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_____	_____
Xiuru Ying	Date

Acculturation and diabetes care utilization among Asian Americans with diabetes

By

Xiuru Ying

Master of Science in Public Health

Health Policy and Management

Puneet Kaur Chehal

Committee Chair

Megha Shah

Committee Member

Adam S. Wilk

Committee Member

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By

Xiuru Ying

Bachelor of Medicine

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Thesis Committee Chair: Puneet Kaur Chehal, PhD, MA

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Abstract

Acculturation and diabetes care utilization among Asian Americans with diabetes
By Xiuru Ying

In the United States, diabetes and its complications cause significant morbidity and mortality and are associated with substantial healthcare costs for the healthcare system and society. Although effective treatments for diabetes exist, unmanaged diabetes remains a major challenge for many individuals, healthcare providers, and insurers. Even though unmanaged diabetes is common and can occur in all racial groups, disparities exist in diabetes care, especially in Asian Americans. Acculturation is a multidimensional socialization process in which individuals from one culture adapt components of another culture. Acculturation can be associated with the prevalence of diabetes among Asian Americans in the United States. There is also evidence linking acculturation to better diabetes care. Therefore, this study explored acculturation's role in diabetes prevalence and diabetes care utilization among Asian Americans in the United States. A conceptual model was developed drawing on the Anderson Behavioral Model for Health Care Utilization. This model had three main components: predisposing, enabling, and need-for-care factors. Another component was personal health behaviors. This study used 2013-2018 California Health Interview Survey (CHIS) data. We restricted our sample to 11,313 adults who self-reported as Asians. Then, we included 1,423 respondents who had diabetes in our analytic sample. This was the first population-based study of the association between acculturation and diabetes prevalence and diabetes care utilization among Asian-American adults in California. No significant association was found between acculturation and diabetes prevalence after adjusting for covariates and personal health behaviors. However, there was a significant association between acculturation and medical plan for diabetes. Higher levels of acculturation were associated with increased use of diabetes care plans among Asian Americans with diabetes, controlling for covariates and personal health behaviors. Acculturation was not significantly associated with foot or eye examinations, hemoglobin A1C checks, and flu shots among Asian-American adults with diabetes. With and without personal health behaviors variables introduced, the results were similar. Acculturation picked up on mechanisms outside of what was measured through personal health behaviors. The study could help develop future health interventions applicable to Asian Americans with diabetes for better diabetes care use.

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Table of Contents

Introduction

In the United States, diabetes and its complications cause significant morbidity and mortality and are associated with substantial healthcare costs. It is estimated that by 2050, the number of Americans diagnosed with diabetes will more than double, from 5.62% to 12.00% (1). Additionally, diabetes was the seventh leading cause of death (2) and has become a more costly disease over time (3). The economic cost of diabetes increased by 26% from 2012 to 2017 ($327 billion in 2017), with the increase concentrated on elderly Medicare enrollees (4).

Although effective treatments for diabetes exist (5), unmanaged diabetes remains a major challenge for many individuals, healthcare providers, and insurers (6). Nine Americans die every twenty minutes from diabetes-related complications (6). Despite an overall improvement in glycemic control in adults with diabetes, more than 85% of diabetic patients have not achieved goals for all three critical care measures simultaneously, including blood glucose, blood pressure, and low-density lipoprotein (LDL) (7). Without timely treatment, diabetes can lead to many complications (8). More specifically, diabetic patients are more likely to develop microvascular (nephropathy, retinopathy, neuropathy) and macrovascular (heart disease, stroke) complications, leading to death (8, 9).

Even though unmanaged diabetes is common and can occur in all racial groups, researchers have documented disparities in diabetes care, especially in Asian Americans. As the fastest-growing racial group in the United States (10), Asian Americans are more at risk of diabetes than non-Hispanic Whites (1.6 times higher) (11) and have more complications (12, 13). For example, Asian Americans with diabetes have a 44% greater risk of end-stage renal disease compared to White Americans (12). In addition, Asian Americans are

significantly less likely to achieve their glycemic and cholesterol targets (14), and they have a higher rate of diabetic retinopathy than patients with diabetes who are Whites (13). Moreover, disparities in diabetes occur among Asian subgroups. In non-Hispanic Asian adults, the prevalence of diabetes was significantly higher in South Asian (23.3%) and Southeast Asian (22.4%) than in East Asian subgroups (14.0%) (15). Furthermore, other studies indicated that the prevalence was highest in Filipino and Asian Indian Americans (16, 17).

Acculturation is a significant contributor to disparities in diabetes care among Asian Americans. Acculturation is a multidimensional socialization process in which individuals from one culture adapt components of another culture (18), including customs, language, activities, habits, and values (19). On the one hand, acculturation has been associated with the prevalence of diabetes among Asian Americans in the United States. Japanese Americans in Hawaii who retained more of a Japanese lifestyle had a lower prevalence of diabetes (20). In addition, foreign-born Japanese had a lower prevalence of diabetes than US-born Japanese (21). Similar studies of Chinese Americans did not find a link between the prevalence of diabetes and acculturation (22). On the other hand, there is evidence linking acculturation to better diabetes care (23). More efficient use of health services may explain this link; however, a more nuanced analysis of the services is more likely to be used (24, 25).

This study aims to explore the role acculturation plays in the prevalence of diabetes among Asian Americans and diabetes care utilization among the large population of Asian Americans with diabetes in California. Potential heterogeneity may exist due to geographic location or subgroup differences (20-22). Using detailed survey data that allows for analysis of additional measures of care utilization (e.g., dilated eye exams or flu shots) is yet to be

studied in the literature.

Literature Review

Diabetes in Asian Americans

Diabetes is a group of metabolic disorders characterized by the inability to produce insulin, insulin resistance, or both, leading to a high blood glucose level (26). Asian Americans are the fastest-growing race in the United States (10). Between 2000 and 2019, the Asian population of the United States almost doubled and is expected to exceed 46 million by 2060 (10). By the middle of this century, Asian Americans will likely become the largest immigrant group in the United States (10).

Asian Americans are more at risk of diabetes and have more complications. In the United States, a 2011-2012 cross-sectional survey found that the prevalence of diabetes was higher among non-Hispanic Asian participants (20.6%) than non-Hispanic White participants (11.3%) (27). In a similar cross-sectional study involving 7575 adults in 2011-2016, the prevalence of diabetes among non-Hispanic Asian Americans was 19.1% (12.1% for non-Hispanic Whites) (15). Given the relative lack of diabetes screening among Asian Americans, diabetes may be more prevalent than statistics suggest. Further, non-Hispanic Asian participants (50.9%) had more undiagnosed cases than other racial groups (27). The difference in the prevalence of diabetes between the Asian-American population and other nationalities can be attributed to genetic, epigenetic, lifestyle, and environmental factors (28).

Without timely treatment, diabetes can lead to many complications, resulting in significant morbidity and mortality in the United States (8). Vascular complications of macrovascular and microvascular systems are the major types of diabetic complications (29). Similar to White Americans, Asian Americans with diabetes generally suffer from

hypertension, hypercholesterolemia, retinopathy, and foot ulcers (30). However, Asian Americans were 34% less likely to receive diabetes care than non-Hispanic Whites (31). One study examining White-Asian Americans' differences in blood glucose, cholesterol, and blood pressure control showed that Asian American patients were significantly less likely to achieve their glycemic goal and 42% less likely to meet their cholesterol goal than White patients (14). Asian Americans also have a higher rate of diabetic retinopathy than White Americans (13).

Acculturation and prevalence of diabetes among Asian Americans

Acculturation is a multidimensional socialization process in which individuals from one culture accept another culture (18). It includes changes in customs, language, activities, habits, and values (19). Researchers used a variety of proxies for acculturation, including length of time in the United States, generational status, birthplace, diet change, health literacy, and language proficiency (22, 32-34).

In the United States (US), acculturation is associated with diabetes prevalence among some minority populations (23, 35, 36). In examining the relationship between acculturation to a Western lifestyle and diabetes prevalence among 8,006 Japanese Americans in Hawaii, a reduced prevalence of diabetes was observed among men who retained a more Japanese lifestyle (20). The prevalence of diabetes was relatively low among foreign-born Japanese living in New York compared to US-born Japanese (21). Also, a significant positive association between dietary acculturation and diabetes risk was found in Asian Indians in the United States (32). However, in the Multi-Ethnic Study of Atherosclerosis, the prevalence of diabetes was not related to acculturation among 737 Chinese participants, with acculturation

measured by using nativity, years living in the US, and language spoken at home (22).

Acculturation and use of diabetes care among Asian Americans with diabetes

According to guidelines for diabetes from the American Diabetes Association (ADA) (37), checking A1C at least every 3-6 months, having a complete foot exam at least once a year, etc., are necessary standards of medical care. Among Asian Americans, acculturation has been associated with adherence to health management behaviors and medical services utilization. For instance, compared to those with lower levels of acculturation, Chinese Americans diagnosed with diabetes with higher levels of acculturation were more likely to perform self-management behaviors, such as taking medications, regulating diet, exercising, self-monitoring blood glucose, and maintaining foot care (25). Moreover, according to national data, acculturation was positively associated with glycemic goal achievement in Asian-American patients (23). One aspect of underutilizing healthcare among Asian Americans with lower levels of acculturation (38) was related to the fact that they have more communication problems with healthcare providers than their more acculturated counterparts (39, 40). Language can be another barrier to high-quality medical care (41).

The relationships between acculturation and diabetes-related health outcomes may be influenced by socioeconomic status, health literacy, and other factors. Among Korean Americans with type 2 diabetes, education and acculturation have been shown to be significant factors affecting health literacy, thereby affecting self-management of diabetes and health outcomes (33). Chinese Americans with type 2 diabetes and low English proficiency were less likely to complete daily diabetic tasks due to limited communication with healthcare providers (42). Language proficiency in other parts of the world has been shown to

impact diabetic complications positively. Among Indian Asians in Singapore, Tamil-speaking Indians were more likely to suffer from type 2 diabetes and diabetic retinopathy than English-speaking Indians (34).

From the above findings, not all diabetes care use has been studied in Asian Americans. For example, no study has explored the relationship of acculturation with dilated eye exams and flu shots in Asian Americans with diabetes.

California

California has the largest Asian population in the United States. It is also a reasonable state to characterize better the relationship between the acculturation of Asians and the prevalence of diabetes and the use of diabetes care. The prevalence of diabetes among Asian immigrants in California has been increasing over the past decade (43). Using California Health Interview Survey (CHIS) 2007 data, results showed that Japanese, Filipinos, and Koreans were 1.6-1.75 times more likely to develop diabetes than Caucasians, taking into account differences in lifestyle and other risk factors between Caucasians and major Asian subgroups in California (44). Moreover, non-obese South Asians had a higher prevalence of diabetes than their White counterparts in California (45).

There are racial differences in disease management among California residents. English proficiency is also a consideration when studying diabetes care in minority groups. Asian Californians with diabetes who had limited English proficiency were less likely to receive standard care for diabetes than Caucasians who were proficient in English (46). Specifically, Asian respondents with limited English proficiency who had diabetes were less likely to receive a foot exam than Caucasians, and they received a foot exam significantly less often

than those proficient in English (46). No studies have explored the relationship between acculturation and diabetes prevalence and diabetes care use in this population.

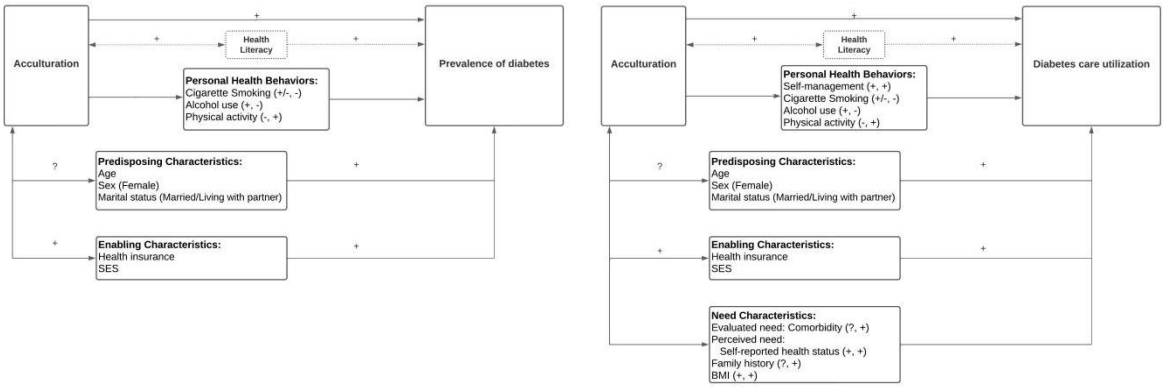
The prevalence of diabetes is disproportionately high in Asian-American populations, and the estimates likely underestimate the true prevalence of diabetes among Asian Americans. Diabetes interventions are effective, given the high mortality and waste of medical resources associated with diabetic complications (3, 29, 47). Thus, there is a need to understand diabetes care utilization in Asian Americans. Research suggested that acculturation might positively affect diabetes care since it could increase help-seeking behaviors and professional services uses (24).

