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Diabetes Prevalence and Risk Factors in Four Asian American Communities

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Abstract

Objective—To estimate the prevalence of diabetes and pre-diabetes and the risk associated with BMI above the Asian cut-point of 23 in 4 Asian American communities.

Research Design and Methods—In a convenience sample of 981 Chinese, Hmong, Korean, and Vietnamese Americans in Sacramento County, California we measured hemoglobin A1c (HbAlc), height, weight, and waist circumference. Diabetes was defined as self-reported diabetes diagnosis or HbA1c ≥ 6.5%, and pre-diabetes as HbAlc 5.7%-6.4% with no diabetes diagnosis. We computed age-standardized prevalence of diabetes, pre-diabetes, and BMI and waist circumference above standard and Asian cut-points, and developed multivariable models of the association of diabetes and pre-diabetes with BMI and waist circumference.

Results—The 4 ethnic groups differed substantially with respect to diabetes prevalence, BMI, and waist circumference. Hmong had the highest prevalence of diabetes (15.0%, 95% confidence interval [CI] 10.7%-19.4%). Diabetes and pre-diabetes were associated with BMI ≥ 25 (diabetes: odds ratio [OR] =3.4, 95% CI 2.1-5.7; pre-diabetes: OR=4.0, 95% CI 2.7-5.8) or between 23 and 25 (diabetes: OR=1.8, 95% CI 1.0-3.1; pre-diabetes: OR=1.6, 95% CI 1.0-2.4). When waist circumference was added to the model, BMI effects were attenuated, and waist circumference ≥ 40 inches (men) or ≥ 35 inches (women) was associated with increased risk of diabetes (OR=3.2, 95% CI 1.6-6.2) and pre-diabetes (OR=1.7, 95% CI 1.0-2.9).

Conclusions—Our findings support the use of a BMI cut-point of 23 and the importance of central adiposity as a risk factor for diabetes in Asians. Diabetes risk reduction interventions for Asians are essential.

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The authors declare no conflicts of interest.

Keywords

Asian; adult diabetes; pre-diabetes; body mass index; waist circumference

Introduction

In 2013, it is estimated that over 19.4 million Asian Americans resided in the United States, comprising approximately 6% of the total U.S. population [1]. By the year 2050 there will be 33.4 million Asian Americans representing a 213% population increase compared to a 49% increase for the rest of the nation [2]. Besides being the fastest growing racial group in percentage terms [3], Asian Americans are quite heterogeneous reflecting more than 50 countries of origin, 200 languages or dialects spoken, and multiple cultural traditions that defy a "one size fits all" characterization [4]. Prior to 2000 a majority of national health surveys classified Asians as "other race" or combined Asians with Pacific Islanders and reported data in the aggregate [5-6].

Aggregated data on non-Hispanic Asians indicate that the prevalence of diagnosed type 2 diabetes is 10.0% compared to 7.5% for non-Hispanic whites, and lower relative to African Americans (15.2%) and Hispanics (12.5%) [7]; however, to better understand the rates of diabetes among Asian Americans, disaggregation is highly preferable [6].

When disaggregated by ethnicity, the variation in diabetes prevalence among specific Asian groups reveals considerable disparities [6, 8-9]. For example, the Diabetes Study of Northern California (DISTANCE) reported that among the 2 million members of an integrated health care system, diabetes prevalence was significantly higher among minority groups than whites (7.3%). The highest prevalence was observed among Pacific Islanders (18.3%), followed by Filipinos (16.1%) and South Asians (15.9%) compared to other ethnic groups including African Americans (13.7%), Latinos (14%) and Native Americans (13.4%) [10]. Other studies that reported disaggregated diabetes prevalence rates included the UC San Diego Filipino Health Study; the North Kohala Study (on the island of Hawaii); the South Asians Living in America (MASALA) study; and the Seattle Japanese American Community Diabetes Study (JACDS). Based on these studies, the diabetes prevalence rates measured by 2 hour plasma glucose, fasting plasma glucose, and hemoglobin A1c were 22.8% (Filipino), 12.9% (Japanese), and 13.0 (South Asian) [11]. In each case, these prevalence rates were higher than current rates for non-Hispanic Whites (11.3%) based on these 3 tests and self-reported diagnosis [7].

