Social and clinically-relevant cardiovascular risk factors in Asian Americans: NHANES 2011-2014

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Abstract:

Little evidence exists examining cardiovascular risk factors among Asian Americans and how social determinants such as nativity status and education pattern risk in the United States (U.S.) context. We used the National Health and Nutrition Examination Survey, which purposely oversampled Asian Americans from 2011 to 2014, and examined prevalence of Type II diabetes, smoking and obesity for Asian Americans (n = 1363) and non-Latino Whites (n = 4121). We classified Asian Americans as U.S. or foreign-born and by years in the U.S. Obesity status was based on standard body mass index (BMI) cut points of ≥ 30 kg/m^2 and Asian-specific cut points (BMI ≥ 25 kg/m^2) that may be more clinically relevant for this population. We fit separate logistic regression models for each outcome using complex survey design methods and tested for the joint effect of race, nativity and education on each outcome. Diabetes and obesity prevalence (applying Asian-specific BMI cut points) were higher among Asian Americans when compared to non-Latino Whites but smoking prevalence was lower. These patterns remained in fully adjusted models and showed small increases with longer duration in the U.S. Joint effects models showed higher odds of prevalent Type II diabetes and obesity (Asian-specific) for foreign-born Asians, regardless of years in the U.S. and slightly higher risk for low education, when compared to non-Latino Whites with high education. Smoking models showed significant interaction effects between race and education for non-Latino Whites only. Our study supports the premise that social as well as clinical factors should be considered when developing health initiatives for Asian Americans.

Keywords: Cardiovascular risk factors | Asian Americans | Disparities | Nativity | Socioeconomic position

Article:

1. Background

Asian Americans are one of the fastest growing racial/ethnic groups in the United States (U.S.), expected to reach 41 million individuals by 2050 (Hoeffel et al., 2012, Ro and Yee, 2010). The majority of Asian American adults are foreign-born and the six largest subgroups in the U.S. are of Asian Indian, Chinese, Filipino, Japanese, Korean, and Vietnamese descent. However, the small number of Asian Americans included in population-based health studies has resulted in limited meaningful analyses of health risks. In 2010, the American Heart Association issued a scientific advisory highlighting substantial gaps in understanding patterns and risk factors contributing to cardiovascular disease (CVD) among Asian Americans (Palaniappan et al., 2010).

An important first step in assessing the cardiovascular health of Asian Americans is determining if disparities exist between Asian Americans and non-Latino Whites, in order to guide disparities prevention efforts (Ro and Yee, 2010). Prior studies have shown similar or higher prevalence of Type II diabetes in Asians when compared to non-Latino Whites (McNeely and Boyko, 2004, Wong et al., 2014, Lee et al., 2011). Moreover, for specific ethnic groups such as Asian Indians, the odds of having diabetes is 2–3 times that of non-Latino Whites (Ye et al., 2009, Karter et al., 2013). Although these studies suggest substantial CVD disparities, they are nonetheless based on regional or clinical populations, and thus limited in their generalizability.

Other clinical research studies have indicated that standard body mass index (BMI) cut points of BMI $\geq$ 30 kg/m^2 used to classify obesity may not be clinically relevant for individuals of Asian descent (Yoon et al., 2006). For example, studies have shown that at all levels of BMI individuals of Asian descent are more likely to be diagnosed with diabetes (Hsu et al., 2012, Ramachandran et al., 2010). Given this growing evidence, the World Health Organization now recommends using BMI cutoffs ranging from 25 to 27 kg/m^2, to classify obesity among Asians (WHO, 2004) and the U.S. American Diabetes Association (ADA) also recommend screening Asian Americans for diabetes at a BMI of 23 kg/m^2 or higher (Hsu et al., 2015).

