Journal of Asian Health

ORIGINAL ARTICLE

Differences in the Age of Diagnosis of Diabetes in Asian American Ethnic Groups: The National Health Interview Survey (NHIS), 2006–2018

Rishab Harish Bhatt[1,2]; Shreya Mukund Ingle[1,3]; Ashley Joann Sackpraseuth[1,4]; Siddharth Venkatraman[5]; Nora Sebeca Sharp[1,6]; Sukyung Chung, PhD[1,7]; Jin Long[1,7]; Latha Palaniappan, MD, MS[1,7,8] and Malathi Srinivasan, MD[1,8]

OBJECTIVE: Asian Americans have a 60% higher prevalence of diabetes than non-Hispanic Whites (NHW), with the highest prevalence for Asian Indians and Filipinos. Understanding the age at which Asian American groups are diagnosed with diabetes nationally has important implications for diabetes screening.

RESEARCH DESIGN AND METHODS: Using the National Health Interview Survey data from 2006 to 2018, we analyzed the age of diagnosis of 24,561 respondents with diabetes, including Asian Indians (n = 320), Chinese (n = 203), Filipino (n = 495), and NHW adults (n = 23,543). We compared the mean age of diabetes diagnosis for Asian groups with NHW, controlling for sociodemographic factors, using multiple linear regression models and Forest plots.

RESULTS: About 85% of the respondents reported having healthcare coverage. Asian Indians are diagnosed with diabetes 5 years earlier (46 years old; 95% CI = 43.88–48.50, $P < 0.001$), Filipinos are not significantly different (50 years old; CI = 47.85–51.31, $P = 0.18$), while Chinese are diagnosed 2 years later (54 years old; CI = 51.76–56.37, $P < 0.05$) than NHW (51 years old; CI = 50.41–51.86, $P < 0.001$). Likewise, females, individuals with foreign nativity, and respondents with $75,000 or above in family income all reported a 1-year earlier age at diagnosis ($P < 0.001$).

CONCLUSION: From the NHIS 2006–2018, Asian Indians are diagnosed with diabetes at a significantly earlier time than NHW, while Chinese are aware of their diabetes years later. Clinicians and guideline organizations should consider ethnicity when determining screening recommendations for the onset and monitoring of the development of diabetes in Asian Americans.

Key Words: diabetes ▪ Asian health ▪ health disparities ▪ Asian subgroups ▪ age of diagnosis

Asians are the fastest-growing minority population in the United States, comprising 5.7% of the US population in 2016 and are projected to increase to 9.1% of the US population by 2060.[1] However, Asians have a different presentation of chronic diseases than non-Hispanic Whites (NHW), which varies by group.[2] For instance, Asians have a 60% higher rate of diabetes than NHW, even when considering sociodemographic variables and obesity.[3] In 2017, diabetes and diabetes complications were the fifth leading cause of death among Asian Americans.[4] Many Asians with strong cultural ties have different nutritional and lifestyle patterns than NHW, which influences the expression of diabetes mellitus type 2, cardiovascular disease, cancer, and other conditions.[5] Additionally, many Asians access healthcare differently than NHW because of financial, cultural, language, and health literacy barriers.[6] For diabetes, these barriers affect individual Asian ethnic groups differently and may account for why the risk of diabetes is substantially higher in Asians across all groups compared to NHW, with Asian Indians and Filipinos having the highest risk.[7,8]

Correspondence to: Rishab Harish Bhatt, Stanford Center for Asian Health Research and Education (CARE), Stanford University School of Medicine, 1265 Welch Road, x200, Palo Alto, CA 94045. Email: rishabb@stanford.edu

For Sources of Funding, see page 9.

Journal of Asian Health is available at https://journalofasianhealth.org

POPULAR SCIENTIFIC SUMMARY

- Screening recommendations for diabetes for Asians have been largely based on diabetes trends in non-Hispanic Whites, as opposed to Asian ethnic groups.
- In aggregate, Asian Americans are diagnosed with diabetes at an earlier age than non-Hispanic Whites. However, aggregation may mask important ethnic group-level differences.
- Diabetes develops at a lower BMI in Asians than non-Hispanic Whites. While the American Diabetes Association now recommends screening Asians over 45 years old for diabetes at a BMI of 23 (versus BMI of 25 for non-Hispanic Whites), little is known about the appropriate age to begin screening for specific Asian ethnic groups.
- Asian Indians are diagnosed with diabetes, on average, at 46 years old, 2 years before Filipinos, 4 years before non-Hispanic Whites, and 6 years before Chinese Americans.
- Despite Chinese Americans and non-Hispanic Whites having equal access to healthcare, Chinese Americans are often unaware of their diabetes status, leading to a later diagnosis of 2 years than non-Hispanic whites and an increased risk for diabetic complications.

In 2015, the US Preventive Services Task Force (USPSTF) recommended universal screening for impaired fasting glucose and diabetes for all American adults over 45 years old, as early interventions improved diabetes outcomes.[9,10] In their final report, the USPSTF acknowledged that Asians are diagnosed with diabetes at earlier ages but did not make any Asian ethnic group-specific diabetes screening recommendations.[9] Metabolic changes leading to diabetes often take years to develop, and appropriate screening for diabetes should be conducted well before the diagnosis of population-based diabetes.[10] The USPSTF's report followed the results of multiple studies, including a large national study conducted in 2011 that had demonstrated variation in diabetes prevalence across Asian ethnic groups in the United States. Asian Indians had the highest odds of type 2 diabetes prevalence, with the odds for Filipinos, other Asians, and Chinese, respectively, following close behind.[11] Another state-specific study in 2015 demonstrated earlier diabetes onset for some Asian ethnic groups.[12] Despite the previous work highlighting disparities in the ages at which Asian Americans are diagnosed with diabetes, neither diabetes prevalence nor age of diagnosis in a national sample of Asian ethnic groups has been reported upon for almost 10 years. Understanding the relative difference in the age of diabetes diagnosis between Asians Americans and the majority white American population may inform the future USPSTF screening recommendations.