The increased risk of diabetes for Asian Americans has been attributed to having a higher percentage of body fat, particularly greater central adiposity at a given BMI level, compared to other racial/ethnic groups [12]. Based on these cumulative findings and analyses, in 2015 the American Diabetes Association recommended that Asians with a BMI of 23 or higher be screened for diabetes [13].

Research Design and Methods

In September 2012, our team at the University of California, Davis Health System received a grant from the Centers for Disease Control and Prevention to initiate the Thousand Asian Americans Study (TAAS). The CDC grant challenged us to screen 1000 Asian American adults for hepatitis B (HBV) because it is the principal etiological risk factor for hepatocellular carcinoma (HCC) in Asians [14]. Our screening efforts focused on four Asian American ethnicities: Chinese, Hmong, Korean, and Vietnamese because their lands of origin in Asia were defined by CDC as being endemic for HBV (chronic HBV prevalence ≥ 2%) [15]. Recognizing the potential causal link between diabetes and HCC [16] we decided to simultaneously measure the prevalence of diabetes and pre-diabetes in these four Asian American communities and related risk factors (body mass index and waist circumference) while offering free hepatitis B testing. In addition, we proposed to estimate the risk of diabetes and pre-diabetes associated with BMI above the Asian cut-point of 23, and to determine the extent to which central adiposity, as measured by waist circumference, can explain the risk associated with higher BMI. The purpose of this paper is to characterize the diabetes-related findings from TAAS in four Asian American communities in Sacramento County, CA, a jurisdiction with one of the largest populations of Asian Americans [17].

Study Population

Between September 2012 and September 2013, we held 28 community screening events throughout Sacramento County, California in partnership with local Asian community-based organizations (Hmong Women's Heritage Association, Shalom Korean Cancer Support Group and California Northstate University Cancer Awareness Research Education Society) and two of the University of California Davis (UCD) student-run medical clinics (Paul Hom Asian Clinic and Vietnamese Cancer Awareness Research Education Society Clinic). All study materials were translated into the languages of our target populations by the UC Davis Interpreting and Translation Services and were than reviewed by our community partners for cultural appropriateness. The materials included: consent form, eligibility form, intake form, advertising materials (flyer, radio announcement script, telephone recruitment script) and a participant medical test result letter. The UC Davis Institutional Review Board approved human subjects participation. Our community partners provided in-language translation during screening events and during participant follow-up. The majority of Chinese and Vietnamese participants were screened at the two student run medical clinics. Most of the Hmong participants were screened at the Hmong Women's Heritage Association office. Half of the Korean participants were screened at local Korean churches and the other half were screened at the Sacramento Korean Association headquarters.

Those eligible for the screening had to be: 1) a resident of Sacramento County; 2) 18 years of age or older; 4) never serologically tested for hepatitis B (per self-report); 4) born or had a parent born from an area of the world considered by the CDC to be of high to intermediate prevalence of HBV [18]. After meeting the eligibility criteria and consenting to be in the study, participants were asked to fill out a brief intake form that including the following: age, ethnicity, country of birth, gender, years lived in the United States, smoking history, current alcohol use, and history of diabetes and other medical conditions. Next, the following measurements were taken by research staff: height (inches), weight (pounds) and waist circumference (inches). After completing the intake form and having their measurements taken, a phlebotomist drew the participant's blood for diagnostic testing. Participants received a $10 gift card to a local store for their time.

Participants received the following tests: hepatitis B surface antigen (HBsAg), hepatitis B surface antibody (anti-HBs) and the total hepatitis B core antibody (anti-HBc) and the hemoglobin A1c (HbA1c) test. All tests were processed by the UC Davis Department of Pathology and Laboratory Medicine.

The HbAlc test was analyzed utilizing the Trinity BioTech Ultra 2 HbA1c Analyzer - Boronate Affinity HPLC. The HbA1c test is the primary test used for diabetes management and diabetes research and reflects an individual's average levels of blood glucose over the past three months [19]. It is considered an objective test of metabolic control that is independent of patients' cooperation, time of day, and insulin [20]. The boronate affinity HbA1c method provides accurate analytical results in the presence of most hemoglobin variants [21].