Notwithstanding the importance of identifying clinically relevant cut points to classify obesity and screen for diabetes, much of this research has focused on genetic or metabolic factors potentially driving BMI-diabetes associations in Asians. A long and rich body of literature (Krieger, 2001, Link and Phelan, 1995) has demonstrated that race/ethnicity, immigrant status and measures of socioeconomic position (SEP), such as education, strongly pattern life opportunities that can result in increased cardiovascular risk in adulthood. For example, in one of the few studies examining social contexts for Asian Americans, the Honolulu Heart Study(Marmot et al., 1975) examined over 8000 men of Japanese descent and showed a gradient of increasing heart disease risk when comparing men living in Japan, Hawaii and California. Since this groundbreaking study, only select studies have investigated associations between social conditions and CVD risk among Asian Americans (Albrecht et al., 2013, Chae et al., 2008, Kandula et al., 2008, Kuerban, 2015).

Characterizing cardiovascular risk by race/ethnicity, nativity status, and SEP would provide much needed evidence to inform targeted initiatives aimed at Asian Americans. Using data from the National Health and Nutrition Examination Survey (NHANES), we first examined racial/ethnic disparities in obesity, diabetes and smoking prevalence for Asian Americans compared to non-Latino Whites. We hypothesized that Asian Americans would have increased

prevalence of cardiovascular risk factors compared to non-Latino Whites, showing a gradient with longer duration in the U.S. among foreign-born Asian Americans. Our final set of analyses investigated heterogeneity in risk factors by nativity and educational attainment, to provide new evidence on the potential independent and synergistic effect of social conditions patterning cardiovascular risk in Asian Americans.

2. Methods

2.1. Study population

NHANES is a nationally representative cross-sectional sample of the non-institutionalized U.S. population designed to assess the health and nutritional status of U.S. adults and children. Beginning in 2011–2012, NHANES purposely started oversampling Asian Americans. As recommended by the National Center for Health Statistics, we merged the 2011–2014 survey years to ensure more stable estimates. NHANES uses both self-reported and laboratory-based assessments of a range of health conditions. Participants complete an in home questionnaire and attend a mobile examination clinic where they undergo laboratory measurements. Individuals who were pregnant and those < 20 years of age were excluded from the analysis, since all the outcomes under study were not assessed in this group.

2.2. Outcome variables

2.2.1. Diabetes

As recommended by the ADA, Type II diabetes can be ascertained through fasting plasma glucose levels, two hour post-challenge oral glucose tests or hemoglobin A1C (Hb A1C) values, where fasting is not required. Since NHANES only ascertains fasting plasma glucose or oral glucose challenge tests for select participants who are scheduled for the morning laboratory measurement sessions, we used HbA1C levels that were assessed on nearly all participants to minimize the potential bias introduced by including participants who had all or a mix of the 3 tests performed. Individuals who had a hemoglobin A1C $\geq$ 6.5%, or if they responded “Yes” to the question asking them if they have ever been told that they have diabetes by a doctor or health professional were classified as having diabetes.

2.2.2. Obesity

Weight and height were directly measured among NHANES participants and BMI provided as kilograms divided by height in meters squared (kg/m^2). We applied a standard classification of BMI $\geq$ 30 kg/m^2 to define obesity (Flegal et al., 2012), and an Asian-specific definition defined as a BMI $\geq$ 25 kg/m^2.

2.3. Current smoking status

There are several approaches to classify smoking. We followed conventional criteria in national surveillance systems that define current smokers as respondents who had smoked at least 100

cigarettes in their life and currently smoked cigarettes every day or some days (Centers for Disease Control and Prevention, 2016).

2.3.1. Main independent variables

Our first set of analyses documents racial/ethnic disparities in diabetes, obesity and smoking using participants' self-reported race/ethnicity, and classifying individuals as non-Latino White or Asian American. Non-Latino Whites born outside of the U.S. were excluded (n = 111) to better capture disparities based on historical patterns of privilege for U.S.-born Whites (Braveman et al., 2010). Second, we conceptualized nativity status (U.S.-born or foreign born, and years in the U.S.), and educational attainment as proxies for social determinants and examined how these factors independently and jointly influence CVD risk in Asian Americans. Number of years living in the U.S. served as a proxy for acculturation-related processes that may influence health (Abraido-Lanza et al., 2006). Given the age distribution of Asian Americans, foreign-born Asians were categorized as living in the U.S. < 20 years or 20 or more years. Education was categorized as those with less than a high school education, high school, some college and college or greater, and for joint effects models individuals were classified as having a college education or more vs. less than college education (see more detailed description under Statistical Analysis). Additional covariates included age (continuous form), gender, and total annual household income. This income variable in NHANES has pre-defined categories that were further collapsed as <$25,000, $25,000 to $74,999, and $75,000 or greater to ease interpretation and improve sample size distribution across categories.

