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Association of Acculturation with Cardiovascular Risk Factors in Asian-American Subgroups☆

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ABSTRACT

Objective: This cross-sectional study aims to better understand the heterogeneous associations of acculturation level on CV risk factors among disaggregated Asian subgroups. We hypothesize that the association between acculturation level and CV risk factors will differ significantly by Asian subgroup.

Methods: We used the National Health Interview Survey (NHIS), a nationally representative US survey, years 2014–18. Acculturation was defined using: (a) years in the US, (b) US citizenship status, and (c) level of English proficiency. We created an acculturation index, categorized into low vs. high (scores of 0–3 and 4, respectively). Self-reported CV risk factors included diabetes, high cholesterol, hypertension, obesity, tobacco use, and sufficient physical activity. Rao-Scott Chi Square was used to compare age-standardized, weighted prevalence of CV risk factors between Asian subgroups. We used logistic regression analysis to assess associations between acculturation and CV risk factors, stratified by Asian subgroup.

Results: The study sample consisted of 6,051 adults ≥ 18 years of age (53.9% female; mean age 46.6 [SE 0.33]). The distribution by race/ethnicity was Asian Indian 26.9%, Chinese 22.8%, Filipino 18.1%, and other Asian 32.3%. The association between acculturation and CV risk factors differed by Asian subgroups. From multivariable adjusted models, high vs. low acculturation was associated with: high cholesterol amongst Asian Indian (OR=1.57, 95% CI: 1.11, 2.37) and other Asian (OR=1.48, 95% CI: 1.10, 2.01) adults, obesity amongst Filipino adults (OR= 1.62, 95% CI: 1.07, 2.45), and sufficient physical activity amongst Chinese (OR= 1.54, 95% CI: 1.09, 2.19) and Filipino adults (OR=1.58, 95% CI: 1.10, 2.27).

Conclusion: This study demonstrates that acculturation is heterogeneously associated with higher prevalence of CV risk factors among Asian subgroups. More studies are needed to better understand these differences that can help to inform targeted, culturally specific interventions.

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1. Introduction

Cardiovascular disease (CVD) is the leading cause of death in the United States (US) [1]. Asians are the fastest-growing racial/ethnic group in the US [2]. Census data from 2020 revealed that roughly 20 million people identified as Asian alone — a 36% increase since 2010 [3]. Many Asians living in the US are immigrants and the impact of acculturation on prevalence of cardiovascular (CV) risk factors has not been well established. Acculturation can be defined as a process in which individuals integrate, adapt, and retain behaviors, attitudes, and values between two cultures [4]. Many studies have shown that acculturation level is related to population health, including CV risk factors. A nationally representative study using the National Health and Nutrition Examination Survey (NHANES) found that Asian and Hispanic adults with higher American acculturation levels, measured by amount of English spoken at home, were more likely to be current smokers or have hypertension [5]. A National Health Interview Survey (NHIS) study from 2010 to 2014 found that higher years of US residency was associated with a higher prevalence of hypertension, obesity, and diabetes mellitus among immigrants [6]. Another NHANES study found higher acculturation level was associated with greater intake of ultra- processed foods among Asian-Americans [7]. The major Asian-American subgroups in the US include Asian Indian, Chinese, Filipino, Japanese, Koreans, and Vietnamese who have heterogeneous CV mortality rates, with the highest rates due to ischemic heart disease and heart failure occurring among Asian Indian men and women [8]. Publicly available, disaggregated Asian subgroup identification in nationally representative data from NHANES and NHIS are limited, thus presenting challenges to understand the association between acculturation level and CV risk factors among the subgroups. As a result, few contemporary studies analyze the association of acculturation with CV risk factor prevalence among Asian subgroups [9]. One study found that higher acculturation was associated with greater risk of type 2 diabetes mellitus and increased carotid artery intima media thickness among South Asian immigrants [10]. As the Asian American population continues to grow rapidly, there is a critical need to evaluate the impact of acculturation on CV risk factors in a contemporary cohort of Asian Americans to better understand differences among major Asian subgroups.

2. Methods

We analyzed data from the NHIS, a nationally representative US household survey, for years 2014–2018 (n = 155,556). Data collection and survey construction methods for NHIS are described elsewhere [11]. Briefly, NHIS is conducted annually by individual adult and household interview. NHIS is approved by the National Center for Health Statistics Institutional Review Board and received informed consent from all respondents.