All communication with participants including recruitment, the consenting process, survey administration and screening events occurred in the participant's preferred language (typically, the Asian language associated with their country of origin, i.e., “in-language”). In addition, participants received an in-language telephone call regarding their hepatitis B and hemoglobin A1c results and were mailed letters detailing their test hepatitis B results; participants who tested positive for hepatitis B received follow-up at UC Davis Medical Center as needed and those who were diabetic or at an increased risk for diabetes were advised to consult with their primary care provider. If they did not have a primary care provider, they were referred to the UCD student-run free community clinics.

Measures

We collected data on two proxy measures of acculturation: preferred language and proportion of life in the U.S. The percentage of life in the U.S. was determined by subtracting the self-reported year of arrival to the U.S. from the current year, dividing by age, and multiplying by 100. Those born in the U.S. were considered to have spent 100 percent of their life in the U.S.

Body mass index (BMI) in kg/m^2 was computed as weight (lb)/[height (in)]^2 × 703. BMI was classified with respect to the standard cut-point for elevated risk of diabetes (BMI≥ 25) and the Asian cut-point (BMI≥ 23) [22]. Similarly, waist circumference was classified with respect to the standard cut-points (≥ 40 inches for men, ≥ 35 inches for women) and the Asian cut points (≥ 35 inches for men, ≥ 32 inches for women) [23]. Diabetes was defined as a self-reported diabetes diagnosis or hemoglobin A1c ≥ 6.5%, in order to account for undiagnosed diabetes; prediabetes was defined as HbAlc 5.7%-6.4% with no self-reported diabetes diagnosis [24].

Statistical analysis

Demographics (age, percentage of life in the U.S., and preferred language) and lifestyle characteristics (self-reported current smoker and use of alcohol in the past 30 days) were compared across the 4 ethnic groups among men and women separately using chi-square tests or Fisher's exact test to compare proportions and analysis of variance (ANOVA) to compare means (Table 1). The proportion of participants in each ethnic group with diabetes, pre-diabetes, BMI above Asian and standard cut-points, and waist circumference above Asian and standard cut-points was computed within age groups (18-44, 45-54, 55-64, and ≥ 65), and age-adjusted comparisons by ethnicity were assessed using the Cochran-Mantel-Haenszel general association statistic [25]. Prevalence estimates with 95% confidence intervals for each ethnic group were age standardized to the Sacramento County 2010 population distribution [26] using the following weights: age 18-44: 0.51, 45-54: 0.19, 55-64: 0.15, ≥ 65: 0.15 (Table 2). Multi-variable logistic regression with generalized logits was used to compute odds ratios and 95% confidence intervals for the association of diabetes and pre-diabetes (vs. having neither condition) with BMI above the standard cut-point and between the Asian and standard cut-points (vs. below both cut-points), adjusting for age (18-44, 45-54, 55-64, ≥ 65), gender, ethnicity, proportion of life in the U.S. (≥50%, < 50%, unknown), current smoker (yes or no), and alcohol use in the past 30 days (yes or no); then waist circumference—categorized as above the standard cut-point, between the Asian and standard cut-points, and below both cut-points—was added to the model in order to determine the extent to which central adiposity explained BMI effects (Table 3). To test for differential effects of BMI by ethnicity and gender we created additional models that included ethnicity-BMI and gender-BMI interaction terms; ethnicity-waist circumference and gender-waist circumference interactions were also tested.

Results

A total of 1004 Asian Americans participated in the parent study; data for the 981 Chinese, Hmong, Korean, and Vietnamese American participants are included in the current analyses (the remaining 23 participants were of other ethnicities e.g. Laotian, Thai, Mongolian, etc. and were excluded from the analysis). Nearly all (967, 99%) were born in Asia. A majority (63%) of the participants were women. Although the age range was 18-92, most participants (77%) were age 45 or older. The 4 ethnic groups differed with respect to demographic characteristics; Korean participants tended to be older, and Hmong and Koreans had lived a larger proportion of their lives in the U.S. Smoking and alcohol use were much more common among men, and except for smoking among women, which was rare in all ethnic groups, there was substantial ethnic variation (Table 1).

The ethnic groups also differed significantly with respect to diabetes prevalence, and BMI and waist circumference distribution categorized by standard and Asian cut-points. The Hmong had the highest age-standardized prevalence of diabetes and the greatest proportion of participants with BMI and waist circumference above cut-points. Pre-diabetes prevalence was highest among Chinese (Table 2).

