMI was substantially lower in Asians than in whites throughout the interval. There were upward trends in BMI in both groups (P values for trend: Asians = 0.003 and whites = 0.001), and the Asian–white BMI difference grew over time, especially in the obese tail of the distribution (age- and sex-adjusted prevalence of obesity in Asians versus whites: 13–17 vs. 19–25%; all $P < 0.05$).

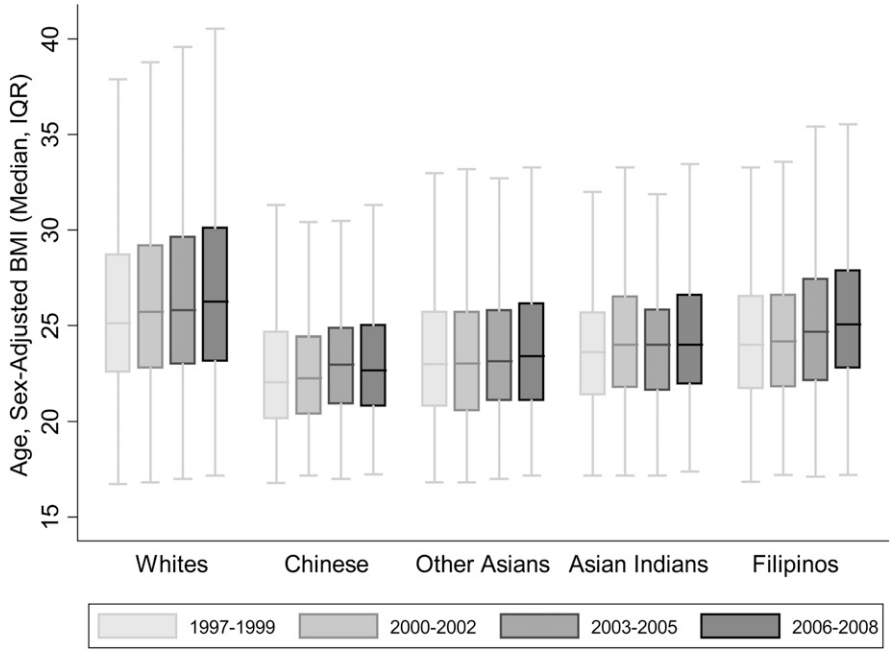

Figure 2—*Each box plot represents age- and sex-standardized BMI, and colors stand for each period by race/ethnicities. P for trends: whites = 0.001, Chinese = 0.042, other Asians = 0.32, Asian Indian = 0.26, and Filipinos = 0.002.*

BMI in Asian subgroups

Adjusted BMI trends within major Asian subgroups are displayed in Fig. 2. Among Asians, Filipinos and Asian Indians had the highest BMIs over the interval, and Chinese subjects had the lowest. Significant upward trends were observed only in Chinese and Filipinos (P = 0.042 and 0.02, respectively). In 2006–2008, the age- and sex-adjusted prevalence of overweight plus obesity using the Asian standard was 71, 69, 57, and 47% in Filipinos, Asian Indians, other Asians, and Chinese, respectively.

Likelihood of type 2 diabetes in Asians versus whites

Finally, we calculated the adjusted OR of prevalent type 2 diabetes in Asians versus whites over the interval (Table 2). After adjusting for age and sex, the odds of prevalent type 2 diabetes in Asians generally were 20–40% greater than in their white counterparts. Additional adjustment for BMI as a categorical variable, using the Asian standard, strengthened these associations ($P < 0.05$ in all time intervals). In the fully adjusted model, the odds of prevalent type 2 diabetes in Asians remained consistently greater than those in whites throughout the period (OR range 1.3–1.5, all $P < 0.05$, except for 2000–2002, OR 1.3 [95% CI 0.9–1.8]). No significant secular trends were observed.

Furthermore, we calculated the adjusted ORs of prevalent type 2 diabetes in Asian subgroups versus whites over the study period. Asian Indians had the highest odds of prevalent type 2 diabetes, followed by Filipinos, other Asians, and Chinese. These observations were stable over the study period (P for trend >0.05). Figure 3 depicts the results for the period of 2006–2008.