In this study, we present the updated prevalence of diabetes in four major Asian ethnic groups in comparison to NHW using the 2006–2018 National Health Interview Survey (NHIS). In addition, we identified disparities in the age of diagnosis of diabetes in Asian ethnic groups living in the United States in relationship to their place of birth. Understanding the age of onset of diabetes may lead to more precise screening recommendations for individual Asian ethnic groups, even when at normal weight.

RESEARCH DESIGN AND METHODS

Data source

We examined the age of diagnosis and diabetes prevalence of Asian ethnic groups and NHW in the National Health Interview Survey (NHIS) from 2006 to 2018. NHIS is an annual, multipurpose, nationwide assessment that collects health-related information about the United States civilian population based on stratified sampling by self-report and is conducted by the National Center for Health Statistics (NCHS).

Funding

This study was considered not human subjects research by the Stanford University Institutional Review Board (protocol #57474) and was funded by the Stanford Center for Asian Health Research and Education (CARE).

Study population

Of the 381,989 NHIS participants from 2006 to 2018, we included 24,561 adults who were 20–80 years old with a self-reported diagnosis of diabetes, who shared an age of diabetes diagnosis, and who were identified as part of an Asian ethnic group (n = 1,018 who were Chinese American, Asian Indian or Filipino) or NHW (n = 23,543).

Variables

In NHIS, individuals shared their age of diabetes onset for either when they were told by a doctor that they had diabetes or sugar diabetes or their age when they received the diagnosis. Individuals were considered to have diabetes mellitus type 2 if they reported diabetes that was diagnosed after 20 years of age. Individuals who were prediabetic, had borderline diabetes, or were women with gestational diabetes were not included. Race/ethnicity was classified into Asian Indian, Filipino, Chinese, and non-Hispanic White. We obtained current age (20–80 years old), sex (male, female, and other), self-reported body mass index (BMI, height in m^2/weight in kg: <25, <30, and ≥ 30 kg/m^2),

highest education attained (less than high school, GED/some college, college degree), family income (<$25,000, <$45,000, <$75,000, and ≥ $75,000), marital status, place of birth/nativity (US-born or foreign-born), health insurance coverage (yes or no), and self-rated health status (numerical scale corresponding to 'Poor/Fair', 'Good', and 'Very good/Excellent'). Income levels were chosen based on the distribution of the data. All variables were found in the 2006–2018 publicly available NHIS Sample Adult, Persons, and Income files.

Statistical analysis

Statistical analyses were performed with R Studio (v.1.2.5033, Boston, MA). The trend over time was analyzed for the age of diagnosis of diabetes among Asian ethnic groups and NHW from 2006 to 2018. A box plot was created to describe and compare the distribution of diabetes diagnosis across racial groups. A linear regression model was then applied to the dataset to reflect the ages seen on the box plot and to understand the sociodemographic effects on the age of diabetes diagnosis. This included selecting particular reference groups for each sociodemographic variable (race, sex, place born, education, income, healthcare coverage, self-rated health status, and BMI). Based on the regression model, the predicted age of diabetes onset was computed for each group based on race/ethnicity, sex, place born, education, income, healthcare coverage, self-rated health status, and BMI. 95% confidence intervals were included in the plots.

Asians only made up 4.1% of the total population sampled in NHIS, while the total US Asian population is 6%. We used the svyglm package in R Studio instead of the standard lm package to account for both the undersampling and NHIS sampling cluster method as svyglm allows for more nuanced survey weighting.[13,14] Entries in NHIS with missing values for the survey questions of interest were excluded from the dataset.[15]

RESULTS

Demographics

Of the NHIS respondents from 2006 to 2018 who were aged 20–80 years, 24,561 respondents reported having diabetes. Of those, 320 were Asian Indian, 203 were Chinese, 495 were Filipino, and 23,543 were NHW (Fig. 1). Table 1 outlines the characteristics of these