Methods

Theoretical Framework

To examine the relationships between acculturation and 1) the prevalence of diabetes among Asian Americans and 2) diabetes care utilization among Asian-American patients with diabetes, we developed a conceptual model (Figure 1) drawing on the Andersen Behavioral Model for Health Care Utilization (48). This model had three main components: predisposing, enabling, and need-related factors, which could facilitate and/or hinder diabetes care utilization among individuals. Predisposing characteristics are biological or social factors that include demographic features, social structural elements, and individuals' beliefs, attitudes, and knowledge about health services. Enabling factors are resources available at the community and individual levels that make it easier to get care. Need-related factors include how people perceive their own health and functional status (i.e., perceived need), as well as how medical professionals evaluate their health and functional requirements (i.e., evaluated need). Another component of this model included personal health behaviors, which recognized personal health practices such as self-care as well as one's interactions with the health care system to influence health outcomes. Based on previous research, we have included the directions for the hypothesized linkages between the constructs in the model.

Figure 1: Conceptual model



Focal Relationships

The primary focal relationship of the conceptual model was the association between acculturation and diabetes care utilization among Asian Americans with diabetes. To better analyze our findings specific to California in the context of the broader research, we also evaluated the association between acculturation and the prevalence of diabetes among Asian Americans.

Acculturation is the process by which individuals or groups moving from one culture adapt to another culture (49). It reflects the sociocultural (food, language preference, cultural identity) and psychological changes that occur when those from different cultures interact (50). Prevalence of diabetes refers to the percentage of people diagnosed with diabetes, reflected in this study as the probability of self-reported diabetes diagnosis. Diabetes care, conducted by health professionals in medical settings, is one part of clinical care utilization that aims to lower future healthcare costs and disease burden in the population (51). For those diagnosed with diabetes, diabetes care services include hemoglobin A1C testing, professional foot examination, and eye examination with dilation (37). Some empirical research findings link acculturation with the prevalence of diabetes among Asian Americans as well as diabetes

care utilization among Asian adults with diabetes.

Health literacy was presented as one mechanism in this model. Through changes in health literacy, acculturation can impact diabetes care utilization. Health literacy refers to abilities that enable people to make informed health decisions and navigate the healthcare system effectively (52). Since higher levels of acculturation are significantly correlated with health literacy and lack of health literacy is a major barrier to the successful management of diabetes, such as glucose control and quality of life (33), health literacy has the potential to be the mediator between acculturation and use of diabetes care. However, health literacy is difficult to measure. It was shown with a dotted line box.

Personal health behaviors were presented as another mechanism in this model. They included cigarette smoking, alcohol use, physical activity, and self-management of diabetes. Among those with increased acculturation, men have reduced smoking, but women have increased it (53). Acculturation can have positive and negative effects, so we observed the net effect of all the factors in the data. Acculturation is positively associated with alcohol consumption (54). Cigarette smoking and alcohol consumption are barriers to diabetes healthcare adherence (55). Physical activity is defined as physical movements produced by skeletal muscles, resulting in energy expenditure (56). Prior research has reported that greater acculturation to the United States is associated with lower physical activity (57). However, more physical activity could improve healthcare use and lead to better diabetes control (57). Self-management of diabetes includes self-monitoring blood glucose, self-checking feet for scores or irritations (58), and regular insulin or diabetic medication adherence. Self-management behaviors are positively associated with acculturation and are suggested to

relate to the broader use of diabetes care (23, 25).

Covariates

The following characteristics were covariates of the focal relationships.

Predisposing characteristics

Demographic covariates included age, biological sex, and marital status. Those who are older (versus younger), female (versus male), and married or living with a partner (versus widowed/separated/divorced or never married) are more likely to be diagnosed with diabetes and use healthcare (59-61). However, how they are associated with acculturation in this population is still being determined.

Enabling characteristics

Enabling characteristics included health insurance and socioeconomic status (SES). Health insurance is a means of financing the cost of health care for individuals (62). Individuals with higher levels of acculturation are more likely to have health insurance, and those with health insurance (versus uninsured) are more likely to be diagnosed with diabetes and access and use healthcare services (63). SES, defined as a family's or individual's relative position in a hierarchical social structure based on their access to or control over wealth, prestige, and power, has been linked to health disparities among US populations (64, 65). SES positively affects acculturation, diabetes prevalence, and healthcare use (66).

Need characteristics

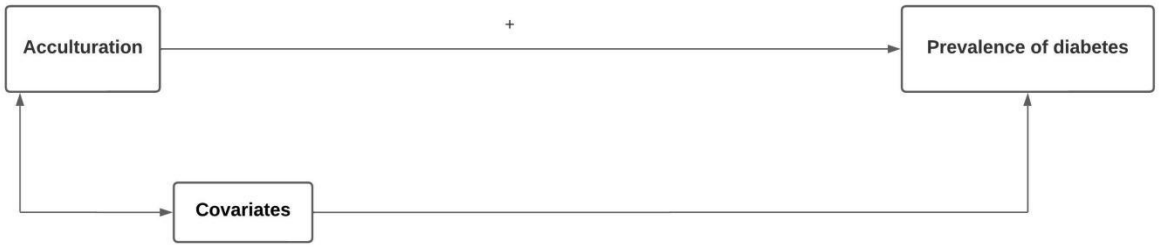
Perceived need shows how people evaluate their own health and functional status, and evaluated need shows how medical professionals evaluate people's health and functional requirements (48). In this study, perceived need included self-reported health status (how

individuals view their overall health), and evaluated need included comorbidity. It was found that Asian groups with lower acculturation levels were more likely to report fair/poor self-rated health status (67). Those with comorbidity or fair/poor self-reported health are more likely to use healthcare.

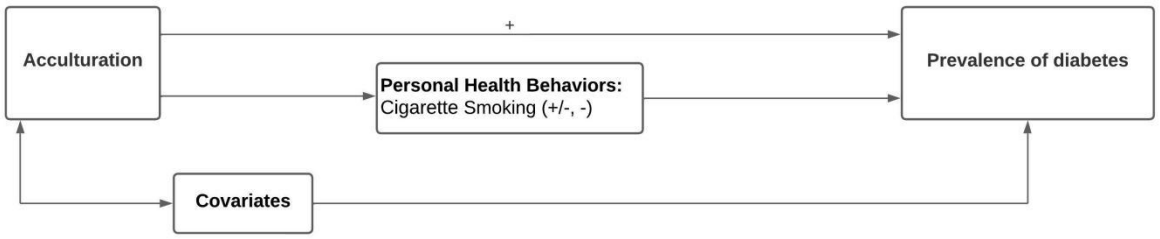
Family history of diabetes can influence insulin resistance and secretion, as evidenced by genetic factors and clustered family lifestyle factors (68, 69). The relationship between acculturation and a family history of diabetes is difficult to determine. Body mass index (BMI) is a statistical index that uses a person's weight and height to calculate body fat (70). BMI has been shown to be positively associated with acculturation (71). Weight gain is a risk factor for diabetes (72). There is a positive relationship between BMI and diabetes risk in Asian populations, and this risk can occur at lower BMI levels (73).

Hypotheses

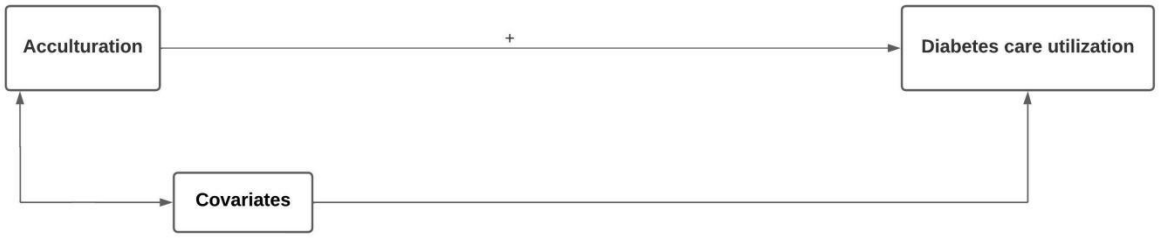
H1: Higher levels of acculturation are associated with a higher prevalence of diabetes among Asian Americans, controlling for covariates.



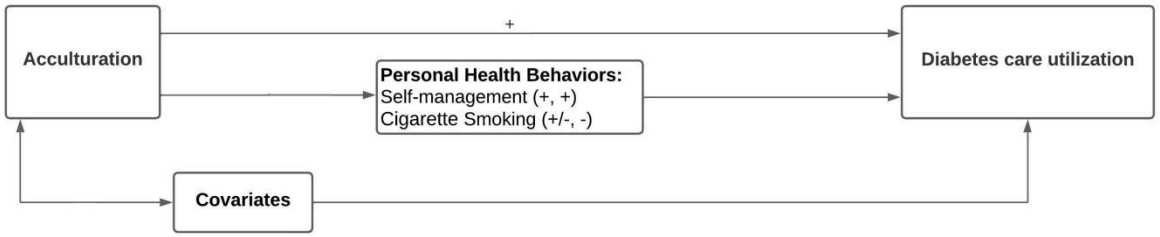
H2: The positive association between acculturation and the prevalence of diabetes among Asian Americans is partially explained after including personal health behaviors in the model.



H3: Higher levels of acculturation are associated with increased use of diabetes care among Asian Americans with diabetes, controlling for covariates.



H4: The positive association between acculturation and the use of diabetes care among Asian Americans with diabetes is partially explained after including personal health behaviors in the model.



Dataset

This study used annual cross-sectional data from the California Health Interview Survey (CHIS) from 2013 to 2018 (74). CHIS is the largest state health survey in the country, covering a wide range of health concerns. It is an ongoing web and telephone survey. CHIS uses a random digit dialing (RDD) telephone sampling strategy. The proportion of phone interviews has increased in recent years to address the growing general population that can only be accessed via cell phones. Over 20,000 Californians (adults, adolescents, and children)

are interviewed annually. Moreover, CHIS is conducted in English, Spanish, Chinese (Cantonese and Mandarin dialects), Korean, Tagalog, and Vietnamese to represent a diverse population.

Our sample included all adults (≥ 18 years old at the time of the survey) who self-reported as Asians and had diabetes or sugar diabetes. Sugar diabetes is an outdated term that some people use to refer to diabetes. Those who had gestational diabetes only and self-reported diagnosis of borderline or prediabetes only were excluded. Some bias may arise from self-reported data compared to health administrative data (75).

Analytic sample derivation

Figure 2 showed the derivation of our analytic sample. Using the CHIS, we identified 124,659 adults (aged ≥ 18 years) living in California who responded to the survey in 2013-2018. We restricted our sample to 11,313 adults who self-reported as Asians (Sample 1). It was measured using the question, "Other than during pregnancy, has a doctor ever told you that you have diabetes or sugar diabetes?" Responses were "Yes" and "No." Then, we excluded 9,890 who had never had diabetes, including those who only had gestational diabetes and those with pre-diabetes or borderline diabetes only.

No missing values were observed in our key independent variables, model covariates, and our three outcome measures (foot examination, eye examination, and medical plan for diabetes). As a result, we included 1,423 respondents with a history of diabetes or sugar diabetes in our second analytic sample (Sample 2). When estimating the hemoglobin A1C check, we excluded 384 respondents with missing values in this outcome measure, resulting in 1,039 respondents in our third analytic sample (Sample 3). We further excluded 166

respondents with missing values in the last outcome measure, flu shot, resulting in 873 respondents in our fourth analytic sample (Sample 4).