2.4. Statistical analysis

Frequencies or means were reported, as appropriate, and presented by race/ethnicity and nativity status. We fit logistic regression models examining associations between race/ethnicity and nativity status for each of the outcomes in separate models. For each outcome, a crude model was fit which included race/ethnicity and nativity alone, followed by models that adjusted for age, gender, income and education. Further, we followed recent recommendations to test for effect modification using joint effects models (Knol and VanderWeele, 2012). In this approach, estimates for all combinations of the main variable and effect modifier are modeled jointly in one regression model and estimates presented in a single table. Of note, while this approach allows researchers to test for interaction on the additive and multiplicative scale, our interest was in examining how the observed increased risk of CVD risk factors for those who are foreign-born and have low levels of education compared to what we would expect if these social determinants worked independently. A larger sample of Asian Americans would be needed to derive more accurate estimates of additive (public health) effects. We created a 6-level variable classifying individuals as: 1) foreign-born Asian with 20 or more years in the U.S. and low education; 2) foreign-born Asian with 20 or more years in the U.S. and high education; 3) foreign-born Asian with < 20 years in the U.S. and low education; 4) foreign-born Asian with < 20 years in the U.S. and high education; 5) non-Latino White and low education; and 6) non-Latino White and high education, who served as the referent group against which all groups were compared. For ease of presentation, we only present the joint effect estimates (shown under columns labeled ‘High and Low Education’, Table 3) and estimates for education disparities within race/ethnicity. We also explored if previously reported patterns of higher risk of diabetes across all levels of BMI held

for Asian Americans in the present sample and fit a logistic regression model testing the interaction between BMI (continuous scale), race/ethnicity and nativity (excluding U.S.-born Asian Americans), adjusting for gender, age, education and income. SAS 9.4 and SAS-callable SUDAAN were used for all statistical analyses and results, including statistical tests, to account for the complex survey design. All statistical testing was two-sided at the 5% significance level.

Table 1. Weighted demographic characteristics of study population and prevalence of outcomes, by race/ethnicity and nativity, NHANES 2011–2014.

Characteristic	Non-Latino Whites (U.S.-born) (n = 4121)	U.S.-born Asians (n = 196)	Asians, foreign born, ≥ 20 years (n = 531)	Asians, foreign-born, < 20 years (n = 636)
Socio-demographic characteristics				
Age, Mean (se)	49.9 (0.5)	36.7 (1.7)	53.2 (0.8)	41.1 (1.1)
Age (years)				
20–39	30.5 (1311)	68.8 (130)	18.1 (85)	51.3 (302)
40–59	38.1 (1293)	17.4 (34)	49.0 (256)	35.8 (229)
60–79	25.4 (1061)	11.1 (26)	29.2 (170)	12.0 (99)
80 +	5.9 (456)	2.7 (6)	3.6 (20)	0.9 (6)
Gender				
Male	48.8 (2033)	48.9 (101)	46.1 (261)	45.7 (302)
Female	51.2 (2088)	51.1 (95)	53.9 (270)	54.3 (334)
Annual household income				
$0–$24,999	18.2 (1243)	11.0 (22)	13.7 (74)	17.8 (114)
$25,000–74,999	40.6 (1566)	33.3 (61)	37.2 (187)	41.1 (246)
$75,000 +	41.2 (1209)	55.7 (103)	49.1 (230)	41.1 (231)
Education				
Less than high school	10.5 (615)	2.9 (6)	15.2 (86)	15.3 (112)
High school	20.8 (919)	7.6 (15)	13.5 (77)	14.9 (99)
Some College	33.7 (1398)	36.8 (68)	21.6 (111)	17.9 (115)
College or more	35.0 (1189)	52.7 (107)	49.6 (257)	51.9 (310)
Diabetes				
Yes	10.5(520)	5.8(11)	18.5(101)	11.8(82)
No	89.5(3601)	94.2(185)	81.5(430)	88.2(554)
BMI (kg/m^2)†				
18.5–< 25	29.2 (1170)	57.0 (103)	54.9 (277)	61.4 (370)
25.0–< 30	34.6 (1340)	28.9 (52)	31.7 (166)	27.6 (173)
30.0 +	36.2 (1484)	14.1 (24)	13.4 (65)	11.1 (62)
Obesity† (standard): n				
Yes	36.2 (1484)	14.1 (24)	13.4 (65)	11.1 (62)
No	63.8 (2510)	85.9 (155)	86.6 (443)	88.9 (543)
Obesity‡ (Asian specific): n				
Yes	36.2 (1484)	43.0 (76)	45.1 (231)	38.6 (235)
No	63.8 (2510)	56.9 (103)	54.9 (277)	61.4 (370)
Smoking				
Yes	20.7 (1000)	12.6 (25)	8.2 (43)	9.1 (59)
No	79.3 (3119)	87.4 (171)	91.8 (487)	90.9 (576)