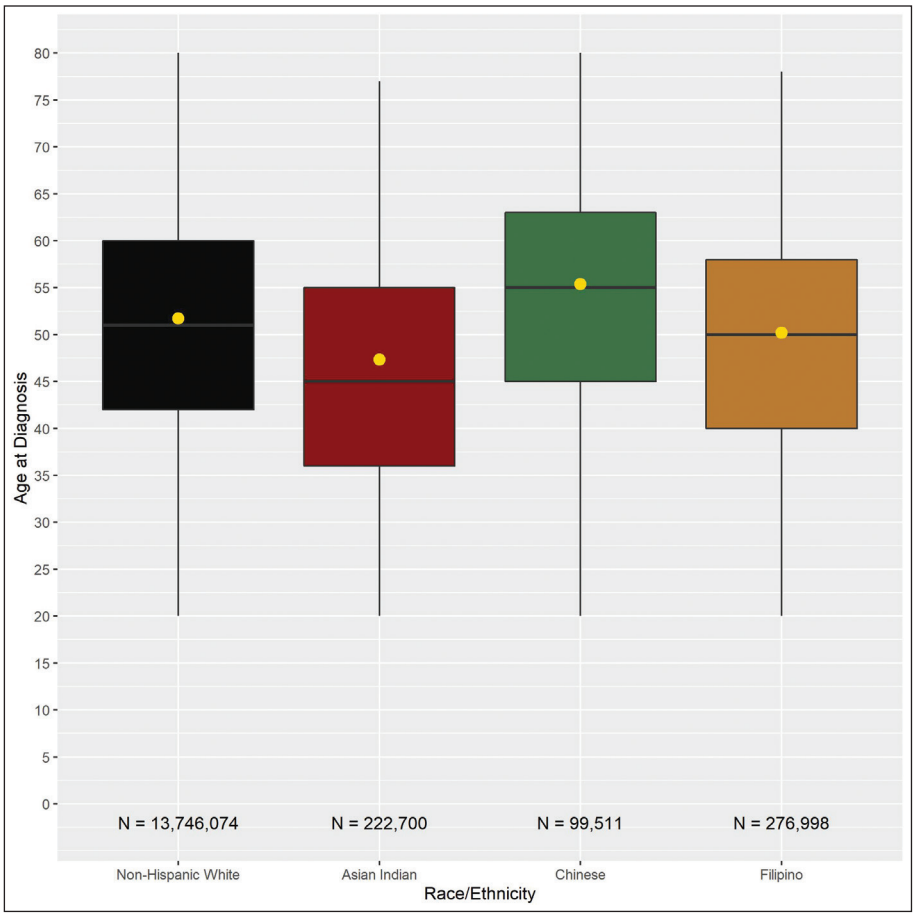

Figure 1. Age of diabetes diagnosis among population-weighted Asian ethnic groups and non-Hispanic Whites, National Health Interview Survey 2006–2018. The mean is indicated with a red circle and the median is indicated with a line.

Table 1. Demographics of National Health Interview Survey participants with diabetes, demographics, 2006–2018, using weighted population.

Characteristics	Non-Hispanic White	Asian Indian	Chinese	Filipino
	N (population weighted %) (95% confidence interval)			
Diabetes prevalence*	15,237,189	238,620	110,947	297,811
2006	966,373 (7.34%) (893,693–1,039,052)	10,942 (7.37%) (6,053–15,831)	10,548 (5.96%) (3,749–17,347)	20,179.23 (11.70%) (11,174.45–29,184.01)
2007	943,306 (7.14%) (867,535–1,019,077)	15,132 (9.99%) (7,436–22,828)	3,120 (1.87%) (179–6,061)	19,959 (11.70%) (9,106–30,811)
2008	1,069,742 (8.03%) (993,039–1,146,445)	16,798 (10.54%) (7,962–25,635)	7,773 (4.74%) (2,286–13,259)	15,703 (8.09%) (7,290–24,115)
2009	1,161,868 (8.66%) (1,084,313–1,239,423)	17,507 (10.10%) (4,591–30,424)	9,432 (6.16%) (4,593–14,272)	16,854 (8.70%) (9,604–24,104)
2010	1,170,282 (8.71%) (1,098,095–1,242,469)	15,282 (9.11%) (8,719–21,845)	6,777 (4.27%) (3,533–10,022)	23,419 (11.05%) (14,747–32,090)
2011	1,153,228 (8.49%) (1,090,176–1,216,279)	14,120 (8.50%) (7,710–20,530)	7,153 (3.78%) (4,023–10,284)	20,973 (10.47% (13,627–28,320)
2012	1,186,725 (8.63%) (1,122,054–1,251,395)	14,247 (7.23%) (7,819–20,675)	7,340 (3.91%) (3,734–10,946)	30,045 (13.18%) (20,974–39,116)
2013	1,253,803 (9.09%) (1,190,298–1,317,308)	15,640 (7.25%) (8,793–22,487)	7,301 (3.35%) (3,580–11,021)	20,957 (9.15%) (14,473–27,441)
2014	1,192,916 (8.62%) (1,129,758–1,256,074)	14,543 (6.09%) (6,737–22,350)	10,101 (4.50%) (4,454–15,748)	21,407 (10.25%) (14,815–27,998)
2015	1,261,699 (9.07%) (1,193,370–1,330,029)	28,722 (10.95%) (20,098–37,346)	8,071 (3.58%) (3,782–12,359)	21,864 (9.62%) (11,603–32,125)
2016	1,270,026 (9.08%) (1,186,685–1,353,368)	17,529 (5.87%) (7,693–27,364)	7,294 (3.11%) (2,751–11,837)	28,760 (11.16%) (16,533–40,988)
2017	1,276,090 (9.06%) (1,178,718–1,373,463)	22,895 (8.26%) (10,961–34,829)	11,212 (4.41%) (3,563–18,861)	28,760 (11.03%) (15,377–42,143)
2018	1,331,131 (9.43%) (1,244,234–1,418,028)	35,263 (11.12%) (20,401–50,124)	14,826 (5.85%) (7,314–22,337)	28,931 (11.05%) (17,709–40,154)
Age at diagnosis analysis				
Unweighted population	23,543	320	203	495
Weighted population (*n*)	13,746,074 (13,427,762–14,064,386)	222,700 (190,165–255,235)	99,511 (81,145–117,878)	276,998 (243,446–310,550)
Sex, %				
Male	7,226,213 (52.6%) (7,018,911–7,433,514)	130,907 (58.8%) (109,776–152,038)	51,227 (51.5%) (39,296–63,159)	123,456 (44.6%) (101,077–145,835)
Female	6,519,861 (47.4%) (6,331,811–6,707,911)	91,793 (41.2%) (67,874–115,712)	48,284 (48.5%) (34,887–61,681)	153,542 (55.4%) (129,851–177,233)
Education, %				
Less than high school	2,552,187 (18.6%) (2,429,817–2,674,558)	23,317 (10.5%) (11,345–35,289)	25,146 (25.3%) (17,438–32,853)	21,307 (7.7%) (13,941–28,672)
High school/GED/some college	6,838,859 (49.8%) (6,639,246–7,038,472)	51,518 (23.1%) (35,719–67,318)	27,934 (28.1%) (19,413–36,454)	112,791 (40.7%) (90,571–135,010)
College degree or more	4,294,993 (31.2%) (4,157,522–4,432,463)	147,533 (66.2%) (122,977–172,090)	44,007 (44.2%) (31,739–56,275)	140,464 (50.7%) (116,524–164,403)
Country of birth, %				
US-born	12,256,670 (89.2%) (11,957,632–12,555,709)	4,154 (1.9%) (1,023–7,285)	15,911 (16.0%) (8,921–22,902)	63,587 (23.0%) (48,541–78,633)
Foreign-born	1,485,329 (10.8%) (1,397,085–1,573,573)	218,546 (98.1%) (186,182–250,910)	83,600 (84.0%) (68,169–99,03)	212,851 (76.8%) (183,092–242,610)
Family income, %				
< $25,000	3,766,011 (27.4%) (3,617,268–3,914,753)	34,221 (15.4%) (19,225–49,217)	29,141 (29.3%) (19,659–38,623)	37,079 (13.4%) (27,872–46,286)
< $45,000	3,239,930 (23.6%) (3,119,376–3,360,483)	34,857 (15.7%) (24,067–45,647)	20,146 (20.2%) (11,645–28,647)	54,745 (19.8%) (41,027–68,463)