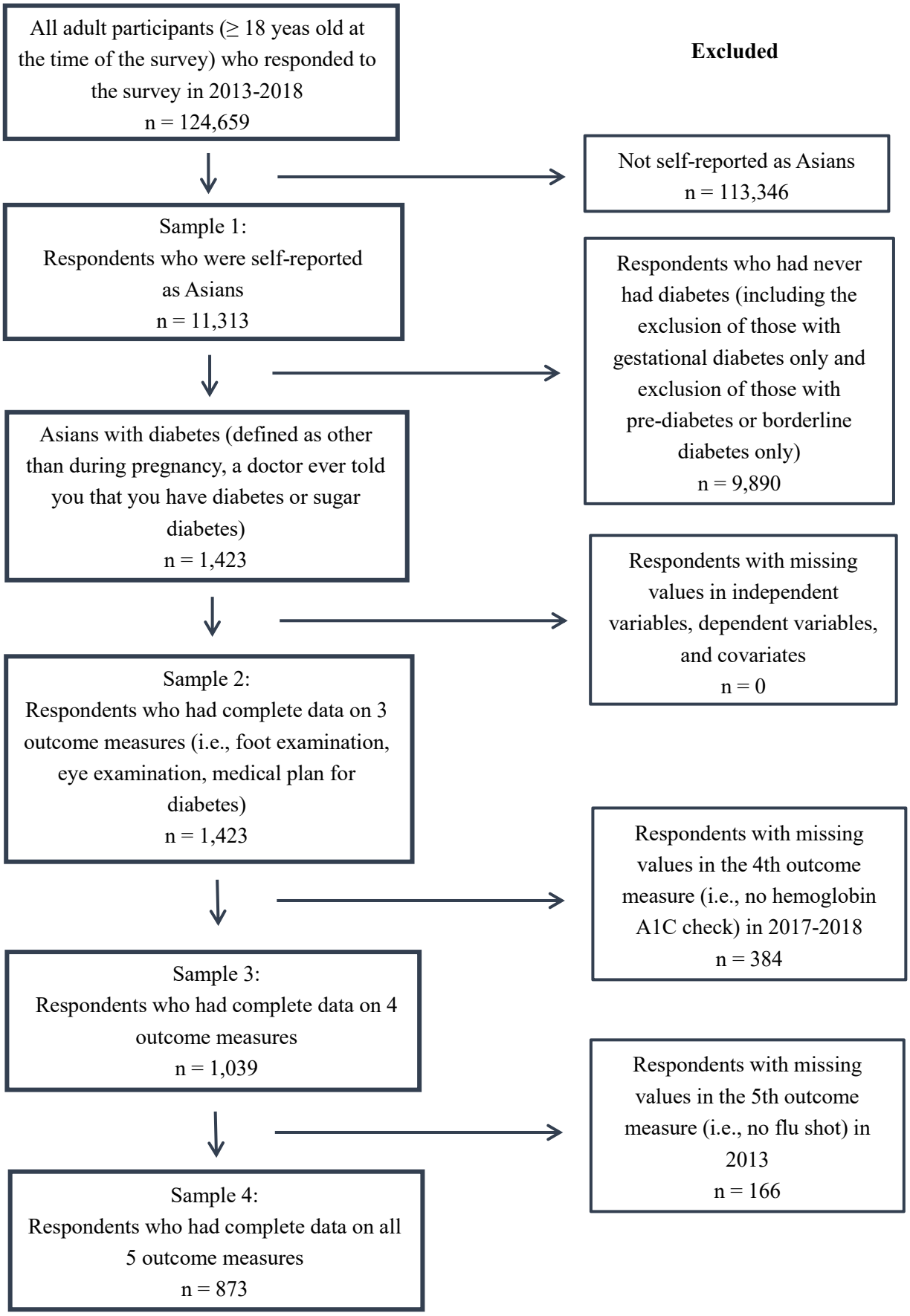


Figure 2: Sample derivation flowchart

Measurement

Acculturation. According to previous literature (76), acculturation was measured by combining birthplace, duration of US residency, and language spoken at home. In the CHIS, birthplace was measured using the question, "In what country were you born?" Responses were reclassified into two categories: US-born and foreign-born. Duration of US residency was measured using question "About how many years have you lived in the United States?" Responses were reclassified into three categories: < 5 years, 5-9 years, and ≥ 10 years. Additionally, language spoken at home was measured using question "What languages do you speak at home?" Responses were reclassified into three categories: a non-English language only, English and another language, and English only. Then, birthplace and duration of US residency were assigned a score of 0-3: 0 = foreign born, resided in the US for < 5 years; 1 = foreign born, resided in the US for 5-9 years; 2 = foreign born, resided in the US for ≥ 10 years; 3 = US born. Language spoken at home was assigned a score of 0-2: 0 = a non-English language only; 1 = English and another language; 2 = English only. Finally, acculturation was dichotomized. The index score was the simple sum of the two previous measures: 0 = less acculturated, acculturation index score 0-3; 1 = more acculturated, acculturation index score 4-5.

Diabetes care utilization. The dependent variables included five outcomes: hemoglobin A1C check, foot examination, eye examination, flu shot, and medical plan for diabetes. The first four were recommendations from the American Diabetes Association (ADA)'s standards of medical care in diabetes (37). We also included the medical plan for diabetes as one of the outcomes since it was an indicator of the anticipated use of medical resources.

Participants were asked, “About how many times in the last 12 months has a doctor or other health professional checked you for hemoglobin ‘A one C’?”, “Number of times doctor checked for feet for sores last year,” “When was the last time you had an eye exam in which the pupils were dilated?”, “During the past 12 months, did you get a flu shot or the nasal flu vaccine called FluMist?” and “Have your doctors or other medical providers worked with you to develop a plan so that you know how to take care of your diabetes?”

Then, five indicator variables were created to assess: whether hemoglobin A1C was checked at least twice in the past year, whether foot examination/eye examination was conducted by a health professional at least once in the past year, whether a flu shot was got in the past year, and whether doctors or other medical providers worked with to develop a plan to take care of diabetes. All responses were re-categorized as dichotomous variables (“Yes” and “No”).

Predisposing characteristics. Predisposing characteristics included age, sex, and marital status. Age was a categorical variable with three categories, 18-44, 45-64, and ≥ 65. Then, sex was a dichotomous variable, categorized as male and female. In addition, marital status was a categorical variable; individuals were married/living with partner, widowed/separated/divorced, or never married.

Enabling characteristics. Enabling characteristics included health insurance and SES. Health insurance status was a categorical variable. Individuals were categorized as uninsured, public only (Medicare and Medicaid, Medicare, Medicaid, and other public), or private. SES was assessed by using categorical variables of income and education. Responses to income as a percent of the federal poverty level (FPL) were categorized as 0-99% FPL, 100-199% FPL,

200-299% FPL, or 300% FPL and above. Education categories included ≤ high school, vocational/some college, college graduate, and graduate degree.

Need characteristics. Evaluated needs included comorbidity, including any chronic diseases. As a perceived need, self-reported general health condition was categorized as excellent/very good/good or fair/poor. Also, BMI was calculated from self-reported height and weight as a categorical variable with four categories, underweight 0-18.49, normal 18.5-24.99, overweight 25.0-29.99, and obese 30.0+.

Personal health behaviors. Personal health behaviors included self-management and cigarette smoking. Taking insulin and taking diabetic pills were two self-management behaviors. Participants were asked, "Are you now taking insulin?" and "Do you now take diabetic pills to lower your blood sugar?" Both responses were re-categorized as dichotomous variables ("Yes" and "No"). Additionally, cigarette smoking was assessed by asking, "Do you now smoke cigarettes every day, some days, or not at all?" Responses were reclassified into four categories: every day, some days, quit smoking, and never smoked.

Table 1: Constructs measures to estimate the association between acculturation and diabetes care utilization

Construct	**Measure**	**Hypothesized relationship to the DV**
Acculturation	• Birthplace and duration of US residency were assigned a score of 0-3: 0 = foreign born, resided in the US for < 5 years; 1 = foreign born, resided in the US for 5-9 years; 2 = foreign born, resided in the US for ≥ 10 years; 3 = US born • Language at home was assigned a score of 0-2: 0 = speaks a non-English language only; 1 = speaks English and another language;	(+)

	2 = speaks English only ● Acculturation was dichotomized: 0 = less acculturated, acculturation index score 0-3; 1 = more acculturated, acculturation index score 4-5	
Diabetes care utilization	Foot examination conducted by a health professional at least once in the past year: ● Yes ● No Eye examination with dilation conducted by a health professional at least once in the past year: ● Yes ● No Doctors or other medical providers worked with to develop a plan to take care of diabetes: ● Yes ● No Hemoglobin A1C checked at least twice in the past year: ● Yes ● No Get a flu shot or the nasal flu vaccine (Flumist) in the past year: ● Yes ● No	--
Health literacy	Unmeasured	(+)
Age (years)	● 18-44 ● 45-64 ● ≥ 65	(+)
Sex	● Male ● Female	(Female)(+)
Marital status	● Married/Living with Partner ● Widowed/Separated/Divorced ● Never married	(Married/Living with Partner)(+)
Health insurance	● Uninsured ● Public only (Medicare & Medicaid, Medicare, Medicaid, Other public) ● Private	(+)
SES	Income as percent of federal poverty level (FPL): ● 0-99% FPL ● 100-199% FPL ● 200-299% FPL ● 300% FPL and above Educational Attainment: ● ≤ High school	(+)

	• Vocational/Some college • College graduate • Graduate degree	
Perceived need	Self-reported general health condition: • Excellent/Very good/Good • Fair/Poor	(+)
Evaluated need	Comorbidity ≥1: • Yes • No	(+)
Family history	Unmeasured	(+)
BMI (kg/m^2)	• Underweight 0-18.49 • Normal 18.5-24.99 • Overweight 25.0-29.99 • Obese 30.0+	(+)
Self-management	Take insulin: • Yes • No Take diabetic pills: • Yes • No	(+)
Cigarette smoking	• Every day • Some days • Quit smoking • Never smoked	(-)
Alcohol use	Unmeasured	(-)
Physical activity	Unmeasured	(+)

Analytic strategy

In order to address the research questions, descriptive analyses and logistic regression models were implemented to assess the focal relationships. The first model aimed to estimate the relationship between acculturation and the prevalence of diabetes among Asian Americans and test H1. The model was (Prevalence of diabetes=1) = $\beta_0 + \beta_1 X_A + \beta_2 X_C + E$, where X_A represented acculturation, and X_C represented covariates. Another model aimed to test H2, which introduced mechanisms. The model was (Prevalence of diabetes=1) = $\beta_0 + \beta_1 X_A + \beta_2 X_C + \beta_3 X_M + E$, where X_A represented acculturation, X_C represented covariates, and X_M represented mechanisms.

The third model aimed to estimate the relationship between acculturation and diabetes care utilization among Asian Americans with diabetes and test H3. The model was (Diabetes care utilization=1) = $\beta_0 + \beta_1 X_A + \beta_2 X_C + E$, where X_A represented acculturation, and X_C represented covariates. The last model aimed to test H4, which introduced mechanisms. The model was (Diabetes care utilization=1) = $\beta_0 + \beta_1 X_A + \beta_2 X_C + \beta_3 X_M + E$, where X_A represented acculturation, X_C represented covariates, and X_M represented mechanisms. In each model, diabetes care utilization had five outcomes, meaning there were five specific models.

Data cleaning and descriptive analyses were performed in SAS 9.4. All regression analyses were performed in STATA 17.0. Regression coefficients were reported as odds ratios, and CHIS sampling weights were used to adjust for nonresponse and the complex survey design.

Sensitivity Analyses

All models were re-estimated to test the robustness of the findings using different cut-point reconstructions of the level of acculturation. Specifically, acculturation was reclassified into three categories: 0 = least acculturated, acculturation index scores 0-2; 1 = moderate acculturated, acculturation index score 3; 2 = most acculturated, acculturation index scores 4-5.

Results

Results from Descriptive Analyses

Sample Characteristics of all Asian Americans

Table 2 presented the weighted characteristics of all Asian Americans overall and stratified by acculturation levels. We included 11,313 individuals, representing 4,293,134 Asian American adults residing in California.

The sample included 63.1% of individuals classified as less acculturated and 36.9% classified as more acculturated (Table 2). Overall, 31.1% were US-born, and 25.2% spoke English only at home. 3.5% of individuals in the less acculturated group were born in the US, and 0.8% of this group spoke English only at home. All individuals in the more acculturated group spoke English at home and were US-born or had resided in the US for more than ten years.

Individuals in the more acculturated group were significantly less likely than those in the less acculturated group to report diabetes diagnosis (6.2% vs. 10.7%, $p < 0.001$, Table 2).