Diabetes was more common among participants with BMI ≥ 25 (odds ratio [OR] =3.4, 95% confidence interval [CI] 2.1-5.7) or between 23 and 25 (OR=1.8, 95% CI 1.0-3.1); pre-diabetes was also more common among those with BMI ≥ 25 (OR=4.0, 95% CI 2.7-5.8) or between 23 and 25 (OR=1.6, 95% CI 1.0-2.4).

When waist circumference was added to the model (model 2), BMI effects were attenuated, and waist circumference above the standard cut-points was associated with increased risk of diabetes (OR=3.2, 95% CI 1.6-6.2) and pre-diabetes (OR=1.7, 95% CI 1.0-2.9) (Table 3). In additional models (not shown), interactions of gender and ethnicity with BMI and waist circumference were not statistically significant (model 1 with interactions: gender-BMI p=0.68, ethnicity-BMI p=0.92; model 2 with interactions: gender-BMI p=0.86, ethnicity-BMI p=0.58, gender-waist p=0.80, ethnicity-waist p=0.21)

Discussion

The purpose of this paper is to characterize the diabetes-related findings from TAAS using the recently American Diabetes Association-recommended Asian American cut-point of BMI 23 in four Asian American communities and determining the extent to which central adiposity, as measured by waist circumference, can explain the risk associated with higher BMI. To this end, our study focused on collecting and analyzing blood samples and self-reported data from 981 Asian American Sacramento County adult residents, with more than 200 participants each from the Chinese, Hmong, Korean, and Vietnamese communities. To the best of our knowledge, this sample represents the largest collection of data from blood biospecimens correlated with socio-cultural demographic data on these specific Asian American ethnic groups to date related to diabetes.

Our findings document that with the exception of Vietnamese, the estimated prevalence of diabetes among all of the other Asian American groups was higher than the rate of diagnosed diabetes among Asian American adults overall (10.0%) [7], although lower than the 16.5% prevalence estimate that includes undiagnosed diabetes detected by fasting plasma glucose as well as HbA1c [7]. Additionally, the prevalence of diabetes for Chinese Americans in our study (11.4%) was higher than the prevalence rates in both China (9.6%) and in Taiwan (9.8%); the prevalence of diabetes for Korean Americans (11.9%) was higher than rates in South Korea (8.9%); the prevalence of diabetes for Vietnamese Americans (8.5%) was higher than the rate in Vietnam (5.4%); the prevalence of diabetes in Hmong Americans in our study (15%) was higher than the rates in Thailand, one of the countries from which Hmong immigrate to the U.S. (7.5%); however, these differences may be due in part to different diabetes ascertainment methods and age standardization [27]. A diet with a greater abundance of calorie dense foods and the transition to a less active lifestyle are likely to explain the higher rates of diabetes in Asian Americans compared to their counterparts in Asia [28]. In the case of the Hmong, the “thrifty gene” syndrome whereby Hmong women, in particular, gain weight more easily has been posited [29].

Among those sampled, Hmong Americans had the highest age-standardized prevalence of diabetes (15.0%, 95% CI 10.7%-19.4%), as well as the highest age-standardized proportion with BMI exceeding the Asian and standard cut-points for diabetes screening. These findings suggest the need for research elucidating the biological and behavioral determinants of a propensity towards diabetes among the Hmong as well as initiating interventional diabetes prevention efforts that are tailored to Hmong values and preferences.

Our prevalence estimates of BMI ≥ 23 were similar to estimates from a study of California Health Interview (CHIS) data for Chinese (49% vs. 52%) and Koreans (54% vs. 60%), but higher for Vietnamese (54% vs. 39%) [22], but our estimates of diabetes prevalence were much higher than the CHIS estimates (Chinese: 11.4% vs. 4.3%, Koreans: 11.9% vs. 5.5%, Vietnamese: 8.5% vs. 2.4%), which were based exclusively on self-report. The CHIS study found that Koreans and Vietnamese were at increased risk of diabetes at BMIs of 23-24.9 compared to non-Hispanic whites [22]

Our findings support the use of a BMI cut-point of 23 [30, 31] as indicating increased risk of diabetes (BMI 23 up to 25 vs. < 23: OR=1.8, 95% CI 1.0-3.1) and pre-diabetes (BMI 23 up to 25 vs. < 23: OR=1.6, 95% CI 1.0-2.4) in Asians, and the association between BMI and having diabetes or pre-diabetes did not differ significantly by Asian ethnicity. The independent effect of waist circumference on diabetes and pre-diabetes supports the importance of central adiposity as a risk factor for diabetes in Asians.