Missing values in annual household income is n = 44, 8, 32, and 23 for non-Latino White, U.S.-born Asian, foreign-born Asian < 20 years, and foreign-born Asians ≥ 20 years groups, respectively, and for BMI n = 30, 2, 4, and 5 for non-Latino White, U.S.-born Asian, foreign-born Asian < 20 years, and foreign-born Asians ≥ 20 years groups, respectively.

† Excludes those with BMI < 18.5 kg/m^2 and obesity is defined as BMI ≥ 30 kg/m^2 for all groups.

‡ Excludes those with BMI < 18.5 kg/m^2 and obesity is defined as BMI ≥ 30 kg/m^2 for non-Latino Whites and BMI ≥ 25 kg/m^2 for Asians.

3. Results

Table 1 shows demographic distribution of the study sample by race/ethnicity and nativity status. Age distribution varied by race/ethnicity and nativity: in general, Asians were younger than non-Latino Whites. A slightly higher percentage of U.S.-born Asians had incomes of $75,000 or higher than non-Latino Whites, and all Asian groups were relatively more educated than non-Latino Whites.

Diabetes prevalence among Asian Americans living in the U.S. 20 or more years was 18.5% compared to 5.8% in U.S.-born Asian Americans, and 10.5% among non-Latino Whites (Table 1, $p \leq 0.0001$) Applying standard cutoffs for obesity, Asians had lower prevalence of obesity than non-Latino Whites ($p \leq 0.0001$). However, once Asian-specific cutoffs were applied, the prevalence of obesity in U.S.-born Asian Americans (43%), foreign-born < 20 years in the U.S. (38.6%) and those ≥ 20 years in the U.S. (45.1%) was higher than non-Latino Whites (36.2%) (0.0017). Foreign-born Asian Americans were less likely to smoke (9.1% and 8.2% for < 20 and ≥ 20 years in the U.S., respectively) than non-Latino Whites (20.7%) and U.S.-born Asian Americans (12.6%, $p \leq 0.0001$).

Table 2. Association between race and nativity status and diabetes, obesity and smoking, NHANES 2011–2014.