Table 2: Weighted sample characteristics of all Asian Americans

	Total sample	**Less acculturated**	**More acculturated**	***p***
CHIS sample size (n)	11,313	7,406	3,907	
Weighted sample size (n)	4,293,134	2,710,390	1,582,744	
Proportion of weighted sample (%)	100	63.1	36.9	
Years of US residence (%)				
< 5	7.5	11.9	0	
5 – 9	7.6	12.1	0	
≥ 10	53.7	72.5	21.6	
US born	31.1	3.5	78.4	
Language spoken at home (%)				
Non-English language only	30.9	49.0	0	
English and another language	43.9	50.3	33.0	
English only	25.2	0.8	67.0	

Diabetes (%)	9.0	10.7	6.2	<0.001***
Age (years) (%)				<0.001***
18-44	55.4	45.9	71.6	
45-64	29.7	34.5	21.5	
≥ 65	14.9	19.6	6.9	
Male (%)	46.8	45.7	48.6	0.169
Marital status (%)				<0.001***
Married/Living with Partner	58.0	66.0	44.4	
Widowed/Separated/Divorced	9.8	11.8	6.5	
Never married	32.2	22.3	49.2	
Health insurance (%)				<0.001***
Uninsured	8.6	9.8	6.4	
Public only	31.0	36.7	21.1	
Private	60.4	53.4	72.4	
Income as percent of federal poverty level (FPL) (%)				<0.001***
0-99% FPL	14.6	18.7	7.6	
100-199% FPL	16.9	21.0	9.8	
200-299% FPL	12.2	12.1	12.4	
300% FPL and above	56.3	48.2	70.2	
Educational Attainment (%)				<0.001***
≤ High school	27.0	31.2	19.8	
Vocational/Some college	12.5	10.6	15.7	
College graduate	51.9	49.6	55.9	
Graduate degree	8.6	8.6	8.6	
Cigarette smoking (%)				0.051+
Every day	4.8	5.5	3.6	
Some days	3.5	3.1	4.2	
Quit smoking	13.5	13.4	13.7	
Never smoked	78.1	78.0	78.5	

P values were from Wald chi-square tests. +: $p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Sample Characteristics of Asian Americans with diabetes

Table 3 presented the weighted characteristics of all Asian Americans with diabetes overall and stratified by acculturation levels. We included 1,423 individuals in our analytic sample, representing 388,047 Asian American adults with diabetes residing in California.

The sample included 74.7% of individuals classified as less acculturated and 25.3% classified as more acculturated (Table 3). Overall, 17.4% were US-born, and 20.7% spoke English only at home. Only 0.4% of individuals in the less acculturated group were born in

the US, and 0.1% spoke English only at home. All individuals in the more acculturated group spoke English at home and were US-born or had resided in the US for more than ten years.

A higher proportion of individuals in the more acculturated group (vs. those in the less acculturated group) had a foot exam in the past year (74.4% vs. 67.4%, $p = 0.264$), received an eye examination with dilation by a health professional at least once in the past year (75.8% vs. 74.3%, $p = 0.812$), and had hemoglobin A1C checked at least twice in the past year (70.8% vs. 67.9%, $p = 0.735$). A lower proportion of individuals in the more acculturated group (vs. those in the less acculturated group) got a flu shot or the nasal flu vaccine (FluMist) in the past year (73.5% vs. 77.9%, $p = 0.642$). However, these differences were not statistically significant (Table 3).

Furthermore, individuals in the more acculturated group were significantly more likely than those in the less acculturated group to have a plan to take care of diabetes developed by doctors or other medical providers (89.5% vs. 74.2%, $p = 0.003$, Table 3).

More acculturated individuals were more likely than their less acculturated peers to have insurance coverage, especially private insurance (56.4% vs. 30.8%), and higher income (both $p < 0.01$). In addition, more acculturated individuals were more likely to be overweight (40.2% vs. 37.1%) or obese (37.1% vs. 20.6%, $p = 0.022$) and self-report excellent, very good, or good health conditions (67.3% vs. 47.4%, $p = 0.013$), and less likely to be over 65 years old (26.1% vs. 47.1%, $p = 0.009$, Table 3).

Table 3: Weighted sample characteristics of Asian Americans with diabetes

	Total sample	**Less acculturated**	**More acculturated**	***p***
CHIS sample size (n)	1,423	1,007	416	
Weighted sample size (n)	388,047	289,913	98,134	

Proportion of weighted sample (%)	100	74.7	25.3	
Years of US residence (%)				
< 5	3.6	4.8	0	
5 – 9	4.1	5.5	0	
≥ 10	74.9	89.2	32.6	
US born	17.4	0.4	67.4	
Language spoken at home (%)				
Non-English language only	37.6	50.3	0	
English and another language	41.8	49.7	18.4	
English only	20.7	0.1	81.6	
Outcomes (%)				
Foot examination	69.2	67.4	74.4	0.264
Eye examination	74.7	74.3	75.8	0.812
Medical plan for diabetes	78.1	74.2	89.5	0.003**
Hemoglobin A1C check [a]	68.6	67.9	70.8	0.735
Flu shot [b]	76.8	77.9	73.5	0.642
Age (years) (%)				0.009**
18-44	15.2	12.9	21.9	
45-64	43.0	40.0	52.0	
≥ 65	41.8	47.1	26.1	
Male (%)	50.0	47.7	56.6	0.222
Marital status (%)				0.057+
Married/Living with Partner	70.6	71.9	66.9	
Widowed/Separated/Divorced	17.6	19.6	11.6	
Never married	11.8	8.5	21.5	
Health insurance (%)				0.007**
Uninsured	4.3	4.9	2.5	
Public only	58.4	64.3	41.1	
Private	37.3	30.8	56.4	
Income as percent of federal poverty level (FPL) (%)				<0.001***
0-99% FPL	22.0	27.4	6.1	
100-199% FPL	23.4	27.3	11.8	
200-299% FPL	11.6	9.6	17.8	
300% FPL and above	43.0	35.7	64.4	
Educational Attainment (%)				0.193
≤ High school	33.3	36.7	23.2	
Vocational/Some college	12.1	10.5	17.0	
College graduate	47.6	46.3	51.3	
Graduate degree	7.0	6.5	8.5	
Self-reported general health condition (%)				0.013*
Excellent/Very good/Good	52.5	47.4	67.3	
Fair/Poor	47.5	52.6	32.7	
Comorbidity ≥1 (%)	68.3	68.3	68.1	0.971

BMI (kg/m^2) (%)				0.022*
Underweight 0-18.49	2.3	2.6	1.5	
Normal 18.5-24.99	35.0	39.7	21.2	
Overweight 25.0-29.99	37.9	37.1	40.2	
Obese 30.0+	24.8	20.6	37.1	
Take insulin (%)	24.6	23.6	27.4	0.603
Take diabetic pills (%)	81.3	82.8	76.7	0.281
Cigarette smoking (%)				0.888
Every day	5.4	5.6	4.8	
Some days	4.1	3.9	4.6	
Quit smoking	24.3	23.2	27.7	
Never smoked	66.2	67.3	62.8	

89.2% of the participants had type-2 diabetes. *P* values were from Wald chi-square tests.
a: 2013-2016 data were included, CHIS sample size = 1,039, weighted sample size = 243,272, proportion of less acculturated = 75.8%; **b**: 2014-2016 data were included, CHIS sample size = 873, weighted sample size = 189,430, proportion of less acculturated = 74.5%. +: $p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Results from Regression Analyses

Association between acculturation and prevalence of diabetes among Asian Americans

Table 4 showed the unadjusted analysis. More acculturated individuals experienced a reduction of 45% in the odds of self-reporting diabetes diagnosis compared to less acculturated individuals (odds ratio [OR] = 0.55, 95% confidence interval [CI] = 0.40-0.76). However, after adjusting for all covariates, including age, sex, marital status, health insurance, income, and educational attainment, the association of acculturation with the prevalence of diabetes became statistically nonsignificant (OR = 1.11., 95% CI = 0.76-1.63, Table 5). Then, after introducing personal health behavior, including cigarette smoking, into the model, the association was still statistically nonsignificant (OR = 1.07., 95% CI = 0.73-1.57, Table 5).

Table 4: Unadjusted logistic regression to estimate the association between acculturation and prevalence of diabetes among Asian Americans

	Diabetes	
	OR (95% CI)	*p*
Acculturation		
Less acculturated	-	
More acculturated	0.55 (0.40, 0.76)***	<0.001

Weighted data analyses using *svy* command in STATA. ***$p < 0.001$

Table 5: Adjusted logistic regression to estimate the association between acculturation and prevalence of diabetes among Asian Americans

	Diabetes			
	Model 1 (Adjusted for all covariates)		Model 2 (Model 1 + Personal health behaviors)	
	OR (95% CI)	*p*	OR (95% CI)	*p*
Acculturation				
Less acculturated	-		-	
More acculturated	1.11 (0.76, 1.63)	0.581	1.07 (0.73, 1.57)	0.731
Age				
18-44	-		-	
45-64	5.60 (3.21, 9.74)***	<0.001	5.47 (3.17, 9.44)***	<0.001
≥ 65	7.63 (4.22, 13.81)***	<0.001	7.54 (4.18, 13.61)***	<0.001
Male (vs. Female)	1.36 (1.03, 1.81)*	0.031	1.15 (0.85, 1.57)	0.368
Marital status				
Married/Living with Partner	1.37 (0.78, 2.40)	0.277	1.31 (0.75, 2.28)	0.341
Widowed/Separated/Divorced	1.27 (0.68, 2.40)	0.452	1.19 (0.63, 2.24)	0.595
Never married	-		-	
Health insurance				
Uninsured	-		-	
Public only	2.38 (1.24, 4.59)*	0.010	2.40 (1.25, 4.63)**	0.009
Private	1.27 (0.68, 2.37)	0.453	1.32 (0.71, 2.47)	0.377
Income as percent of federal poverty level (FPL)				
0-99% FPL	-		-	
100-199% FPL	0.92 (0.60, 1.43)	0.716	0.93 (0.60, 1.44)	0.732
200-299% FPL	0.78 (0.49, 1.26)	0.310	0.77 (0.48, 1.25)	0.286
300% FPL and above	0.67 (0.44, 1.08)	0.107	0.68 (0.43, 1.07)+	0.092
Educational Attainment				
≤ High school	-		-	
Vocational/Some college	1.30 (0.83, 2.02)	0.249	1.30 (0.84, 2.02)	0.244
College graduate	1.25 (0.90, 1.75)	0.183	1.30 (0.93, 1.80)	0.119
Graduate degree	1.10 (0.63, 1.92)	0.733	1.19 (0.69, 2.07)	0.532
Cigarette smoking				
Every day			1.29 (0.71, 2.34)	0.395
Some days			1.83 (0.87, 3.86)	0.110
Quit smoking			1.71 (1.18, 2.47)**	0.005
Never smoked			-	

Weighted data analyses using *svy* command in STATA. +: $p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Association between acculturation and use of diabetes care among Asian Americans with diabetes

In unadjusted analysis, acculturation was significantly associated with developing a medical plan for diabetes. More specifically, the odds of developing a medical plan for diabetes in the more acculturated group (relative to the less acculturated group) were 2.97 to

1 (OR = 2.97, 95% CI = 1.34-6.60; Table 6). In contrast, statistically nonsignificant associations of acculturation with foot examination (OR = 1.41., 95% CI = 0.75-2.62), eye examination (OR = 1.08, 95% CI = 0.55-2.15), hemoglobin A1C check (OR = 1.14, 95% CI = 0.52-2.51), and flu shot (OR = 0.79, 95% CI = 0.28-2.18) were observed (Table 6).

Regression models observed similar patterns that adjusted for predisposing and enabling factors, including age, sex, marital status, health insurance, income, and educational attainment. The odds of developing a medical plan for diabetes in the more acculturated group (relative to the less acculturated group) were 2.49 to 1 (OR = 2.49, 95% CI = 1.04-5.95; Supplemental Table 1). Statistically nonsignificant associations of acculturation with foot examination (OR = 1.25, 95% CI = 0.61-2.56), eye examination (OR = 1.15, 95% CI = 0.54-2.43), hemoglobin A1C check (OR = 0.75, 95% CI = 0.32-1.79), and flu shot (OR = 0.65, 95% CI = 0.18-2.32) were still observed (Supplemental Table 1).

After adjusting for all covariates, including age, sex, marital status, health insurance, income, educational attainment, self-reported general health condition, comorbidity, and BMI, adjusted models showed statistically nonsignificant associations of acculturation with foot examination (OR = 1.28, 95% CI = 0.63-2.63), eye examination (OR = 1.25, 95% CI = 0.59-2.66), medical plan for diabetes (OR = 2.41, 95% CI = 0.97-5.96), hemoglobin A1C check (OR = 0.84, 95% CI = 0.35-2.04), and flu shot (OR = 0.70, 95% CI = 0.18-2.80; Table 7). However, there was a tendency for acculturation to be significantly associated with the medical plan for diabetes (p = 0.057, Table 7).