(*Continued*)

Table 1. (Continued)

< $75,000	3,051,411 (22.2%) (2,934,273–3,168,549)	37,378 (16.8%) (24,628–50,128)	11,159 (11.2%) (6,988–15,330)	66,181 (23.9%) (48,628–83,734)
≥ $75,000	3,688,723 (26.8%) (3,537,063–3,840,382)	116,244 (52.2%) (92,687–139,801)	39,066 (39.3%) (26,388–51,743)	118,994 (43.0%) (95,712–142,275)
Body Mass Index, %				
< 25	1,759,530 (12.8%) (1,679,194–1,839,866)	68,253 (30.6%) (52,678–83,828)	55,924 (56.2%) (40,68–71,162)	91,797 (33.1%) (73,147–110,447)
< 30	4,015,332 (29.2%) (3,878,942–4,151,722	109,981 (49.4%) (84,436–135,526	25,895 (26.0%) (18,165–33,625)	106,581 (38.5%) (86,211–126,950)
+ 30	7,971,212 (58.0%) (7,751,101–8,191,323)	44,466 (20.0%) (32,648–56,284)	17,692 (17.8%) (10,062–25,322)	78,621 (28.4%) (60,824–96,418)
Has health coverage, %				
Yes	12,749,944 (92.8%) (12,456,220–13,043,669)	204,704 (91.9%) (172,791–236,616)	94,469 (94.9%) (76,685–112,254)	260,118 (93.9%) (226,263–293,974)
No	978,207 (7.1%) (905,530–1,050,884	17,996 (8.1%) (10,733–25,260)	5,042 (5.1%) (610–9,474)	16,641 (6.0%) (6,517–26,765)
Reported health status, %				
Poor/fair	5,185,678 (37.7%) (5,008,367–5,362,989	54,491 (24.5%) (39,373–69,608)	37,350 (37.5%) (27,704–46,995)	75,805 (27.4%) (58,898–92,713)
Good	5,203,449 (37.9%) (5,042,215–5,364,682)	76,805 (34.5%) (59,623–93,986)	40,447 (40.6%) (30,330–50,564)	120,254 (43.4%) (96,788–143,720)
Very good/excellent	3,356,948 (24.4%) (3,237,469–3,476,427)	91,405 (41.0%) (70,878–111,932)	21,714 (21.8%) 12,953–30,476)	80,939 (29.2%) (61,991–99,887)

*Diabetes prevalence calculation did not require survey respondents to report or estimate their age at diagnosis.

Population weighting was conducted by using the survey and srvyr packages. Weights and sampling design were implemented as per NHIS provided values. Since data were aggregated between two different survey designs, statistical weights, PSU, and STRATA values were consolidated and adjusted as per NHIS documentation. Using summary statistic and tally functions from the srvyr and survey packages, population-weighted predictions with confidence intervals were computed.

groups after adjusting for sampling. For the NHW group, 52.6% were male, compared to 58.8% males among Asian Indians, 51.5% males in the Chinese population, and 44.6% males in the Filipino population. In Asian ethnic groups, most respondents with diabetes were foreign-born, including 98.1% of Asian Indians, 84% of Chinese, and 76.8% of Filipinos. In contrast, 10.8% of NHW participants with diabetes were foreign-born.

Many patients with self-reported diabetes were graduates, including 31.2% of NHW, 66.2% of Asian Indians, 44.2% of Chinese, and 50.7% of Filipinos. Despite the fluctuation in financial and education status, each ethnic group had substantial access (92–95%) to healthcare coverage over the past year. Healthcare coverage has significant effects on BMI and personal health status outcomes. Overall, 24.4% of NHW, 41.0% of Asian Indians, 21.8% of Chinese, and 29.2% of Filipinos stated that they had 'very good' self-rated health status. The obesity rate was highest among NHW, affecting 58.0% of individuals, whereas only 20.0% Asian Indians, 17.8% Chinese, and 28.4% Filipinos reported obesity.