CONCLUSIONS—These data support the following three main conclusions. First, although Asian Americans were more likely to attend college, were less likely to smoke, were less likely to

Table 2—*Adjusted ORs of prevalent type 2 diabetes in Asians versus whites, NHIS 1997–2008*

	1997–1999	2000–2002	2003–2005	2006–2008
Model 1	1.3 (1.0–1.6)	1.2 (0.9–1.5)	1.3 (1.0–1.6)	1.4 (1.2–1.7)
Model 2	1.5 (1.2–1.8)	1.4 (1.0–1.8)	1.5 (1.2–1.9)	1.7 (1.4–2.0)
Model 3	1.5 (1.1–2.0)	1.3 (0.9–1.8)	1.3 (1.0–1.7)	1.4 (1.2–1.7)

Numbers data are OR (95% CI). Model 1: Adjusted for age (continuous) and sex. Model 2: Model 1 + BMI categories (underweight/normal weight: BMI <23 kg/m^2 for Asians and BMI <25 kg/m^2 for whites; overweight: $23 \leq$ BMI < 27.5 kg/m^2 for Asians and $25 \leq$ BMI < 30 kg/m^2 for whites; obese: BMI ≥ 27.5 kg/m^2 for Asians and BMI ≥ 30 kg/m^2 for whites). Model 3: Model 2 + education, incomes, nation of birth, current smoking and alcohol drinking status, and leisure-time physical activity.

drink, and had lower BMI, Asian Americans are ~30% more likely to have type 2 diabetes than their white counterparts. Second, both BMI and diabetes prevalence are rising in all Asian subgroups, especially Filipinos. Third, although the OR of diabetes in Asians versus whites has remained relatively stable over the past decade, the steady climb in diabetes prevalence in both groups coincides with a widening gap in terms of absolute diabetes prevalence. We noted that compared with whites, Asian Americans were more likely to be overweight but less likely to be obese, after applying the modified Asian criteria. Nonetheless, we should interpret the observation with caution because the real overweight/obesity cut points are likely to vary for different Asian populations (11).

Our results are consistent with previous studies of diabetes in Asian Americans. Using 3-year (2004–2006) pooled NHIS data, Barnes et al. (5) reported an age-standardized diabetes prevalence of 7.5% in whites versus 6.4% in Asian Americans. In a study using the 2001 U.S. Behavioral Risk Factor Surveillance System data, McNeely and Boyko (6) found that type 2 diabetes was 60% more likely in Asian Americans than in whites (OR 1.6 [95% CI 1.1–2.2]). Most recently, two studies used NHIS data to compare the risk of type 2 diabetes in subgroups of Asians (i.e., Chinese, Filipinos, Asian Indians, and other Asians) to whites. Oza-Frank et al. (12) showed that the risk in Asians was higher than whites across all Asian subgroups (OR range 1.3–3.5). Ye et al. (13) likewise observed that Asian Indians and Filipinos were more likely to have type 2 diabetes than whites (OR range 1.1–2.3) after multiple adjustment. In this study, we further investigated trends in diabetes prevalence over time and in relation to patterns of change in BMI. We found that although the ORs of diabetes in Asians versus whites has remained quite stable over the past decade, obesity and diabetes prevalence in both race groups increased concurrently. Those increases contribute to the growing medical and societal burdens in the U.S. attributed to diabetes and its complications.