Outcome **Race/ethnicity, nativity**	**N with/without outcome**	**Unadjusted odds ratio (95% CI)**	**Adjusted odds ratio (95% CI)**
Diabetes			
Non-Latino Whites	520/3601	Ref	Ref
U.S.-born Asians	11/185	0.53 (0.27, 1.03)	1.24 (0.63, 2.43)
Foreign-born Asians, ≥ 20 years	101/430	1.94 (1.49, 2.53)	1.92 (1.34, 2.75)
Foreign-born Asians, < 20 years	82/554	1.15 (0.84, 1.57)	1.97 (1.41, 2.76)
Obesity (standard)[†]			
Non-Latino Whites	1484/2510	Ref	Ref
U.S.-born Asians	24/155	0.29 (0.20, 0.41)	0.34 (0.23, 0.50)
Foreign-born Asians, ≥ 20 years	65/443	0.27 (0.22, 0.34)	0.30 (0.24, 0.39)
Foreign-born Asians, < 20 years	62/543	0.22 (0.16, 0.30)	0.25 (0.18, 0.34)
Obesity (Asian-specific)[‡]			
Non-Latino Whites	1484/2510	Ref	Ref
U.S.-born Asians	76/103	1.33 (1.00, 1.76)	1.64 (1.23, 2.19)
Foreign-born Asians, < 20 years	235/370	1.11 (0.89, 1.37)	1.28 (1.04, 1.58)
Smoking			
Non-Latino Whites	1000/3119	Ref	Ref
U.S.-born Asians	25/171	0.55 (0.40, 0.76)	0.51 (0.37, 0.69)
Foreign-born Asians, ≥ 20 years	43/487	0.34 (0.24, 0.49)	0.41 (0.28, 0.60)
Foreign-born Asians, < 20 years	59/576	0.38 (0.27, 0.54)	0.29 (0.20, 0.42)

CI – Confidence Intervals.

Note: Models are adjusted for age, gender, income, and education.

[†] Excludes those with BMI < 18.5 kg/m^2 and obesity is defined as BMI ≥ 30 kg/m^2 for all groups.

[‡] Excludes those with BMI < 18.5 kg/m^2 and obesity is defined as BMI ≥ 30 kg/m^2 for non-Latino Whites and BMI ≥ 25 kg/m^2 for Asians.

Logistic regression results showed that in unadjusted models foreign-born Asians who lived in the U.S. at least 20 years had nearly double the odds of diabetes (OR = 1.94, 95% CI: 1.49, 2.53) of non-Latino Whites (Table 2). Conversely, for U.S.-born Asians, the odds of diabetes was significantly lower (OR = 0.53; 95% CI: 0.27, 1.03) when compared to Non-Latino Whites. After adjusting for age, gender, education, and income, the odds of diabetes for all Asian

Americans increased compared to non-Latino Whites but was statistically significant only for foreign-born Asian Americans (OR = 1.97; 95% CI: 1.41, 2.76 for those living in the U.S. < 20 years, and OR = 1.92; 95% CI: 1.34, 2.75 for those with 20 or more years in the U.S.).

Applying standard obesity cutoffs, U.S. and foreign-born Asian Americans have a decreased odds of obesity compared to non-Latino Whites, even after adjusting for age, gender, education, and income (Table 2). Application of Asian-specific cutoffs revealed increased odds of obesity for U.S.-born Asians (OR = 1.64; 95% CI: 1.23, 2.19), those living in the U.S. 20 years or more (OR = 1.58; 95% CI: 1.26, 1.99), and marginally significant associations for the foreign-born living < 20 years in the U.S. (OR = 1.28, 95% CI: 1.04, 1.58), after adjusting for age, gender, education, and income.

Smoking results indicate significantly decreased odds of smoking for all groups of Asian Americans compared to non-Latino Whites, after adjusting for age, gender, education, and income (Table 2).