Diabetes prevalence, 2006–2018

Across the years 2006 to 2018, diabetes prevalence increased for NHW and Asian Indians. Table 1 reports the year-by-year prevalence of diabetes among all Asian subgroups from 2006 to 2018, and Fig. 2 displays the prevalence graphically. In 2006, 7.3% of NHW and 7.4% of Asian Indians reported having a diagnosis of diabetes. In 2018, that percentage increased to 9.4% of NHW and 11.1% of Asian Indians. However, the prevalence of diabetes seems to have dropped between the years 2006 and 2018 from 6.0% to 5.8% for Chinese and from 11.7% to 11.1% for Filipinos.

Age of diagnosis in racial groups

After adjusting for sociodemographic factors, the age of diabetes diagnosis was 2 years older for Chinese (54 years old; 95% CI = 51.76–56.37, $P < 0.05$) and 4 years younger for Asian Indians (46 years old; 95% CI = 43.88–48.50, $P < 0.001$) than NHW (51 years old; 95% CI = 50.41–51.86, $P < 0.001$) (Fig. 3). In contrast, Filipinos did not differ significantly in the age at diabetes diagnosis (50 years old; 95% CI = 47.85–51.31, $P = 0.18$) compared to NHW.

In addition to race/ethnicity, demographic (nativity, sex, and BMI) and socioeconomic characteristics (family income, healthcare coverage, self-rated health status, and highest level of education attained) were also found to be associated with the age of diabetes mellitus type 2 diagnosis. Survey participants born

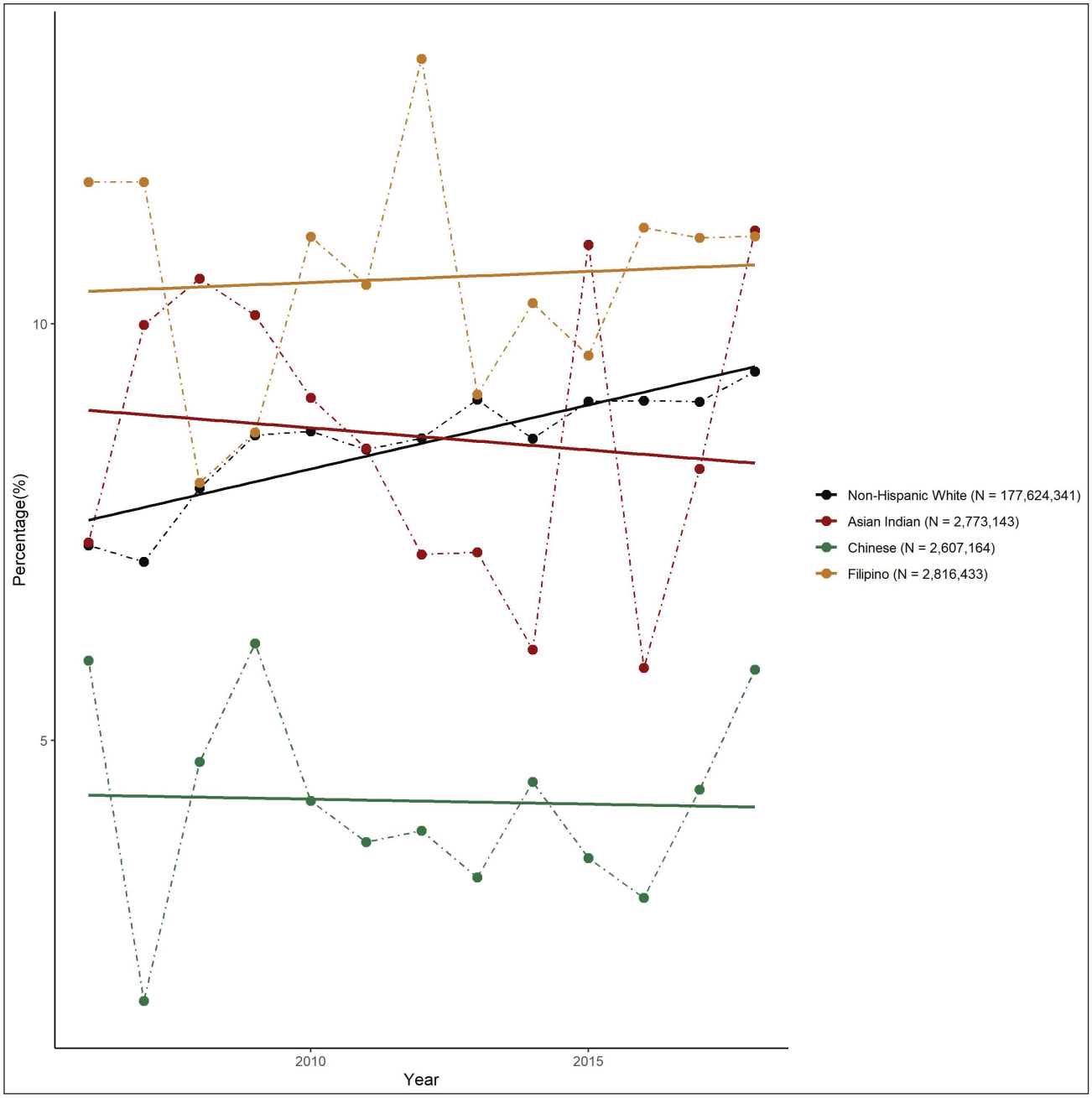

Figure 2. Diabetes prevalence time series, data from the National Health Interview Survey from the years 2006–2018.

outside of the United States (foreign nativity) and females had a 1 year earlier age of diabetes diagnosis ($P < 0.001$) than NHW participants. Participants with a BMI over 30 ('obese') were diagnosed with diabetes 2.5 years earlier than NHW participants with a BMI less than 25 ($P < 0.001$).