Except for Chinese Americans, our prevalence estimates of pre-diabetes were lower than the national prevalence among Asian Americans of 32% [7]. We found that both Hmong and Koreans had lower risk of pre-diabetes than Chinese Americans, adjusting for age, gender, proportion of life in the U.S., BMI, waist circumference, smoking, and alcohol use. Whether this is due to differences in lifestyle factors, such as diet and physical activity, and/or differences in metabolism, requires further research.

The major limitation of our data and hence our findings is that our study was based on a convenience sample. Through our outreach efforts and our collaborations with our community partners: Paul Hom Asian Free Clinic for Chinese; Hmong Women's Heritage Association for Hmong; Shalom: a support group for Korean cancer survivors who arranged for outreach with Korean churches; and the Vietnamese Cancer Awareness Research Education Society Clinic, we attracted people who were concerned about their risk of hepatitis B and wanted a free hepatitis B test with a small incentive. Participants hence reflected the reach and effectiveness of our collaborative outreach and community engagement efforts, as well as the health concerns of the individuals who responded to outreach efforts. While we cannot say that our samples are representative of Chinese, Hmong, Korean, or Vietnamese in either Sacramento County or the USA, we are pleased with the enthusiastic response from the community. Our eligibility criteria regarding the birthplace of the participant or his/her parents in a hepatitis B endemic area and not having been tested for hepatitis B may have caused selection bias; however, it is not obvious how these inclusion criteria would affect estimates of the diabetes prevalence or risk associated with higher BMI and waist circumference, and we controlled for proportion of life in U.S. in our models. By the same token, because the invitation to participate in TAAS was based on screening for HBV, the recruitment approach is unlikely to have resulted in selection bias of those interested in diabetes per se.

Another limitation of our study was the use of only hemoglobin A1c, in addition to self-report, as the basis of ascertaining diabetes and pre-diabetes prevalence. The use of all 3 tests (2-hour plasma glucose, fasting plasma glucose, and hemoglobin A1c) to measure undiagnosed diabetes doubled estimated diabetes prevalence among Asian Americans in aggregate compared to previous diagnosis alone (20.6% vs. 10.0%) [7], and compared to diagnosis by hemoglobin A1c alone among Filipinos (22.8% vs. 12.2%), Japanese (12.9% vs. 4.2%), and South Asians (13.0% vs. 6.8%) [11]. We acknowledge that had 2-hour plasma glucose and fasting blood glucose been used our rates would have been substantially higher and that we underestimated the true prevalence rates. In addition, only 23% of the sample was under age 45 vs. 51% of the Sacramento County adult population, leading to age-standardized prevalence estimates with large confidence intervals.

Another limitation is that our study was cross-sectional in nature; as others have indicated longitudinal cohort studies associated with customized interventions to reduce diabetes risk factors are warranted. Relating concerns related to diabetes, obesity, and their linkage to metabolic syndrome as well as their etiological relationships to HCC represents compelling challenge in future interventional studies to mitigate health risks for Asian Americans.

Conclusions

Based on our findings, screening using the American Diabetes Association cut point of a BMI of 23 is warranted. The risk associated with higher BMI was explained in part by central adiposity, as indicated by having a waist circumference above the standard cut-points for men and women. Having a BMI above 23 was relatively common, with an age-standardized prevalence of about 50% for Chinese, Koreans, and Vietnamese, and over 80% for Hmong. Pre-diabetes, which is on the diabetes causal pathway, was also common. Lifestyle interventions, such as the Diabetes Prevention Program, are needed in order to stem the tide of diabetes and other weight-related conditions in Asian American communities.