Joint effect results showed expected directions of associations for all outcomes, except for obesity where associations depend on the BMI cut point applied (Table 3). The odds of diabetes among foreign-born Asians ranges from 2.4 to 3.6 times that of non-Latino Whites with high education status (referent group), for all combinations of duration of residence in the U.S. and educational level (inner cells of high/low education and race/ethnicity categories). Moreover, marginal estimates (last column) comparing diabetes prevalence by educational attainment showed that low education non-Latino Whites had 2-times the odds of diabetes than high education non-Latino Whites (OR = 2.0 95% CI: 1.32–3.04). A similar pattern was observed for Asian Americans but findings did not reach statistical significance. A similar pattern was observed for Asian Americans but findings did not reach statistical significance. Joint effect models also showed that the effect of race/ethnicity and nativity depends on whether standard or Asian-specific BMI cutoffs are applied. Applying standard obesity cutoffs, the odds of obesity for foreign-born Asians, regardless of duration in the U.S. and education status, is significantly lower than the odds for non-Latino Whites with high education. However, once Asian-specific obesity cutoffs are applied, the estimated odds of obesity are higher for foreign-born Asians at all education levels and years in the United States. For example, the odds of obesity (Asian-specific) for foreign-born Asians living in the U.S. at least 20 years with high education was 1.99 (95% C.I. 1.41, 2.79) that of non-Latino Whites with high education and for foreign-born Asians living in the U.S. at least 20 years with low education was 1.91 (95% C.I. 1.34, 2.72). There were no significant education effects within race and nativity categories, except for non-Latino Whites.

Results for current smoking status were less consistent. Asians living in the U.S. at least 20 years, with low educational attainment, had higher estimated odds of smoking compared to non-Latino Whites with high education, but results were not statistically significant. Low educational attainment was associated with a significant increased odds of smoking among non-Latino Whites (Table 3, last column: OR = 3.81; 95% CI: 2.99, 4.86) and foreign-born Asian Americans living in the U.S. at least 20 years (Table 3, last column: OR = 1.97; 95% CI = 1.07, 3.64).

Table 3. Joint effect of race, nativity and education on diabetes, obesity and smoking status, NHANES 2011–2014.

	High education		Low education		
Outcome Race/ethnicity, nativity	**N with/without outcome**	**Odds ratio comparing high education race/ethnicity, nativity groups to non-Latino White high education**	**N with/without outcome**	**Odds ratio comparing low education race/ethnicity, nativity groups to non-Latino White high education**	**Odds ratio comparing low to high education within strata of race/ethnicity, nativity**
Diabetes					
Non-Latino Whites	86/1103	Ref	434/2498	2.00 (1.32, 3.04)	2.00 (1.32, 3.04)
Foreign-born Asians, ≥ 20 years	42/215	2.53 (1.40, 4.59)	59/215	3.26 (1.87, 5.68)	1.29 (0.71, 2.32)
Foreign-born Asians, < 20 years	27/283	2.43 (1.52, 3.89)	55/271	3.61 (2.32, 5.62)	1.49 (0.96, 2.31)
Obesity (Standard)†					
Non-Latino Whites	334/824	Ref	1150/1686	1.53 (1.21, 1.94)	1.53 (1.21, 1.94)
Foreign-born Asians, ≥ 20 years	33/216	0.42 (0.27, 0.63)	32/227	0.34 (0.22, 0.53)	0.81 (0.44, 1.49)
Foreign-born Asians, < 20 years	29/270	0.30 (0.20, 0.44)	33/273	0.32 (0.21, 0.51)	1.10 (0.64, 1.87)
Obesity (Asian-specific)‡					
Non-Latino Whites	334/824	Ref	1150/1686	1.54 (1.22, 1.94)	1.54 (1.22, 1.94)
Foreign-born Asians, ≥ 20 years	109/140	1.99 (1.41, 2.79)	122/137	1.91 (1.34, 2.72)	0.96 (0.64, 1.43)
Foreign-born Asians, < 20 years	114/185	1.60 (1.18, 2.19)	121/185	1.52 (1.05, 2.20)	0.95 (0.62, 1.44)
Smoking					
Non-Latino Whites	94/1095	Ref	906/2024	3.81 (2.99, 4.86)	3.81 (2.99, 4.86)
Foreign-born Asians, ≥ 20 years	14/242	0.73 (0.41, 1.30)	29/245	1.44 (0.87, 2.37)	1.97 (1.07, 3.64)
Foreign-born Asians, < 20 years	22/288	0.68 (0.36, 1.29)	37/288	0.84 (0.58, 1.20)	1.22 (0.64, 2.33)

CI – Confidence Intervals.
Models are adjusted for age, gender, and income.
Note: High education is defined as college or greater, low education is high school or less.
† Excludes those with BMI < 18.5 kg/m^2 and obesity defined as BMI ≥ 30 kg/m^2 for all groups.
‡ Excludes those with BMI < 18.5 kg/m^2 and obesity defined as BMI ≥ 30 kg/m^2 for Non-Latino Whites and BMI ≥ 25 kg/m^2 for Asian groups.