Then, after introducing personal health behaviors, including insulin use, diabetic pills intake, and cigarette smoking, into the model, acculturation was significantly associated with

developing a medical plan for diabetes. The odds of developing a medical plan for diabetes in the more acculturated group (relative to the less acculturated group) were 2.66 to 1 (OR = 2.66, 95% CI = 1.06-6.73; Table 8). Statistically nonsignificant associations of acculturation with foot examination (OR = 1.30., 95% CI = 0.64-2.64), eye examination (OR = 1.26, 95% CI = 0.59-2.67), hemoglobin A1C check (OR = 0.66, 95% CI = 0.26-1.64), and flu shot (OR = 0.55, 95% CI = 0.14-2.09) were observed (Table 8).

Table 6: Unadjusted logistic regression to estimate the association between acculturation and diabetes care utilization among Asian Americans with diabetes

	Foot examination		**Eye examination**		**Medical plan for diabetes**		**Hemoglobin A1C check [a]**		**Flu shot [b]**	
	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*
Acculturation										
Less acculturated	-		-		-		-		-	
More acculturated	1.41 (0.75, 2.62)	0.282	1.08 (0.55, 2.15)	0.815	2.97 (1.34, 6.60)**	0.008	1.14 (0.52, 2.51)	0.738	0.79 (0.28, 2.18)	0.642

Weighted data analyses using *svy* command in STATA. **a**: 2013-2016 data were included; **b**: 2014-2016 data were included. ** $p < 0.01$

Table 7: Adjusted logistic regression to estimate the association between acculturation and diabetes care utilization among Asian Americans with diabetes, adjusting for all covariates

	Foot examination		**Eye examination**		**Medical plan for diabetes**		**Hemoglobin A1C check [a]**		**Flu shot [b]**	
	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*
Acculturation										
Less acculturated	-		-		-		-		-	
More acculturated	1.28 (0.63, 2.63)	0.495	1.25 (0.59, 2.66)	0.555	2.41 (0.97, 5.96)+	0.057	0.84 (0.35, 2.04)	0.704	0.70 (0.18, 2.80)	0.614
Age										
18-44	-		-		-		-		-	
45-64	0.79	0.656	2.98	0.017	0.36	0.181	0.27	0.112	1.02	0.981

	(0.27, 2.27)		(1.22, 7.31)*		(0.08, 1.62)		(0.05, 1.36)		(0.25, 4.22)	
≥ 65	0.97 (0.32, 2.98)	0.962	2.19 (0.76, 6.32)	0.149	0.16 (0.04, 0.73)*	0.018	0.11 (0.02, 0.79)*	0.028	1.82 (0.37, 8.97)	0.459
Male (vs. Female)	1.20 (0.64, 2.24)	0.577	0.58 (0.30, 1.13)	0.108	1.12 (0.54, 2.33)	0.752	1.14 (0.58, 2.26)	0.707	1.34 (0.51, 3.53)	0.550
Marital status										
Married/Living with Partner	0.71 (0.29, 1.75)	0.456	1.05 (0.34, 3.22)	0.931	1.18 (0.42, 3.34)	0.757	0.62 (0.22, 1.74)	0.365	3.59 (0.64, 20.20)	0.147
Widowed/Separated/Divorced	0.97 (0.33, 2.90)	0.959	0.84 (0.24, 2.96)	0.787	1.26 (0.37, 4.28)	0.706	0.65 (0.18, 2.33)	0.509	1.35 (0.17, 10.52)	0.776
Never married	-		-		-		-		-	
Health insurance										
Uninsured	-		-		-		-		-	
Public only	2.89 (0.83, 10.04)+	0.095	3.46 (0.90, 13.26)+	0.070	2.46 (0.63, 9.68)	0.197	7.60 (1.93, 29.88)**	0.004	4.18 (0.56, 31.24)	0.163
Private	3.61 (1.08, 12.10)*	0.038	2.03 (0.51, 8.08)	0.312	1.58 (0.37, 6.72)	0.536	5.32 (1.34, 21.15)*	0.018	4.32 (0.56, 33.35)	0.160
Income as percent of federal poverty level (FPL)										
0-99% FPL	-		-		-		-		-	
100-199% FPL	0.50 (0.23, 1.12)+	0.092	0.61 (0.26, 1.45)	0.263	0.60 (0.28, 1.28)	0.184	0.71 (0.28, 1.79)	0.465	0.57 (0.16, 2.00)	0.380
200-299% FPL	0.79 (0.24, 2.61)	0.696	0.87 (0.30, 2.57)	0.805	0.43 (0.15, 1.26)	0.125	3.37 (0.84, 13.56)+	0.086	0.68 (0.11, 4.11)	0.678
300% FPL and above	0.67 (0.30, 1.54)	0.347	1.25 (0.45, 3.41)	0.669	0.96 (0.39, 2.34)	0.924	1.43 (0.51, 3.98)	0.498	1.09 (0.29, 4.10)	0.899
Educational Attainment										
≤ High school	-		-		-		-		-	
Vocational/Some college	1.38 (0.61, 3.12)	0.441	1.12 (0.42, 2.95)	0.823	1.19 (0.47, 2.97)	0.713	1.02 (0.31, 3.34)	0.980	1.02 (0.23, 4.60)	0.974
College graduate	1.81 (0.89, 3.68)	0.101	2.28 (1.15, 4.52)*	0.019	1.60 (0.79, 3.24)	0.193	1.22 (0.50, 2.94)	0.661	0.73 (0.22, 2.44)	0.604
Graduate degree	2.56 (0.67, 9.78)	0.168	2.75 (0.73, 10.35)	0.134	4.71 (1.21, 18.44)*	0.026	1.24 (0.27, 5.61)	0.782	1.32 (0.04, 49.73)	0.879
Self-reported general health condition										
Excellent/Very good/Good	0.93 (0.51,	0.809	0.69 (0.36,	0.276	0.99 (0.50,	0.979	0.60 (0.32,	0.118	0.69 (0.22,	0.525

(vs. Fair/Poor)	1.69)		1.34)		1.96)		1.14)		2.16)	
Comorbidity ≥1 (vs. no comorbidity)	1.50 (0.82, 2.76)	0.192	1.02 (0.50, 2.08)	0.961	1.27 (0.65, 2.48)	0.490	1.56 (0.69, 3.54)	0.289	0.75 (0.26, 2.17)	0.597
BMI										
Underweight 0-18.49	0.36 (0.06, 2.30)	0.278	0.32 (0.05, 2.02)	0.226	2.17 (0.19, 24.95)	0.532	1.58 (0.19, 12.95)	0.669	0.52 (0.03, 8.70)	0.647
Normal 18.5-24.99	-		-		-		-		-	
Overweight 25.0-29.99	0.61 (0.32, 1.17)	0.139	0.50 (0.24, 1.02)+	0.057	0.96 (0.49, 1.87)	0.903	0.70 (0.31, 1.56)	0.379	0.73 (0.22, 2.40)	0.604
Obese 30.0+	0.87 (0.40, 1.86)	0.711	0.66 (0.29, 1.51)	0.322	2.14 (0.94, 4.89)+	0.071	0.94 (0.35, 2.56)	0.908	0.81 (0.20, 3.31)	0.766

Weighted data analyses using *svy* command in STATA. **a**: 2013-2016 data were included; **b**: 2014-2016 data were included. +: $p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 8: Adjusted logistic regression to estimate the association between acculturation and diabetes care utilization among Asian Americans with diabetes, adjusting for all covariates and personal health behaviors

	Foot examination		**Eye examination**		**Medical plan for diabetes**		**Hemoglobin A1C check [a]**		**Flu shot [b]**	
	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*
Acculturation										
Less acculturated	-		-		-		-		-	
More acculturated	1.30 (0.64, 2.64)	0.469	1.26 (0.59, 2.67)	0.550	2.66 (1.06, 6.73)*	0.038	0.66 (0.26, 1.64)	0.369	0.55 (0.14, 2.09)	0.379
Age										
18-44	-		-		-		-		-	
45-64	0.70 (0.23, 2.11)	0.529	2.87 (1.14, 7.21)*	0.026	0.29 (0.07, 1.28)	0.103	0.26 (0.05, 1.26)+	0.094	0.87 (0.19, 3.84)	0.848
≥ 65	0.81 (0.25, 2.60)	0.723	2.17 (0.71, 6.63)	0.172	0.12 (0.03, 0.54)**	0.006	0.10 (0.01, 0.67)*	0.018	1.64 (0.32, 8.35)	0.547
Male (vs. Female)	1.17 (0.60, 2.26)	0.647	0.62 (0.30, 1.26)	0.187	1.28 (0.57, 2.89)	0.546	0.93 (0.44, 1.96)	0.852	1.64 (0.54, 4.99)	0.383
Marital status										
Married/Living with Partner	0.64 (0.23, 1.76)	0.390	1.07 (0.35, 3.27)	0.907	1.14 (0.39, 3.33)	0.807	0.50 (0.15, 1.59)	0.238	4.22 (0.75, 23.87)	0.103
Widowed/Separated/Divorced	0.95 (0.27, 3.33)	0.938	0.86 (0.24, 3.01)	0.808	1.31 (0.37, 4.64)	0.671	0.54 (0.13, 2.19)	0.384	1.95 (0.36, 10.70)	0.441
Never married	-		-		-		-		-	
Health insurance										

Uninsured	-		-		-		-		-	
Public only	2.49 (0.66, 9.31)	0.176	3.02 (0.77, 11.78)	0.111	1.82 (0.45, 7.41)	0.403	8.79 (1.92, 40.13)**	0.005	3.40 (0.38, 30.79)+	0.275
Private	3.07 (0.85, 11.18)+	0.088	1.83 (0.45, 7.46)	0.399	1.18 (0.27, 5.29)	0.824	5.61 (1.26, 25.04)*	0.024	3.73 (0.43, 32.15)	0.231
Income as percent of federal poverty level (FPL)										
0-99% FPL	-		-		-		-		-	
100-199% FPL	0.56 (0.24, 1.30)	0.176	0.62 (0.26, 1.49)	0.283	0.63 (0.28, 1.40)	0.256	0.74 (0.28, 1.93)	0.533	0.59 (0.15, 2.30)	0.448
200-299% FPL	0.84 (0.25, 2.80)	0.773	0.85 (0.28, 2.60)	0.780	0.41 (0.14, 1.22)	0.109	3.11 (0.72, 13.52)	0.130	0.88 (0.13, 6.13)	0.895
300% FPL and above	0.70 (0.31, 1.62)	0.409	1.38 (0.50, 3.81)	0.538	1.18 (0.49, 2.82)	0.712	1.60 (0.54, 4.67)	0.393	1.17 (0.31, 4.43)	0.817
Educational Attainment										
≤ High school	-		-		-		-		-	
Vocational/Some college	1.43 (0.62, 3.33)	0.403	1.08 (0.41, 2.82)	0.882	1.20 (0.48, 3.01)	0.701	0.95 (0.28, 3.28)	0.939	1.38 (0.28, 6.83)	0.694
College graduate	1.85 (0.88, 3.92)	0.106	2.17 (1.06, 4.41)*	0.034	1.54 (0.76, 3.13)	0.233	1.20 (0.48, 2.99)	0.695	0.69 (0.19, 2.49)	0.573
Graduate degree	2.94 (0.73, 11.93)	0.131	2.53 (0.63, 10.10)	0.188	5.06 (1.19, 21.47)*	0.028	1.38 (0.28, 6.76)	0.690	1.57 (0.05, 51.79)	0.798
Self-reported general health condition										
Excellent/Very good/Good (vs. Fair/Poor)	0.93 (0.52, 1.68)	0.815	0.70 (0.36, 1.36)	0.288	0.96 (0.49, 1.88)	0.902	0.63 (0.32, 1.22)	0.166	0.69 (0.20, 2.34)	0.546
Comorbidity ≥1 (vs. no comorbidity)	1.42 (0.77, 2.61)	0.255	0.99 (0.47, 2.05)	0.973	1.18 (0.59, 2.36)	0.647	1.50 (0.67, 3.32)	0.321	0.67 (0.22, 2.02)	0.471
BMI										
Underweight 0-18.49	0.27 (0.03, 2.22)	0.222	0.27 (0.04, 1.59)	0.145	1.73 (0.23, 12.88)	0.594	1.02 (0.15, 7.08)	0.983	0.35 (0.02, 6.50)	0.483
Normal 18.5-24.99	-		-		-		-		-	
Overweight 25.0-29.99	0.53 (0.27, 1.04)+	0.064	0.49 (0.24, 1.00)+	0.051	0.85 (0.41, 1.75)	0.659	0.58 (0.26, 1.31)	0.190	0.82 (0.29, 2.35)	0.712
Obese 30.0+	0.76 (0.35, 1.68)	0.499	0.61 (0.26, 1.43)	0.256	1.78 (0.74, 4.26)	0.197	0.76 (0.28, 2.02)	0.578	0.91 (0.21, 3.92)	0.895
Take insulin (vs. not)	2.46 (1.22,	0.012	1.86 (0.88,	0.104	5.29 (2.45,	<0.001	3.33 (1.42,	0.006	1.23 (0.33,	0.754