Family income, personal health status, and education were also associated with the age at diabetes diagnosis. Individuals with an annual family income between $45,000–$75,000 and greater than $75,000 had a 1 year ($P < 0.001$) and 3 years ($P < 0.001$) earlier age of diabetes diagnosis, respectively. Those with an annual family income less than $45,000 experienced no difference in the average age of diagnosis of diabetes compared to NHW ($P = 0.96$). Populations without adequate healthcare coverage were on average diagnosed with diabetes 8 years earlier ($P < 0.001$). Personal health status was also shown to be a predictor for diabetes diagnosis. As personal health status increased, the age of diagnosis of diabetes was delayed. Specifically, the age of diagnosis of diabetes was 1.5 years later for individuals with a personal health status of 'Good' ($P < 0.001$) and 2 years later for individuals who reported 'Very good' ($P < 0.001$). In terms of

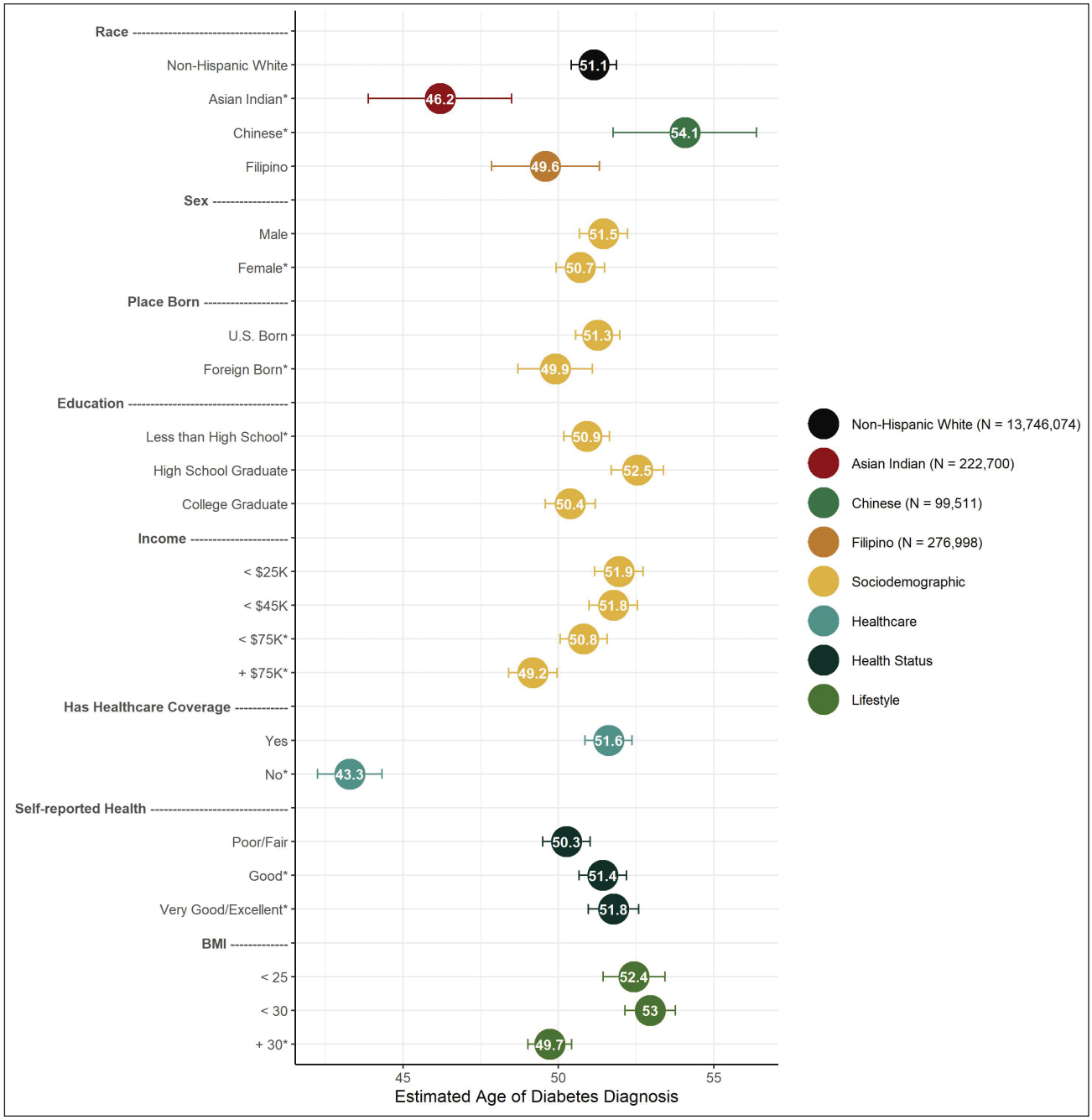

Figure 3. Predicted age of diabetes diagnosis from the multivariable regression analysis. Predicted age and 95% confidence interval.

education, participants with fewer years of secondary education were diagnosed with diabetes 2 years earlier ($P < 0.001$).