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Table 1

Characteristics of a Sample of Asian American Residents of Sacramento County, CA 2012-2013 (n=981)

Women		Chinese (n=140) n (%)	Hmong (n=139) n (%)	Korean (n=191) n (%)	Vietnamese (n=145) n (%)	All (n=615) n (%)	p-value
Demographic							
Age (years)	18-44	26 (19)	36 (26)	31 (16)	34 (23)	127 (21)	<.0001
	45-54	45 (32)	38 (27)	48 (25)	42 (29)	173 (28)	
	55-64	61 (44)	46 (33)	49 (26)	57 (39)	213 (35)	
	≥ 65	8 (6)	19 (14)	63 (33)	12 (8)	102 (17)	
	Mean (SD)	51.7 (11.8)	51.4 (14.0)	58.4 (14.9)	51.8 (11.8)	53.8 (13.7)	<.0001
	Min-Max	18-80	19-89	20-91	19-82	18-91	
Life in U.S. (%)	< 25	53 (41)	20 (15)	40 (22)	56 (40)	169 (29)	<.0001
	25-50	49 (38)	42 (31)	67 (36)	48 (34)	206 (35)	
	≥ 50	27 (21)	74 (54)	79 (42)	36 (26)	216 (37)	
	Mean (SD)	32.5 (20.9)	49.5 (21.2)	42.3 (21.1)	33.4 (20.3)	39.7 (21.9)	<.0001
	Min-Max	0-100	9.1-100	0-100	0-100	0-100	
Preferred Language	Asian only	127 (91)	116 (85)	156 (82)	135 (93)	534 (87)	0.0052
	English	12 (9)	21 (15)	35 (18)	10 (7)	78 (13)	
Lifestyle							
Current Smoker	Yes	1 (1)	1 (1)	7 (4)	1 (1)	10 (2)	0.1211
	No	139 (99)	138 (99)	183 (96)	143 (99)	603 (98)	
Alcohol Past 30 Days	Yes	18 (13)	6 (4)	39 (20)	28 (19)	91 (15)	0.0002
	No	122 (87)	133 (96)	152 (80)	117 (81)	524 (85)	

Men		Chinese (n=102) n (%)	Hmong (n=84) n (%)	Korean (n=92) n (%)	Vietnamese (n=88) n (%)	All (n=366) n (%)	p-value
Demographic							
Age (years)	18-44	17 (17)	28 (33)	11 (12)	25 (28)	81 (22)	
	45-54	25 (25)	22 (26)	24 (26)	18 (20)	89 (24)	<.0001
	55-64	50 (49)	25 (30)	22 (24)	33 (38)	130 (36)	
	≥ 65	10 (10)	9 (11)	35 (38)	12 (14)	66 (18)	

Men		**Chinese (n=102) n (%)**	**Hmong (n=84) n (%)**	**Korean (n=92) n (%)**	**Vietnamese (n=88) n (%)**	**All (n=366) n (%)**	**p-value**
	Mean (SD)	54.1 (10.7)	48.2 (16.6)	59.5 (13.7)	51.2 (13.6)	53.4 (14.2)	<.0001
	Min-Max	22-76	18-81	20-92	21-83	18-92	
Life in U.S. (%)	< 25	43 (45)	6 (7)	19 (21)	24 (28)	92 (26)	<.0001
	25-50	25 (26)	25 (31)	40 (44)	30 (34)	120 (34)	
	≥ 50	27 (28)	50 (62)	31 (34)	33 (38)	141 (40)	
	Mean (SD)	32.2 (21.6)	55.0 (22.7)	42.6 (19.8)	39.5 (21.9)	41.9 (22.9)	<.0001
	Min-Max	0-97.1	10.7-100	0-100	0-94.1	0-100	
Preferred Language	Asian only	92 (90)	51 (61)	65 (71)	76 (86)	284 (78)	<.0001
	English	10 (10)	32 (39)	27 (29)	12 (14)	81 (22)	
Lifestyle							
Current Smoker	Yes	30 (29)	13 (15)	12 (13)	22 (25)	77 (21)	0.0159
	No	72 (71)	71 (85)	80 (87)	65 (75)	288 (79)	
Alcohol Past 30 Days	Yes	39 (38)	24 (29)	36 (39)	62 (70)	161 (44)	<.0001
	No	63 (62)	60 (71)	56 (61)	26 (30)	205 (56)	

Note: gender-specific ethnic differences in proportions were assessed using Fisher's exact test (current smoker—women) or chi-square test (all others), and differences in means were assessed using analysis of variance (ANOVA).