	4.94)*		3.92)		11.43)**		7.81)**		4.61)	
Take diabetic pills (vs. not)	2.60 (1.41, 4.80)**	0.002	1.24 (0.61, 2.53)	0.555	2.61 (1.23, 5.54)*	0.013	1.69 (0.72, 3.96)	0.229	1.59 (0.48, 5.25)	0.446
Cigarette smoking										
Every day	0.72 (0.18, 2.89)	0.644	1.27 (0.27, 6.05)	0.761	0.97 (0.31, 3.02)	0.958	1.51 (0.28, 8.13)	0.629	0.14 (0.02, 0.90)*	0.038
Some days	1.10 (0.21, 5.66)	0.907	0.76 (0.13, 4.54)	0.765	0.90 (0.09, 8.69)	0.928	0.78 (0.11, 5.42)	0.803	13.55 (0.05, 3463.25)	0.355
Quit smoking	1.45 (0.69, 3.06)	0.329	0.76 (0.33, 1.72)	0.503	0.76 (0.35, 1.65)	0.483	2.14 (0.99, 4.59)+	0.052	0.74 (0.21, 2.68)	0.647
Never smoked	-		-		-		-		-	

Weighted data analyses using *svy* command in STATA. **a**: 2013-2016 data were included; **b**: 2014-2016 data were included. +: $p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Results from Sensitivity Analyses

Sensitivity analyses were conducted using three acculturation levels. Both descriptive analyses and regression analyses were performed. Results were displayed in supplemental tables 2-8 in the appendix. Descriptive results suggested that individuals in the most acculturated group were significantly less likely than those in the least or moderate acculturated groups to report diabetes diagnosis. Additionally, individuals in the most acculturated group were significantly more likely than those in the least or moderate acculturated groups to develop a plan to manage diabetes.

Regression analyses suggested similar results. For the association between acculturation and the prevalence of diabetes, the unadjusted analysis also showed that most acculturated individuals experienced a reduction of 43% in the odds of self-reporting diabetes diagnosis compared to least acculturated individuals. And after adjusting for all covariates and personal health behaviors, the association of acculturation with the prevalence of diabetes was statistically nonsignificant. For the association between acculturation and the use of diabetes

care, all three models showed that the odds of developing a medical plan for diabetes in the most acculturated group were significantly higher than in the least acculturated group.

Discussion

Key findings

This was the first population-based study of the association between acculturation and diabetes prevalence and diabetes care utilization among Asian-American adults in California. No significant association was found between acculturation and diabetes prevalence after controlling for covariates and personal health behaviors. However, there was a significant association between acculturation and medical plan for diabetes. Adults in the more acculturated group had higher odds of having the plan to take care of diabetes developed by doctors or other medical providers than those in the less acculturated group after adjusting for covariates and personal health behaviors. Acculturation was not significantly associated with foot or eye examinations, hemoglobin A1C checks, and flu shots among Asian-American adults with diabetes. With and without personal health behaviors variables introduced, the results were similar. Therefore, acculturation picked up on mechanisms outside of what was measured through personal health behaviors.

In this study, our findings were consistent with some previous studies. However, our study tested the Asian-American population as a whole, while previous studies focused on Asian subgroups. In one study of Chinese Americans, the prevalence of diabetes was found not related to acculturation (22). Our results also suggested no association between acculturation and diabetes prevalence. Both this study and our study used nativity, years living in the US, and language spoken at home to measure acculturation. Nevertheless, there were inconsistencies. Previous studies demonstrated that more acculturated Chinese Americans diagnosed with diabetes were more likely to have a foot exam than less

acculturated individuals (25). However, our analyses showed a nonsignificant association between acculturation and foot examinations among Asian Americans with diabetes.

Our study was the first to find a significant association between acculturation and the development of a medical plan for diabetes among Asian Americans with diabetes. Acculturation increasing medical plan use may be related to health literacy. More acculturated individuals may become more familiar with the healthcare system and more comfortable accessing healthcare services (77), which may lead to increased use of medical plans for diabetes. The language barrier may be another factor. Less acculturated Asian Americans have been reported to have more communication problems with healthcare providers than their more acculturated counterparts (39, 40). In California, many adult asthma patients with limited English proficiency were less likely than their counterparts to receive an asthma management plan from their healthcare providers (78).

Patients with diabetes need to develop appropriate habits to maintain long-term disease control and reduce potential complications. One strategy for primary care physicians is to provide care plans for patients with chronic diseases to optimize their ability to manage conditions (79). Studies have shown that glycemic, blood pressure, and lipid goals can be achieved by implementing a diabetes care plan (80, 81). Written care plans are a method of medical planning that better facilitate goal-setting discussions between patients and health care providers (82). Based on the literature, written care plans for diabetes appear to be common and have been widely used (83-85). The American Diabetes Association recommends that patients with diabetes have a written care plan, including the patient's current health status, goals, interventions, and management of complications (85). However,

while written care plans are common, medical technology has led to the development of digital care plans which may be more accessible and convenient, including mobile apps, web-based platforms, or other digital tools that help patients manage their diabetes and communicate with their healthcare providers (86, 87). Because the CHIS survey did not specify the form of a medical plan, a potential concern is that it needs to be made certain that all respondents understood the plan in the same way. However, since medical plans for diabetes are mostly perceived as written, we are less concerned about generating bias from less acculturated respondents stating they did not receive a plan because of the interpretation of the plan.

Implications

Our study has some implications. From the clinical perspective, since written care plans are more effective in goal setting for disease management (82), increasing access or awareness of diabetes medical plans to patients with diabetes among Asian populations in California could improve disease management. To enhance the management of diabetes, the development of a medical plan can refer to the written and personalized diabetes care management plan (DCMP), developed in accordance with the 2012 American Diabetes Association Standard of Care guidelines (88). Also, the plan could be provided in patients' primary language to ensure adequate information on diabetes care for patients with limited English proficiency.

From the policy perspective, since language barriers can impede access to health care for Asian Americans, especially those who are less acculturated, policymakers can set up cultural and linguistic competency training for healthcare providers to effectively communicate with

and provide health care services to Asian-American patients. It could include providing language translation services, developing culturally appropriate health education materials, and increasing healthcare workers' diversity to reflect their communities better (89). In addition, policymakers can increase diabetes screening and management among Asian Americans through targeted outreach and education campaigns, culturally appropriate diabetes care programs, and increased availability of diabetes care resources in areas with high Asian-American populations. Future initiatives could also consider Asian-specific risk factors to reduce the burden of diabetes and its complications, such as encouraging physical activities (43).

Limitations and strengths

There were some limitations to this study. First, while adjusting our estimates, there remained a possibility of unobserved factors correlated with both acculturation and diabetes prevalence or use of medical care that might affect the reported estimates. Then, self-reported data created recall bias. In addition, this study did not include outcomes of diabetes care that were necessary for people with diabetes, such as urine tests and pneumococcal vaccines. Furthermore, we did not do analyses among Asian subgroups. Finally, variables measuring acculturation might only partially capture the complex acculturation process and its health effects. Studies suggested that age at migration and length of residence in the resettlement setting may influence the unfolding of acculturation. Immigrants who migrated at an earlier age may have a faster rate of acculturation than those who migrated later in life (90-92). A study assessing age differences to explain how acculturation affects the mental health of Mexican Americans showed that older adults might not be more susceptible to the stressors

associated with acculturation (93). However, our study did not use age at migration as a variable to measure acculturation but used age as a categorical variable in covariates. This approach could lead to a misspecification of the model, which may introduce bias into the estimates, resulting in either an overestimate or underestimate of the actual effect of acculturation on diabetes outcomes. Although including age as one covariate can address some of the potential confounding effects of age, it may not fully capture the complex relationship between acculturation, age, and diabetes outcomes. Suppose the effects of acculturation on diabetes prevalence and use of diabetes care depend on age. In this case, it is crucial to consider the potential variation in these effects across different age groups. For example, the relationship between acculturation and diabetes prevalence and the use of diabetes care may be stronger among younger Asian Americans compared to older ones. It could be due to differences in the level and type of exposure to American culture among different age groups, as well as differences in health behaviors and access to medical care.

Despite these limitations, there were also several strengths. First, CHIS data included a large sample of Asians. Then, this study was the first to find a significant association between acculturation and developing a medical plan for diabetes among Asian Americans with diabetes in California, a large and diverse state. Finally, this study filled a gap in the literature by exploring the potential associations between acculturation and eye exams, A1C checks, and flu shots among Asian Americans with diabetes. Although the results were insignificant, the study sheds light on the importance of investigating these potential associations in future research.

Future research

To enhance the study, it is necessary to have a larger sample size that includes a more diverse Asian population to examine differences among subgroups. Using longitudinal data can facilitate the analysis of the sequence of events, assess sensitivities, and provide a more precise evaluation of the constructs. Additionally, future research should explore other outcomes related to diabetes care. Finally, it is essential to consider age at migration when measuring acculturation.

Conclusion

In conclusion, this study was the first to find a significant association between acculturation and developing a medical plan for diabetes among Asian Americans with diabetes. Higher levels of acculturation were associated with increased use of diabetes care plans among Asian Americans with diabetes, controlling for covariates and personal health behaviors. The study could help better understand the effects of acculturation on diabetes care utilization for Asian Americans with diabetes and develop future health interventions applicable to them.

Appendix

Supplemental Table 1: Adjusted logistic regression to estimate the association between acculturation and diabetes care utilization among Asian Americans with diabetes, adjusting for predisposing and enabling characteristics

	Foot examination		**Eye examination**		**Medical plan for diabetes**		**Hemoglobin A1C check [a]**		**Flu shot [b]**	
	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*
Acculturation										
Less acculturated	-		-		-		-		-	
More acculturated	1.25 (0.61, 2.56)	0.540	1.15 (0.54, 2.43)	0.722	2.49 (1.04, 5.95)*	0.041	0.75 (0.32, 1.79)	0.522	0.65 (0.18, 2.32)	0.509
Age										
18-44	-		-		-		-		-	
45-64	0.84 (0.29, 2.38)	0.739	3.06 (1.23, 7.58)*	0.016	0.31 (0.06, 1.44)	0.134	0.28 (0.06, 1.35)	0.112	0.98 (0.24, 4.01)	0.979
≥ 65	1.00 (0.35, 2.86)	0.998	2.13 (0.76, 5.98)	0.149	0.14 (0.03, 0.64)*	0.011	0.13 (0.02, 0.81)*	0.029	1.61 (0.33, 7.86)	0.557
Male (vs. Female)	1.18 (0.63, 2.21)	0.611	0.55 (0.29, 1.05)+	0.072	1.13 (0.55, 2.33)	0.731	1.10 (0.57, 2.14)	0.769	1.23 (0.48, 3.16)	0.667
Marital status										
Married/Living with Partner	0.73 (0.29, 1.85)	0.502	1.13 (0.38, 3.40)	0.829	1.11 (0.41, 3.01)	0.835	0.69 (0.25, 1.86)	0.457	3.78 (0.73, 19.67)	0.114
Widowed/Separated/Divorced	1.02 (0.34, 3.07)	0.968	0.95 (0.28, 3.28)	0.940	1.25 (0.40, 3.93)	0.705	0.73 (0.21, 2.55)	0.619	1.48 (0.20, 11.12)	0.700
Never married	-		-		-		-		-	
Health insurance										
Uninsured	-		-		-		-		-	
Public only	3.19 (0.91, 11.13)+	0.069	3.29 (0.97, 11.20)+	0.056	2.68 (0.70, 10.28)	0.149	8.19 (2.19, 30.59)**	0.002	4.16 (0.70, 24.80)	0.117
Private	3.65 (1.07, 12.43)*	0.038	1.86 (0.50, 6.93)	0.351	1.78 (0.44, 7.25)	0.418	5.64 (1.52, 20.99)*	0.010	4.13 (0.65, 26.18)	0.132
Income as percent of federal poverty level (FPL)										
0-99% FPL	-		-		-		-		-	
100-199%	0.51	0.084	0.65	0.312	0.62	0.193	0.70	0.450	0.62	0.437