DISCUSSION

In this 12-year national sample of Asians in America, Asian Indians were diagnosed with diabetes 2 years before Filipinos, 4 years before NHW, and 6 years before Chinese Americans. Additionally, the incidence of diabetes increased by 1–3% per year for all Asian ethnic groups and NHW between 2006 and 2018. Asian Indians stand out as the Asian ethnic group with the earliest age of diagnosis of diabetes, with US-born and females having an even earlier age of diagnosis compared to other Asian ethnic groups. Chinese Americans were found to have a later age of diagnosis of diabetes, and those with a lower education level and higher self-rated health status had an even later age of diagnosis. We found an earlier onset of age of diabetes onset with patients without healthcare insurance, who were obese,

were less educated, had more income, had high self-rated health statuses, and were born outside the United States.

Our findings from a 12-year national sample parallel a state-specific sample of Asian Indians showing a significant earlier age of diabetes diagnosis than NHW.[12] Asian Indians have been found to have language and communication barriers with healthcare providers, which prevented them from having a thorough understanding of diabetes.[16,17] Additionally, many Asian Indians have diets that are vastly different from the traditional American diet,[16] and euro-centric dietary recommendations (such as 'cut down on sugary cereal and full fat milk') may be inappropriate for Asian diets (better, 'limit to one idli in the morning, and add more sambar').[16,17] Despite facing these barriers, Asian Indians tend to have a lower age of diagnosis because of increased awareness in the community.

Even with equal access to care, Chinese Americans are often unaware in relation to NHW of their diabetes diagnosis, potentially postponing diabetes leading to their later diagnosis by 2 years and increased risk for diabetic complications.[12] The rising diabetes US rates trends amongst Chinese in the US parallel the rising rates of diabetes in an urbanizing China. In China, the prevalence of diabetes has increased almost 10%, from 0.67% in 1980 to 10.4% in 2013.[18] For this reason, the Chinese Diabetes Society has published diabetes guidelines for specific Chinese populations to standardize diabetes clinical care for patients in China. These guidelines defined high-risk populations as adults (>18) with one of the following risk factors: over the age of 40, history of prediabetes, overweight or obese, sedentary lifestyle, first degree relative with type 2 diabetes, history of gestational diabetes, hypertension, dyslipidemia, atherosclerotic cardiovascular disease, history of steroid diabetes, polycystic ovary syndrome, and long-term use of antipsychotics or antidepressants. The guidelines recommend early screening for these high-risk people, such as an oral glucose tolerance test (OGTT) for individuals with abnormal fasting plasma glucose (FDG), lifestyle interventions for prediabetics, and increased intervention for patients with cardiovascular risks.[18]

Asians may develop diabetes at a lower BMI than other racial/ethnic groups, and up to 50% of Asians with diabetes may be undiagnosed.[19] 'Screen at 23' campaigns have encouraged healthcare providers to screen Asians at a BMI of 23 rather than a BMI of 25, which has been the standard for NHW.[19,20] In response, in 2015, the American Diabetes Association's 'Standards for Medical Care in Diabetes' lowered the BMI cutoff for diabetes screening for Asians.[20]

Throughout the United States and Asia, diabetes prevalence has been increasing – especially in urban China and India. This suggests that more nuanced screening recommendations for Asian ethnic groups may allow us to diagnose a large portion of the Asian population that has been overlooked. Likewise, several studies have documented the disproportionate effect of diabetes on Asian Indians, corroborating the need for greater testing and screening for diabetes at earlier ages in Asian Indians compared to other Asian ethnic groups and NHW.

Our study has several limitations. NHIS relies on accurate self-report, which may be affected by recall bias about the age at which participants were diagnosed with diabetes. Respondents may have been reluctant to disclose potentially stigmatizing conditions or behaviors such as diabetes, minimizing behaviors or viewpoints considered socially acceptable within their culture.[8] NHIS was conducted in English and undersampled Asians, as only 4.2% of NHIS 2006–2018 participants were Asian, while in 2016, 5.7% of the US population were Asian.[1] Additionally, previous literature grouped Chinese, Koreans, and Japanese separately which allowed for a more nuanced exploration of each group.[21] However, the NHIS dataset only had the Chinese group. This grouping limited our ability to investigate the later diagnosis of diabetes in Chinese. While our analysis adjusted for population distribution, undersampling could lead to under- or over-estimation of results. Finally, reported age of diabetes diagnosis may not be the individuals' true age of diabetes or prediabetes onset, as individuals may have been unaware of their diabetes status, perhaps influenced by personal and socio-demographic factors, including age, degree of acculturation, health literacy, access to care, and education.

Diabetes is part of a metabolic syndrome that results in premature death from heart disease, stroke, and renal failure, with preventable complications of blindness, infections, and amputations. In our study, among disaggregated Asians, we found a widely differing age of self-reported diabetes onset and an increasing prevalence of diabetes that varied by Asian ethnic groups. Current diabetes screening guidelines have been based on diabetes epidemiology in largely White populations. Diabetes screening recommendations should be updated to reduce the recommended age of screening for Asian Indians by 4 years and Filipinos by 2 years. Recommendations should also improve diabetes screening and awareness among Chinese in the United States.

ARTICLE INFORMATION

Received May 16, 2021; accepted May 25, 2021.