4. Discussion

Our study adds to the emerging evidence of increased cardiovascular disease among Asians and provides new data on cardiovascular risk factors for Asian Americans. We identified

substantial disparities in diabetes and obesity prevalence (using Asian-specific cut points) when comparing Asian Americans to non-Latino Whites, with prevalence of diabetes and obesity increasing with longer duration in the U.S. Smoking prevalence was higher in U.S.-born Asians compared to their foreign-born counterparts but overall was lower than non-Latino Whites. Joint effects models examining interrelationships between race/ethnicity, nativity and educational attainment on each health outcome showed distinct patterns of associations. Joint exposure of low education and foreign-born status significantly increased odds of diabetes and Asian-specific obesity compared to non-Latino Whites with high education, but there were no clear gradients in this association since odds generally increased regardless of time spent in the U.S. For smoking prevalence, the odds were higher in foreign-born Asians with low levels of education living in the U.S. 20 or more years and lower for all other groups compared to non-Latino Whites with high education, but associations were statistically significant only among non-Latino Whites.

A prior study from the Behavioral Risk Factor Surveillance System showed a 5% prevalence for type 2 diabetes among Asian Americans vs. 7% among non-Latino Whites (McNeely and Boyko, 2004). However, this estimate was based on self-report, did not adjust for confounders or assess differences by nativity. Wong et al. (2013) reported a higher prevalence of high-fasting blood sugar (indicating diabetes) among foreign-born Chinese-American adults with longer duration of stay in the U.S., but results were non-significant possibly due to the small study population (n = 126). Our study used clinically-confirmed HbA1C values using a nationally representative sample of foreign and U.S.-born Asian Americans, although we note that the number of observations in the sample for U.S.-born Asians with confirmed diabetes was low and thus precluded their inclusion in joint effects modeling. A recently published study (Jackson et al., 2015) using the same NHANES sample corroborates our finding of increased diabetes prevalence in Asians compared to non-Latino Whites. However, their study compared all Asians (U.S.-born and foreign-born) to non-Latino Whites and only used one survey wave (2011 − 2012), possibly leading to less reliable estimates.

Currently, the ADA recommends lower BMI cutoffs for Asians to address their increased risk of diabetes (Romeo and Abrahamson, 2015). Our analysis shows that Asian nativity groups had lower obesity prevalence using standard BMI cutoff (obesity defined as BMI $\geq$ 30 kg/m^2) than Non-Latino Whites, but a higher prevalence using the Asian-specific BMI cutoff (BMI $\geq$ 25 kg/m^2). Specifically, the highest obesity prevalence was observed among U.S.-born Asians and those living in the U.S. at least 20 years, with foreign-born Asians < 20 years in the U.S having the lowest prevalence. These findings correspond with a recent study that shows the relevance of using lower BMI cutoffs for appropriate diabetes screening (Araneta et al., 2015) and corroborates WHO recommendations for BMI cut points in Asians (Expert Consultation, 2004). Some researchers have proposed the Barker or 'thrifty-gene" hypothesis (Wong et al., 2015) as a potential mechanism to explain observed associations, suggesting that poor nutrition early in life and lower development of lean body mass may lead to decreased glucose absorption and hence diabetes risk in adulthood.