FPL	(0.24, 1.10)+		(0.28, 1.51)		(0.30, 1.27)		(0.28, 1.77)		(0.19, 2.08)	
200-299% FPL	0.79 (0.24, 2.60)	0.700	0.92 (0.32, 2.68)	0.881	0.43 (0.16, 1.16)+	0.095	3.00 (0.86, 10.54)+	0.086	0.78 (0.14, 4.38)	0.775
300% FPL and above	0.69 (0.31, 1.58)	0.384	1.24 (0.47, 3.27)	0.660	0.99 (0.42, 2.35)	0.985	1.29 (0.48, 3.46)	0.605	1.11 (0.33, 3.80)	0.862
Educational Attainment										
≤ High school	-		-		-		-		-	
Vocational/Some college	1.34 (0.59, 3.00)	0.483	1.00 (0.39, 2.60)	0.995	1.33 (0.54, 3.29)	0.534	0.92 (0.28, 2.95)	0.889	0.92 (0.20, 4.33)	0.918
College graduate	1.71 (0.85, 3.42)	0.130	1.99 (1.02, 3.91)*	0.044	1.50 (0.76, 2.96)	0.241	1.00 (0.41, 2.40)	0.995	0.67 (0.23, 2.00)	0.476
Graduate degree	2.24 (0.56, 8.99)	0.253	2.38 (0.66, 8.52)	0.184	4.31 (1.16, 15.99)*	0.029	1.02 (0.19, 5.52)	0.980	1.25 (0.04, 42.01)	0.901

Weighted data analyses using *svy* command in STATA. **a**: 2013-2016 data were included; **b**: 2014-2016 data were included. +: $p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Supplemental Table 2: Weighted sample characteristics of all Asians by three acculturation levels

	Total sample	**Least acculturated**	**Moderate acculturated**	**Most acculturated**	***p***
CHIS sample size (n)	11313	4364	3042	3907	
Weighted sample size (n)	4293134	1532430	1177959	1582744	
Proportion of weighted sample (%)	100	35.7	27.4	36.9	
Years of US residence (%)					
< 5	7.5	21.1	0	0	
5 – 9	7.6	20.6	1.0	0	
≥ 10	53.7	58.3	90.9	21.6	
US born	31.1	0	8.1	78.4	
Language spoken at home (%)					
Non-English language only	30.9	80.3	8.1	0	
English and another language	43.9	19.0	90.9	33.0	
English only	25.2	0.7	1.0	67.0	
Diabetes (%)	9.0	10.5	11.0	6.2	<0.001***
Age (years) (%)					<0.001***
18-44	55.4	45.3	46.7	71.6	
45-64	29.7	32.2	37.4	21.5	
≥ 65	14.9	22.5	15.9	6.9	
Male (%)	46.8	43.9	48.0	48.6	0.066+
Marital status (%)					<0.001***
Married/Living with Partner	58.0	67.4	64.1	44.4	
Widowed/Separated/Divorced	9.8	10.8	13.0	6.5	

Never married	32.2	21.8	22.9	49.2	
Health insurance (%)					<0.001***
Uninsured	8.6	12.3	6.6	6.4	
Public only	31.0	42.1	29.7	21.1	
Private	60.4	45.6	63.7	72.4	
Income as percent of federal poverty level (FPL) (%)					<0.001***
0-99% FPL	14.6	25.8	9.5	7.6	
100-199% FPL	16.9	24.8	16.0	9.8	
200-299% FPL	12.2	13.0	10.9	12.4	
300% FPL and above	56.3	36.4	63.6	70.2	
Educational Attainment (%)					<0.001***
≤ High school	27.0	40.2	19.5	19.8	
Vocational/Some college	12.5	8.5	13.3	15.7	
College graduate	51.9	44.6	56.1	55.9	
Graduate degree	8.6	6.7	11.1	8.6	
Cigarette smoking (%)					0.125
Every day	4.8	5.9	5.0	3.6	
Some days	3.5	3.2	3.0	4.2	
Quit smoking	13.5	12.4	14.7	13.7	
Never smoked	78.1	78.5	77.3	78.5	

P values were from Wald chi-square tests.+: $p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Supplemental Table 3: Weighted sample characteristics of Asians with diabetes by three acculturation levels

	Total sample	**Least acculturated**	**Moderate acculturated**	**Most acculturated**	***p***
CHIS sample size (n)	1423	625	382	416	
Weighted sample size (n)	388047	160496	129417	98134	
Proportion of weighted sample (%)	100	41.4	33.4	25.3	
Years of US residence (%)					
< 5	3.6	8.7	0	0	
5 – 9	4.1	10.0	0	0	
≥ 10	74.9	81.3	99.1	32.6	
US born	17.4	0	0.9	67.4	
Language spoken at home (%)					
Non-English language only	37.6	90.0	0.9	0	
English and another language	41.8	9.8	99.1	18.4	
English only	20.7	0.1	0	81.6	
Outcomes (%)					
Foot examination	69.2	62.6	73.4	74.4	0.138
Eye examination	74.7	71.5	77.7	75.8	0.635
Medical plan for diabetes	78.1	69.8	79.7	89.5	0.004**

Hemoglobin A1C check [a]	68.6	62.8	72.8	70.8	0.442
Flu shot [b]	76.8	72.9	83.1	73.5	0.396
Age (years) (%)					0.006**
18-44	15.2	8.3	18.7	21.9	
45-64	43.0	37.7	42.8	52.0	
≥ 65	41.8	54.0	38.5	26.1	
Male (%)	50.0	49.7	45.2	56.6	0.382
BMI (kg/m^2) (%)					0.031*
Underweight 0-18.49	2.3	2.6	2.6	1.5	
Normal 18.5-24.99	35.0	40.6	38.6	21.2	
Overweight 25.0-29.99	37.9	40.7	32.7	40.2	
Obese 30.0+	24.8	16.2	26.2	37.1	
Marital status (%)					0.194
Married/Living with Partner	70.6	72.5	71.1	66.9	
Widowed/Separated/Divorced	17.6	19.3	20.0	11.6	
Never married	11.8	8.2	8.9	21.5	
Health insurance (%)					<0.001***
Uninsured	4.3	5.7	4.0	2.5	
Public only	58.4	75.0	51.0	41.1	
Private	37.3	19.3	45.0	56.4	
Income as percent of federal poverty level (FPL) (%)					<0.001***
0-99% FPL	22.0	37.1	15.4	6.1	
100-199% FPL	23.4	31.7	21.8	11.8	
200-299% FPL	11.6	10.9	7.8	17.8	
300% FPL and above	43.0	20.3	54.9	64.4	
Educational Attainment (%)					<0.001***
≤ High school	33.3	50.9	19.1	23.2	
Vocational/Some college	12.1	6.3	15.7	17.0	
College graduate	47.6	38.8	55.7	51.3	
Graduate degree	7.0	4.0	9.5	8.5	
Self-reported general health condition (%)					<0.001***
Excellent/Very good/Good	52.5	39.0	57.9	67.3	
Fair/Poor	47.5	61.0	42.1	32.7	
Comorbidity ≥1 (%)	68.3	70.3	65.9	68.1	0.823
Take insulin (%)	24.6	22.7	24.7	27.4	0.822
Take diabetic pills (%)	81.3	84.1	81.2	76.7	0.531
Cigarette smoking (%)					0.987
Every day	5.4	5.3	6.0	4.8	
Some days	4.1	3.4	4.5	4.6	
Quit smoking	24.3	22.7	23.8	27.7	
Never smoked	66.2	68.7	65.6	62.8	

P values were from Wald chi-square tests. a: 2013-2016 data were included; b: 2014-2016 data were included. +:

$p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Supplemental Table 4: Unadjusted logistic regression to estimate the association between acculturation and prevalence of diabetes among Asian Americans

	Diabetes	
	OR (95% CI)	*p*
Acculturation		
Least acculturated	-	
Moderate acculturated	1.06 (0.78, 1.42)	0.724
Most acculturated	0.57 (0.40, 0.79)**	0.001

Weighted data analyses using *svy* command in STATA. **$p < 0.01$

Supplemental Table 5: Adjusted logistic regression to estimate the association between acculturation and prevalence of diabetes among Asian Americans

	Diabetes			
	Model 1 (Controlled for all covariates)		**Model 2 (Model 1 + Personal health behaviors)**	
	OR (95% CI)	*p*	OR (95% CI)	*p*
Acculturation				
Least acculturated	-		-	
Moderate acculturated	1.33 (0.95, 1.87)+	0.096	1.32 (0.94, 1.86)	0.111
Most acculturated	1.30 (0.86, 1.97)	0.208	1.24 (0.82, 1.89)	0.302
Age				
18-44	-		-	
45-64	5.58 (3.20, 9.74)***	<0.001	5.46 (3.16, 9.43)***	<0.001
≥ 65	7.71 (4.26, 13.96)***	<0.001	7.60 (4.21, 13.72)***	<0.001
Male (vs. Female)	1.36 (1.02, 1.80)*	0.034	1.15 (0.84, 1.56)	0.375
Marital status				
Married/Living with Partner	1.39 (0.79, 2.44)	0.252	1.33 (0.76, 2.33)	0.311
Widowed/Separated/Divorced	1.25 (0.66, 2.36)	0.486	1.17 (0.62, 2.21)	0.630
Never married	-		-	
Health insurance				
Uninsured	-		-	
Public only	2.35 (1.22, 4.54)*	0.011	2.36 (1.22, 4.56)*	0.011
Private	1.25 (0.67, 2.35)	0.478	1.30 (0.70, 2.44)	0.406
Income as percent of federal poverty level (FPL)				
0-99% FPL	-		-	
100-199% FPL	0.90 (0.58, 1.39)	0.628	0.90 (0.58, 1.40)	0.647
200-299% FPL	0.75 (0.47, 1.22)	0.249	0.74 (0.46, 1.21)	0.231
300% FPL and above	0.64 (0.41, 1.01)+	0.054	0.63 (0.40, 1.00)*	0.048
Educational Attainment				
≤ High school	-		-	
Vocational/Some college	1.22 (0.78, 1.91)	0.377	1.23 (0.79, 1.91)	0.363
College graduate	1.20 (0.85, 1.70)	0.298	1.24 (0.89, 1.74)	0.203
Graduate degree	1.04 (0.59, 1.83)	0.895	1.13 (0.64, 1.98)	0.679
Cigarette smoking				
Every day			1.30 (0.72, 2.34)	0.392
Some days			1.79 (0.85, 3.76)	0.125
Quit smoking			1.71 (1.18, 2.47)**	0.005

Never smoked	-

Weighted data analyses using *svy* command in STATA. +: $p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Supplemental Table 6: Unadjusted logistic regression to estimate the association between acculturation and diabetes care utilization among Asian Americans with diabetes

	Foot examination		**Eye examination**		**Medical plan for diabetes**		**Hemoglobin A1C check [a]**		**Flu shot [b]**	
	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*
Acculturation										
Least acculturated	-		-		-		-		-	
Moderate acculturated	1.64 (0.90, 3.01)	0.107	1.39 (0.70, 2.72)	0.344	1.70 (0.88, 3.27)	0.114	1.59 (0.76, 3.30)	0.217	1.83 (0.65, 5.13)	0.249
Most acculturated	1.74 (0.91, 3.32)+	0.096	1.25 (0.58, 2.67)	0.570	3.70 (1.62, 8.46)**	0.002	1.44 (0.61, 3.37)	0.405	1.03 (0.34, 3.18)	0.956

Weighted data analyses using *svy* command in STATA. **a**: 2013-2016 data were included; **b**: 2014-2016 data were included. +: $p < 0.1$, **$p < 0.01$

Supplemental Table 7: Adjusted logistic regression to estimate the association between acculturation and diabetes care utilization among Asian Americans with diabetes, adjusting for all covariates

	Foot examination		**Eye examination**		**Medical plan for diabetes**		**Hemoglobin A1C check [a]**		**Flu shot [b]**	
	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*
Acculturation										
Least acculturated	-		-		-		-		-	
Moderate acculturated	1.50 (0.79, 2.84)	0.214	1.36 (0.65, 2.89)	0.415	1.20 (0.56, 2.56)	0.639	1.27 (0.57, 2.84)	0.562	2.31 (0.71, 7.59)	0.166
Most acculturated	1.61 (0.74, 3.51)	0.226	1.50 (0.64, 3.51)	0.354	2.65 (1.01, 6.95)*	0.048	0.99 (0.39, 2.51)	0.981	1.15 (0.22, 5.99)	0.871
Age										
18-44	-		-		-		-		-	
45-64	0.82 (0.28, 2.36)	0.708	3.07 (1.26, 7.46)*	0.014	0.36 (0.08, 1.65)	0.190	0.27 (0.05, 1.37)	0.115	1.12 (0.25, 4.98)	0.877
≥ 65	1.03 (0.33, 3.21)	0.965	2.28 (0.78, 6.65)	0.130	0.17 (0.04, 0.76)*	0.020	0.12 (0.02, 0.83)*	0.032	2.32 (0.45, 12.05)	0.314