Affiliations

[1]Stanford Center for Asian Health Research and Education, Stanford University School of Medicine, Stanford, CA; [2]Departments of Neuroscience and Behavioral Biology and Computer Science, Emory University, Atlanta, GA; [3]Department of Natural Sciences, Rice University, Houston, TX; [4]Department of Industrial and Manufacturing Systems Engineering, Iowa State University, Ames, IA; [5]Stanford Center for Asian Health Research and Education, Johns Hopkins University

School of Medicine, Baltimore, MD; [6]Computational and Systems Biology Interdepartmental Program, University of California Los Angeles, Los Angeles, CA; [7]Department of Pediatrics, Stanford School of Medicine, Stanford, CA; [8]Quantitative Sciences Unit, Primary Care and Population Health, Department of Medicine, Stanford University, Stanford, CA; [9]Division of Primary Care and Population Health, Stanford University School of Medicine, Stanford, CA

Acknowledgments

All authors acknowledge the support provided by the Stanford Center for Asian Health Research and Education (CARE), Palo Alto, CA. The authors would also like to acknowledge Shozen Dan for his assistance with the statistical analysis. All authors contributed to the conceptualization, writing, and analysis of the manuscript. The authors have no potential conflicts of interest relevant to this article to report. Dr. Malathi Srinivasan is the senior author and guarantor for this manuscript.

Conflict of interest and funding

The authors have not received any funding or benefits from industry or elsewhere to conduct this study.

REFERENCES

1. Vespa J, Medina L, Armstrong DM. Population Estimates and Projections. p. 15.
2. McNeely MJ, Boyko EJ. Type 2 diabetes prevalence in Asian Americans: results of a national health survey. *Diabetes Care*. 2004;27(1):66–69. doi: 10.2337/diacare.27.1.66
3. Wang EJ, Wong EC, Dixit AA, Fortmann SP, Linde RB, Palaniappan LP. Type 2 diabetes: identifying high risk Asian American subgroups in a clinical population. *Diabetes Res Clin Pract*. 2011;93(2):248–254. doi: 10.1016/j.diabres.2011.05.025
4. Hastings KG, Jose PO, Kapphahn KI, et al. Leading causes of death among Asian American subgroups (2003–2011). *PLoS One*. 2015;10(4):e0124341. doi: 10.1371/journal.pone.0124341
5. Hsu WC, Yoon HH. Building cultural competency for improved diabetes care: Asian Americans and Diabetes. *J Fam Pract*. 2007;56:S7–S13.
6. Kim W, Keefe RH. Barriers to healthcare among Asian Americans. *Soc Work PublHealth*.2010;25(3–4):286–295.doi: 10.1080/19371910903240704
7. Jiali Y, 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. doi: 10.1016/j.annepidem.2009.03.022
8. Oza-Frank R, Ali MK, Vaccarino V, Narayan KMV. Asian Americans: diabetes prevalence across U.S. and World Health Organization weight classifications. *Diabetes Care*. 2009;32(9):1644–6. doi: 10.2337/dc09-0573
9. Siu AL. Screening for abnormal blood glucose and type 2 diabetes mellitus: U.S. preventive services task force recommendation statement. *Ann Intern Med*. 2015;163(11):861–8. doi: 10.7326/M15-2345
10. U.S. Preventive Services Task Force. Screening for type 2 diabetes mellitus in adults: U.S. preventive services task force recommendation statement. *Ann Intern Med*. 2008;148(11):846. doi: 10.7326/0003-4819-148-11-200806030-00007
11. Lee JWR, Brancati FL, Yeh H-C. Trends in the prevalence of type 2 diabetes in Asians versus Whites: results from the United States National Health Interview Survey, 1997–2008. *Diabetes Care*. 2011;34(2):353–7. doi: 10.2337/dc10-0746
12. Becerra MB, Becerra BJ. Disparities in age at diabetes diagnosis among Asian Americans: implications for early preventive measures. *Prev Chronic Dis*. 2015;12:E146. doi: 10.5888/pcd12.150006
13. 2018 National Health Interview Survey (NHIS) Survey Description. 2019.
14. Svyglm Function | R Documentation. Available from: https://www.rdocumentation.org/packages/survey/versions/4.0/topics/svyglm [cited 28 December 2020]
15. Lumley T. Package 'survey': analysis of complex survey samples. Available from: https://cran.r-project.org/web/packages/survey/survey.pdf [cited 3 April 2020]
16. Sohal T, Sohal P, King-Shier KM, Khan NA. Barriers and facilitators for type-2 diabetes management in South Asians: a systematic review. *PLoS One*. 2015;10(9):e0136202. doi: 10.1371/journal.pone.0136202
17. Pardhan S, Nakafero G, Raman R, Sapkota R. Barriers to diabetes awareness and self-help are influenced by people's demographics: perspectives of South Asians with type 2 diabetes. *Ethn Health*. 2020;25(6):843–861. doi: 10.1080/13557858.2018.1455809
18. Jia W, Weng J, Zhu D, et al. Standards of medical care for type 2 diabetes in China 2019. *Diabetes/Metabol Res Rev*. 2019;35(6):e3158. doi: 10.1002/dmrr.3158
19. Screen at 23 | The New BMI for Diabetes Screening. Available from: https://screenat23.org/ [cited 22 January 2021]
20. Association AD. 2. Classification and diagnosis of diabetes: standards of medical care in diabetes – 2020. *Diabetes Care*. 2020;43(Supplement 1):S14–31. doi: 10.2337/dc20-S002
21. Cheng YJ, Kanaya AM, Araneta MRG, et al. Prevalence of diabetes by race and ethnicity in the United States, 2011–2016. *JAMA*. 2019;322(24):2389. doi: 10.1001/jama.2019.19365