Our study is one of the first to explicitly examine how race/ethnicity, nativity, and educational attainment pattern diabetes prevalence and other cardiovascular disease risk factors in Asian Americans. Compared to non-Latino Whites, the prevalence of diabetes was lower among U.S.-born Asians and higher among foreign-born Asians. However, in joint effect models, diabetes

prevalence among foreign-born Asians was similar by duration of stay in the U.S. and educational attainment when compared to non-Latino Whites. Thus, in contrast to the higher prevalence of diabetes for those who were less educated among non-Latino Whites, we did not find a significant effect of education on diabetes prevalence among foreign-born Asians. This finding concurs with a study by Boykin et al.(Boykin et al., 2011) that examined the effects of education on risk of diabetes among Asian men and women and demonstrated that while gradients in the risk of diabetes by education is present for other racial/ethnic groups, they were not present for the Asian cohort (largely Chinese). The extent to which this observation holds in specific Asian groups remains to be studied. It is also important to note that years in the U.S., as a proxy for acculturation, does not capture the complex process of adaptation that immigrants experience, potentially resulting in inconclusive or null findings. We found a lower smoking prevalence among Asian Americans compared to Non-Latino Whites, similar to prior literature (Chae et al., 2006, Li et al., 2013, Tong et al., 2008). Smoking was higher among U.S.-born Asians compared to their foreign-born counterparts but showed a slightly higher smoking prevalence among those with shorter duration in the U.S. Data from the Current Population Survey–Tobacco Use Supplement data, 1998–1999, 2005–2006, and 2010–2011 also found a lower smoking prevalence in Asian immigrants than U.S. born groups (Kuerban, 2015). Given that the sample does not allow us to classify individuals by country of origin, it may be that this apparently lower prevalence among the foreign-born masks important differences in smoking for groups originating from Asian countries with high smoking rates. The present study had some limitations. As a cross-sectional study, we were unable to examine development of diabetes or obesity over time with longer duration in the U.S., limiting causal inferences. Further, we were unable to disaggregate CVD risk factors by the heterogeneous group of Asian Americans. A growing number of studies report varying CVD risk across Asian groups (Lee et al., 2011, Ye et al., 2009, Islam et al., 2010), attributed to their distinct patterns of immigration and integration into U.S. society. Smoking status was also based on self-report and may have missed some smokers. However, we are unaware of studies suggesting differential misclassification of smoking status by race/ethnicity or nativity status that would explain our observed smoking-nativity relationship. Also, at the time of publication, nutrition data for these study years were not available and thus future research would benefit from including diet and physical activity to determine if they explain the increased diabetes risk observed. Although we used the most recently available data for two survey waves of NHANES, the study population nonetheless included few U.S.-born Asians who were over 20 years of age. This precluded our ability to run interaction models with this group, which in exploratory models showed substantial differences in diabetes risk compared to their foreign-counterparts. Additionally, it is important to note that while regression models were generated for all other Asian American groups and indicated statistically significant estimates, prevalence of CVD risk factors for some groups was low and thus based on small sample sizes. A final limitation is that education is only one component of socioeconomic position that may influence CVD risk in Asian Americans (de Castro et al., 2010). More comprehensive measures such as accumulated wealth were not available.

An important strength of our study was the use of a national survey that included both self-report and laboratory-confirmed data. Moreover, the sample size for foreign-born Asians allowed us to explicitly examine how select CVD risk factors vary by length of stay in the U.S. particularly for diabetes, a chronic health condition that disproportionately affects Asian Americans.

5. Conclusions

This study highlights the high prevalence and urgency of addressing diabetes in Asian Americans. We found that both race/nativity and education play a role in patterning CVD, although low education was not consistently associated with increased odds of disease. These findings challenge usual depictions of Asian Americans as a healthy group and provide new data on the salience of social contexts, such as immigrant status and years living in the U.S., in shaping diabetes risk for this population. There is a need to continue monitoring social gradients in health as the Asian American population integrates into U.S. society and experiences systems of racial stratification and racism that are deleterious to well-being (Chae et al., 2008, Gee et al., 2009). This is particularly the case for U.S.-born generations which are projected to represent 50% of Asian Americans by the year 2030 (Chae et al., 2008, Ro and Yee, 2010). Following recommendations of the AHA (Palaniappan et al., 2010) to continuously oversample Asians should improve the ability of population-based surveys to better profile CVD risk and other chronic conditions in this population.

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