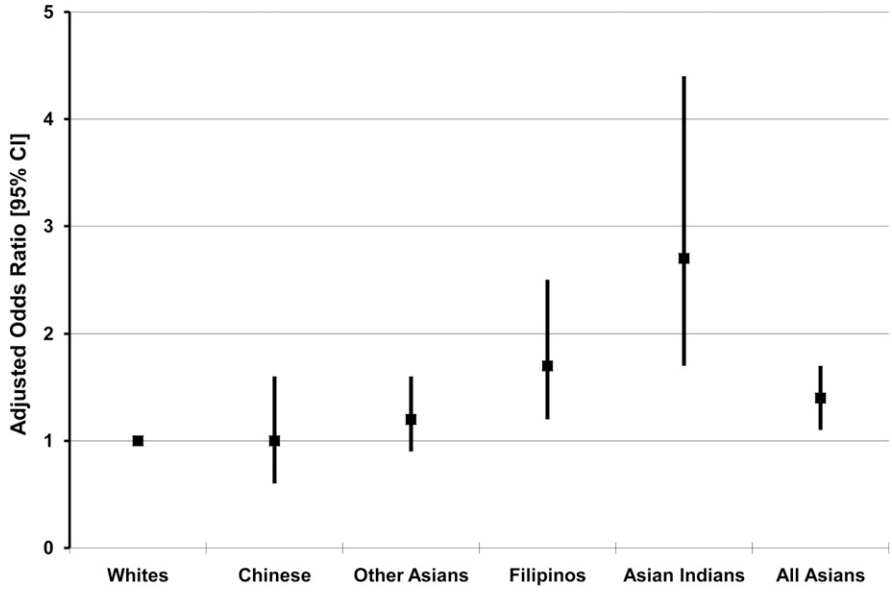

Figure 3—*ORs (95% CIs) of prevalent type 2 diabetes in Asian subgroups versus whites in the fully adjusted model (controlled for age, sex, BMI categories, education, incomes, nation of birth, current smoking and alcohol drinking status, and leisure-time physical activity).*

There are several possible explanations for the Asian–white disparity in diabetes risk. First, Asians appear to be more genetically predisposed to develop type 2 diabetes compared with their white counterparts (14–16). Second, chronic stress related to immigration acculturation could contribute to visceral adiposity and insulin resistance (16). Finally, Asians are known to have higher visceral fat accumulation compared with whites at any given level of BMI (17). Rush et al. (18) reported that for the same BMI, the body fat percentage in Asian Indians was higher than whites as well as other Asian populations. Likewise, for the same waist circumference, Filipino women had a higher visceral fat and visceral-to-subcutaneous abdominal fat ratio than white women (19). Those unfavorable fat distributions may contribute to the higher risk of diabetes in those two Asian populations (9).

Physical inactivity is a well-established risk factor for incident type 2 diabetes independent from adiposity (20). Although physical inactivity did not completely explain the excess risk of type 2 diabetes in Asian Americans in our analysis, it is known to be a common diabetes risk factor in Asian Americans. For example, Kandula et al. (21) observed that Asian immigrants were 50% less likely to meet the recommended physical activity level than U.S.-born non-Asians, based on the 2001 California Health Interview Survey. Physical inactivity is of particular interest from a public health perspective because it is more readily modifiable than adiposity.

Strengths of our study include a very large, nationally representative sample with uniform ascertainment of diabetes and related variables over a time interval during which the population of Asian Americans and the prevalence of type 2 diabetes have both climbed dramatically.

Nevertheless, several limitations deserve mention. First, the secular patterns we observed were based entirely on cross-sectional data; therefore, these results

may have been influenced by survival and/or selection bias related to immigration that limited the inferences about racial disparities in incident diabetes risk. Second, the NHIS is based exclusively on self-reported data. Because participants were asked to select a primary race, possible misclassification in mixed-race participants may underestimate the associations. It is also possible that the disparities we observed arose in part from racial differences in physician diagnosis and/or patient recall of diabetes. Use of self-reported height and weight may lead to underestimation of BMI, but we know of no evidence that the degree of underestimation differs systematically in Asian Americans versus whites (22). Finally, information on other diabetes risk factors, such as dietary intake and family history of diabetes, are not available in the NHIS. Hence, we could not rule out the possibility of residual confounding.

The main implication of our study is that type 2 diabetes is a growing public health problem for Asian Americans that requires urgent attention. Although greater genetic predisposition no doubt plays a role, future research should identify modifiable risk factors that underlie the Asian–white disparity in diabetes prevalence as a step toward the development of culturally tailored prevention strategies.

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J.R.L. researched data, wrote the manuscript, and contributed to the discussion. F.L.B. reviewed and edited the manuscript and contributed to the discussion. H.-C.Y. researched data, reviewed and edited the manuscript, and contributed to the discussion.

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