Table 2

Prevalence of Diabetes and Metabolic Risk Factors by Age in a Sample of Asian American Residents of Sacramento County, CA 2012-2013

		Chinese (n=242) n (%)	Hmong (n=223) n (%)	Korean (n=283) n (%)	Vietnamese (n=233) n (%)	All (n=981) n (%)	p-value
Diabetes							
Age	18-44	1 (2)	3 (5)	2 (5)	1 (2)	7 (3)	0.0198
	45-54	11 (16)	9 (15)	8 (11)	2 (3)	30 (12)	
	55-64	20 (19)	28 (40)	14 (20)	18 (21)	80 (24)	
	≥ 65	5 (28)	7 (25)	28 (29)	6 (26)	46 (28)	
Prev. (95% CI)		11.4 (7.0-15.8)	15.0 (10.7-19.4)	11.9 (7.8-16.0)	8.5 (5.0-12.1)	11.7 (9.8, 13.7)	
Pre-diabetes							
Age	18-44	12 (29)	6 (9)	7 (17)	7 (12)	32 (16)	0.0634
	45-54	23 (34)	24 (41)	18 (25)	28 (47)	93 (36)	
	55-64	51 (50)	24 (34)	28 (40)	37 (43)	140 (42)	
	≥ 65	8 (44)	9 (32)	39 (40)	11 (48)	67 (40)	
Prev. (95% CI)		35.2 (27.0-43.4)	22.5 (17.1-27.8)	25.4 (18.9-31.8)	28.6 (22.6-34.6)	27.2 (24.1-30.3)	
BMI ≥ 23							
Age	18-44	20 (47)	52 (83)	19 (48)	32 (54)	123 (60)	<.0001
	45-54	38 (54)	56 (93)	38 (53)	32 (54)	164 (63)	
	55-64	61 (55)	67 (94)	48 (68)	49 (55)	225 (66)	
	≥ 65	8 (44)	24 (86)	62 (65)	12 (50)	106 (64)	
Prev. (95% CI)		49.0 (40.3-57.8)	86.8 (81.5-92.2)	54.1 (45.6-62.6)	53.7 (46.0-61.4)	62.0 (58.2-65.9)	
BMI ≥ 25							
Age	18-44	10 (23)	39 (62)	13 (33)	18 (31)	80 (39)	<.0001
	45-54	17 (24)	47 (78)	24 (33)	20 (34)	108 (41)	
	55-64	35 (32)	62 (87)	30 (42)	32 (36)	159 (47)	
	≥ 65	4 (22)	19 (68)	36 (38)	6 (25)	65 (39)	
Prev. (95% CI)		24.6 (17.2-32.0)	69.7 (62.7-76.8)	34.9 (26.9-42.9)	31.1 (24.1-38.2)	40.6 (36.8-44.5)	
Waist (in.) ≥ Asian cut-point							
Age	18-44	18 (42)	40 (63)	11 (28)	23 (40)	92 (45)	<.0001

		Chinese (n=242) n (%)	Hmong (n=223) n (%)	Korean (n=283) n (%)	Vietnamese (n=233) n (%)	All (n=981) n (%)	p-value
	45-54	41 (59)	51 (86)	24 (33)	32 (53)	148 (57)	
	55-64	71 (66)	64 (90)	40 (57)	53 (61)	228 (68)	
	≥ 65	10 (59)	26 (93)	61 (65)	15 (63)	112 (69)	
Prev. (95% CI)		51.3 (42.6-60.0)	75.8 (69.2-82.3)	39.0 (31.2-46.9)	49.2 (41.6-56.9)	54.4 (50.5-58.3)	
Waist (in.) ≥ Std. cut-point							
Age	18-44	7 (16)	23 (36)	6 (15)	6 (11)	42 (21)	<.0001
	45-54	12 (17)	35 (59)	6 (8)	14 (23)	67 (26)	
	55-64	34 (31)	40 (56)	9 (13)	20 (23)	103 (31)	
	≥ 65	2 (12)	18 (64)	26 (28)	7 (29)	53 (33)	
Prev. (95% CI)		18.1 (11.7-24.5)	47.7 (40.5-54.9)	15.5 (9.3-21.7)	17.6 (12.2-23.1)	24.9 (21.6-28.2)	