Male (vs. Female)	1.20 (0.64, 2.25)	0.574	0.58 (0.30, 1.12)	0.105	1.13 (0.54, 2.34)	0.749	1.15 (0.58, 2.27)	0.696	1.41 (0.51, 3.86)	0.504
Marital status										
Married/Living with Partner	0.72 (0.29, 1.76)	0.469	1.05 (0.35, 3.22)	0.925	1.18 (0.42, 3.33)	0.755	0.63 (0.23, 1.72)	0.364	3.56 (0.57, 22.28)	0.174
Widowed/Separated/Divorced	0.95 (0.32, 2.86)	0.929	0.82 (0.23, 2.88)	0.759	1.25 (0.37, 4.21)	0.721	0.65 (0.18, 2.28)	0.498	1.30 (0.15, 10.89)	0.811
Never married	-		-		-		-		-	
Health insurance										
Uninsured	-		-		-		-		-	
Public only	2.89 (0.82, 10.16)+	0.097	3.44 (0.89, 13.27)+	0.073	2.42 (0.60, 9.69)	0.212	7.45 (1.92, 28.86)**	0.004	3.47 (0.43, 28.23)	0.243
Private	3.55 (1.04, 12.10)*	0.043	2.01 (0.50, 8.01)	0.323	1.54 (0.36, 6.63)	0.564	5.19 (1.32, 20.42)*	0.019	4.09 (0.50, 33.52)	0.189
Income as percent of federal poverty level (FPL)										
0-99% FPL	-		-		-		-		-	
100-199% FPL	0.48 (0.22, 1.06)+	0.069	0.59 (0.25, 1.38)	0.224	0.58 (0.27, 1.26)	0.172	0.68 (0.26, 1.78)	0.434	0.51 (0.14, 1.88)	0.311
200-299% FPL	0.75 (0.22, 2.50)	0.635	0.83 (0.29, 2.43)	0.740	0.43 (0.15, 1.26)	0.123	3.22 (0.80, 12.93)	0.100	0.59 (0.08, 4.12)	0.594
300% FPL and above	0.61 (0.26, 1.40)	0.242	1.15 (0.43, 3.05)	0.782	0.92 (0.37, 2.25)	0.847	1.34 (0.45, 3.93)	0.596	0.80 (0.19, 3.38)	0.758
Educational Attainment										
≤ High school	-		-		-		-		-	
Vocational/Some college	1.24 (0.55, 2.81)	0.610	1.03 (0.37, 2.82)	0.956	1.13 (0.43, 2.99)	0.809	0.94 (0.29, 3.08)	0.923	0.89 (0.17, 4.58)	0.889
College graduate	1.71 (0.85, 3.43)	0.133	2.18 (1.10, 4.33)*	0.026	1.55 (0.75, 3.21)	0.237	1.18 (0.49, 2.85)	0.707	0.68 (0.20, 2.37)	0.548
Graduate degree	2.41 (0.60, 9.58)	0.213	2.61 (0.67, 10.18)	0.165	4.46 (1.09, 18.29)*	0.038	1.17 (0.26, 5.21)	0.840	1.15 (0.03, 49.67)	0.943
Self-reported general health condition										
Excellent/Very good/Good (vs. Fair/Poor)	0.89 (0.49, 1.64)	0.718	0.67 (0.35, 1.30)	0.240	0.97 (0.48, 1.94)	0.928	0.59 (0.31, 1.10)+	0.094	0.62 (0.19, 2.01)	0.430
Comorbidity ≥1 (vs. no comorbidity)	1.49 (0.80, 2.77)	0.212	1.01 (0.49, 2.08)	0.974	1.27 (0.64, 2.50)	0.494	1.56 (0.68, 3.56)	0.290	0.73 (0.24, 2.22)	0.581
BMI										

Underweight 0-18.49	0.35 (0.06, 2.04)	0.241	0.32 (0.05, 1.93)	0.211	2.12 (0.19, 23.31)	0.540	1.47 (0.18, 11.74)	0.716	0.37 (0.03, 4.89)	0.450
Normal 18.5-24.99	-		-		-		-		-	
Overweight 25.0-29.99	0.63 (0.33, 1.21)	0.165	0.51 (0.25, 1.04)+	0.063	0.97 (0.50, 1.89)	0.927	0.70 (0.31, 1.56)	0.385	0.76 (0.23, 2.47)	0.641
Obese 30.0+	0.85 (0.40, 1.83)	0.683	0.65 (0.29, 1.47)	0.300	2.13 (0.93, 4.88)+	0.073	0.93 (0.35, 2.53)	0.894	0.79 (0.19, 3.40)	0.755

Weighted data analyses using *svy* command in STATA. **a**: 2013-2016 data were included; **b**: 2014-2016 data were included. +: $p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Supplemental Table 8: Adjusted logistic regression to estimate the association between acculturation and diabetes care utilization among Asian Americans with diabetes, adjusting for all covariates and personal health behaviors

	Foot examination		**Eye examination**		**Medical plan for diabetes**		**Hemoglobin A1C check [a]**		**Flu shot [b]**	
	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*
Acculturation										
Least acculturated	-		-		-		-		-	
Moderate acculturated	1.50 (0.77, 2.91)	0.235	1.36 (0.63, 2.92)	0.428	1.11 (0.54, 2.29)	0.781	1.24 (0.54, 2.86)	0.606	2.80 (0.78, 10.04)	0.113
Most acculturated	1.64 (0.76, 3.54)	0.209	1.50 (0.64, 3.54)	0.352	2.81 (1.04, 7.59)*	0.041	0.76 (0.27, 2.14)	0.609	1.00 (0.21, 4.82)	0.999
Age										
18-44	-		-		-		-		-	
45-64	0.73 (0.24, 2.19)	0.574	2.96 (1.19, 7.37)*	0.020	0.29 (0.07, 1.31)	0.108	0.26 (0.05, 1.28)+	0.097	0.95 (0.20, 4.65)	0.954
≥ 65	0.85 (0.26, 2.78)	0.791	2.27 (0.74, 6.91)	0.150	0.12 (0.03, 0.56)**	0.007	0.10 (0.01, 0.70)*	0.020	2.05 (0.38, 11.06)	0.404
Male (vs. Female)	1.19 (0.61, 2.31)	0.613	0.62 (0.31, 1.28)	0.196	1.29 (0.57, 2.93)	0.538	0.94 (0.45, 1.98)	0.878	1.84 (0.56, 5.98)	0.312
Marital status										
Married/Living with Partner	0.65 (0.24, 1.77)	0.401	1.07 (0.35, 3.27)	0.899	1.14 (0.39, 3.33)	0.804	0.50 (0.16, 1.57)	0.235	4.01 (0.64, 25.27)	0.139
Widowed/Separated/Divorced	0.94 (0.27, 3.27)	0.917	0.84 (0.24, 2.94)	0.783	1.31 (0.37, 4.60)	0.677	0.54 (0.13, 2.15)	0.378	1.88 (0.30, 11.56)	0.497
Never married	-		-		-		-		-	
Health insurance										
Uninsured	-		-		-		-		-	
Public only	2.47	0.179	2.96	0.120	1.80	0.417	8.62	0.005	2.59	0.414

	(0.66, 9.25)		(0.75, 11.66)		(0.44, 7.42)		(1.90, 39.21)**		(0.26, 25.56)	
Private	2.99 (0.82, 10.92)+	0.098	1.79 (0.43, 7.35)	0.421	1.16 (0.25, 5.30)	0.845	5.48 (1.23, 24.32)*	0.025	3.09 (0.35, 26.98)	0.305
Income as percent of federal poverty level (FPL)										
0-99% FPL	-		-		-		-		-	
100-199% FPL	0.53 (0.23, 1.23)	0.140	0.60 (0.25, 1.43)	0.245	0.62 (0.28, 1.39)	0.245	0.71 (0.26, 1.91)	0.496	0.52 (0.13, 2.10)	0.359
200-299% FPL	0.81 (0.24, 2.72)	0.728	0.82 (0.27, 2.49)	0.724	0.41 (0.14, 1.22)	0.108	2.97 (0.68, 13.06)	0.149	0.73 (0.09, 5.83)	0.769
300% FPL and above	0.63 (0.27, 1.49)	0.296	1.27 (0.47, 3.43)	0.643	1.15 (0.48, 2.76)	0.760	1.49 (0.48, 4.66)	0.493	0.81 (0.19, 3.46)	0.776
Educational Attainment										
≤ High school	-		-		-		-		-	
Vocational/Some college	1.28 (0.55, 3.00)	0.569	0.99 (0.36, 2.70)	0.981	1.16 (0.44, 3.09)	0.762	0.89 (0.25, 3.10)	0.852	1.21 (0.21, 6.89)	0.832
College graduate	1.73 (0.82, 3.63)	0.149	2.05 (1.01, 4.19)*	0.048	1.51 (0.72, 3.14)	0.271	1.15 (0.46, 2.87)	0.759	0.61 (0.17, 2.20)	0.446
Graduate degree	2.72 (0.64, 11.46)	0.173	2.39 (0.58, 9.88)	0.229	4.89 (1.12, 21.44)*	0.035	1.29 (0.26, 6.38)	0.757	1.30 (0.03, 52.49)	0.891
Self-reported general health condition										
Excellent/Very good/Good (vs. Fair/Poor)	0.90 (0.50, 1.62)	0.716	0.68 (0.35, 1.32)	0.248	0.95 (0.49, 1.84)	0.871	0.61 (0.32, 1.18)	0.144	0.61 (0.17, 2.19)	0.449
Comorbidity ≥1 (vs. no comorbidity)	1.41 (0.76, 2.61)	0.276	0.98 (0.47, 2.05)	0.962	1.18 (0.58, 2.37)	0.650	1.50 (0.67, 3.36)	0.320	0.66 (0.20, 2.12)	0.481
BMI										
Underweight 0-18.49	0.27 (0.03, 2.01)	0.199	0.26 (0.04, 1.54)	0.137	1.72 (0.23, 12.70)	0.596	0.98 (0.14, 6.81)	0.986	0.26 (0.02, 3.18)	0.219
Normal 18.5-24.99	-		-		-		-		-	
Overweight 25.0-29.99	0.55 (0.28, 1.06)+	0.075	0.49 (0.24, 1.01)+	0.055	0.86 (0.42, 1.76)	0.671	0.58 (0.26, 1.31)	0.190	0.85 (0.29, 2.48)	0.771
Obese 30.0+	0.75 (0.34, 1.65)	0.478	0.60 (0.26, 1.39)	0.236	1.78 (0.74, 4.27)	0.198	0.75 (0.28, 2.00)	0.563	0.89 (0.19, 4.09)	0.878
Take insulin (vs. not)	2.39 (1.19, 4.82)*	0.015	1.82 (0.87, 3.83)	0.113	5.25 (2.44, 11.29)***	<0.001	3.29 (1.40, 7.72)**	0.006	1.26 (0.32, 4.89)	0.741

Take diabetic pills (vs. not)	2.66 (1.42, 4.96)**	0.002	1.26 (0.62, 2.55)	0.518	2.61 (1.22, 5.57)*	0.013	1.69 (0.72, 3.97)	0.225	1.67 (0.50, 5.55)	0.398
Cigarette smoking										
Every day	0.69 (0.17, 2.77)	0.603	1.24 (0.26, 5.83)	0.786	0.95 (0.30, 2.95)	0.927	1.43 (0.27, 7.48)	0.671	0.10 (0.02, 0.65)*	0.016
Some days	1.00 (0.21, 4.88)	0.999	0.71 (0.12, 4.03)	0.694	0.88 (0.09, 8.80)	0.912	0.71 (0.09, 5.37)	0.741	9.34 (0.04, 2113.23)	0.418
Quit smoking	1.41 (0.66, 3.00)	0.370	0.74 (0.33, 1.68)	0.474	0.75 (0.35, 1.63)	0.468	2.12 (0.99, 4.57)+	0.054	0.71 (0.19, 2.69)	0.610
Never smoked	-		-		-		-		-	

Weighted data analyses using *svy* command in STATA. **a**: 2013-2016 data were included; **b**: 2014-2016 data were included. +: $p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

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