Notes: (1) Age-adjusted associations with ethnicity were assessed using the Cochran-Mantel-Haenszel general association statistic (2) Estimates of prevalence with 95% confidence intervals (CI) are age standardized to the Sacramento County 2010 population distribution: 18-44: 0.51, 45-54: 0.19, 55-64: 0.15, ≥ 65: 0.15. (3) Diabetes = self-reported diagnosis or hemoglobin A1c ≥ 6.5; pre-diabetes = hemoglobin A1c 5.7-6.4 and no diabetes diagnosis. (4) Waist circumference cut-points (inches): Standard: 40 (men), 35 (women); Asian: 35 (men), 32 (women)

Table 3

Characteristics Associated with Diabetes and Pre-Diabetes in a Sample of Asian American Residents of Sacramento County, CA 2012-2013

	Model 1 (n=948)		Model 2 (n=935)	
Characteristic	**Diabetes OR† (95% CI)**	**Pre-Diabetes OR† (95% CI)**	**Diabetes OR† (95% CI)**	**Pre-Diabetes OR† (95% CI)**
BMI (kg/m^2)				
≥ 25	**3.4 (2.1-5.7)**	**4.0 (2.7-5.8)**	**2.1 (1.1-3.9)**	**3.0 (1.9-4.7)**
23-25	**1.8 (1.0-3.1)**	**1.6 (1.0-2.4)**	1.4 (0.8-2.6)	1.4 (0.9-2.2)
< 23 (ref)	1.0	1.0	1.0	1.0
Waist vs. Cut-points‡				
Above	NA	NA	**3.2 (1.6-6.2)**	**1.7 (1.0-2.9)**
Between			1.1 (0.6-1.9)	1.3 (0.9-2.0)
Below (ref)			1.0	1.0
Ethnicity				
Chinese (ref)	1.0	1.0	1.0	1.0
Hmong	0.7 (0.4-1.3)	**0.4 (0.2-0.6)**	0.7 (0.3-1.3)	**0.4 (0.2-0.6)**
Korean	0.7 (0.4-1.2)	**0.5 (0.3-0.8)**	0.9 (0.5-1.6)	**0.6 (0.4-1.0)**
Vietnamese	0.7 (0.4-1.3)	0.8 (0.5-1.2)	0.7 (0.4-1.3)	0.8 (0.5-1.2)
Gender				
Female	1.0 (0.6-1.5)	0.8 (0.6-1.1)	0.6 (0.4-1.0)	0.7 (0.5-1.1)
Male (ref)	1.0	1.0	1.0	1.0
Life in U.S. (%)				
≥ 50	1.4 (0.9-2.1)	0.9 (0.7-1.3)	1.4 (0.9-2.1)	0.9 (0.6-1.3)
< 50 (ref)	1.0	1.0	1.0	1.0
Unknown	1.5 (0.6-4.0)	1.3 (0.6-2.9)	1.3 (0.5-3.7)	1.2 (0.5-2.8)
Current Smoker				
Yes	1.3 (0.6-2.8)	0.9 (0.5-1.6)	1.3 (0.6-2.8)	0.9 (0.5-1.7)
No (ref)	1.0	1.0	1.0	1.0
Alcohol User Past 30 days				
Yes	**0.5 (0.3-0.8)**	0.9 (0.6-1.3)	**0.5 (0.3-0.8)**	0.9 (0.6-1.3)
No (ref)	1.0	1.0	1.0	1.0

†Adjusted for age and all tabulated variables in the model using logistic regression with generalized logits to estimate the odds of diabetes or pre-diabetes vs. having neither condition

‡Waist circumference cut-points (inches): Above: ≥40 (men), ≥35 (women); between: ≥35 up to 40 (men), ≥32 up to 35 (women); below: <35 (men), <32 (women).

Notes: (1) OR=odds ratio, CI=confidence interval, NA=not applicable, ref=referent level. (2) Diabetes = self-reported diagnosis or hemoglobin A1c ≥ 6.5; pre-diabetes = hemoglobin A1c 5.7-6.4 and no diabetes diagnosis.