We included non-Hispanic Asian respondents (n = 8260) who self-identified as Asian Indian, Chinese, Filipino, or "other Asian," an aggregate category including Japanese, Korean, Vietnamese, and other Asian individuals, which is not publicly available to maintain participant confidentiality due to low sample size. We limited respondents to non-US born individuals answering "No" to the question "Were you born in the United States?" (n = 6111). We excluded respondents with missing acculturation (defined in detail below) data (n = 60). The analytic sample consisted of 6051 non-US born adults. Sample size for each analysis varies with availability of response data.

Acculturation was classified based on participant responses to the three questions [12,13]: (1) "How long have you stayed in the United States?" with less than 5 years assigned zero points, between 5 and 15 years assigned one point, and greater than 15 years assigned two points; (2) "Are you a citizen of the United States?" with binary responses "Yes" assigned one point and "No" assigned zero points; and (3) "How well do you speak English, would you say…" with response options "Very well" and "Well" assigned one point and "Not well", "Not at all" assigned zero points (Fig. 1). The sum of these three variables (number of years in the U.S., citizenship status, and English proficiency) was used to create a novel summative acculturation index with 2 levels: low and high (scores of 0–3 and $\geq$ 4, respectively) to achieve an equal distribution between the levels. Assigning points to create a summative acculturation score has been used and validated in prior population studies using similar variables (being born in the United States, speaking predominantly English, and years living in the US) [14–16]. We also constructed a secondary measure of acculturation removing citizenship status from the score and dichotomized the sum score accordingly (low acculturation: 0–2 points, high acculturation: 3 points).

Sex was coded as binary "Male" or "Female." We categorized the continuous age variable into 4 groups: 18–44, 45–64, 65–74, and 75 years and older. Marital status was coded as either "Married" or "Not married." We categorized education into less than high school, high school completion or GED, some college, and greater than college education. Income was based on annual family income and categorized into $\leq$\$34,999, \$35,000-\$74,999, \$75,000-\$99,999, and $\geq$\$100,000. Insurance status was categorized as "Public", "Private", and "Uninsured." We included seeing a general doctor in the past 12 months as a covariate in our adjusted models to address the impact of care-seeking behavior on CV risk factor prevalence.

CV risk factors were defined from self-reported responses. Binary (yes/no) presence of 1) high cholesterol, 2) hypertension, and 3) diabetes mellitus was based on if the respondent was ever told by a health professional that they had the condition. 4) Obesity status was derived from self-reported height and weight and categorized based on World Health Organization (WHO) body mass index (BMI) cutoffs for Non-Hispanic Asians (BMI $\geq$ 27.5 kg/m^2), based on evidence for higher prevalence of metabolic syndrome at lower BMI ranges in disaggregated Asian subgroups compared to non-Hispanic White individuals [17,18]. We categorized the presence of 5) Tobacco use based on if the respondent identified as a "former smoker", "current every day smoker", "current some day smoker", or "smoker with current status unknown" in response to the question "Do you smoke every day, some days, or not at all?" 6) Physical activity was dichotomized as sufficient vs. insufficient physical activity (combined total amount of light- moderate and vigorous physical activity >150 min/week), based on national standards [19].

We described demographic and socioeconomic characteristics of the sample stratified by Asian subgroups. Next, we determined the prevalence of each cardiovascular risk factor of interest according to Asian subgroup and acculturation level, age standardized to the US 2010 standard population [20]. We determined whether the prevalence of each CV risk factor differed by Asian subgroups using Rao-Scott Chi Square tests [21] with a significance cutoff of $p<0.05$. Finally, we used multivariable logistic regression analyses to determine whether acculturation was associated with each risk factor of interest after controlling for age, sex, socioeconomic factors (marital status, education, income, insurance status), and health behaviors (tobacco use and sufficient physical activity) in successive models. When either tobacco use or sufficient physical activity was the outcome in the regression model, it was removed as a covariate in that model. We applied a Bonferroni correction to account for multiple comparisons. We also tested for a statistical interaction between Asian subgroups and acculturation. All analyses accounted for the stratified design of the NHIS and were weighted to adjust for sampling probability and non-response. Analyses were conducted using RStudio Version 1.4.1717 and STATA Version 16 [22,23].

3. Results

Our population of Asian American immigrant adults was 53.9% female. The distribution by subgroup was Asian Indian 26.9%, Chinese 22.8%, Filipino 18.1%, and other Asian 32.3%. Asian Indian individuals were younger, more likely to be married and have higher education and

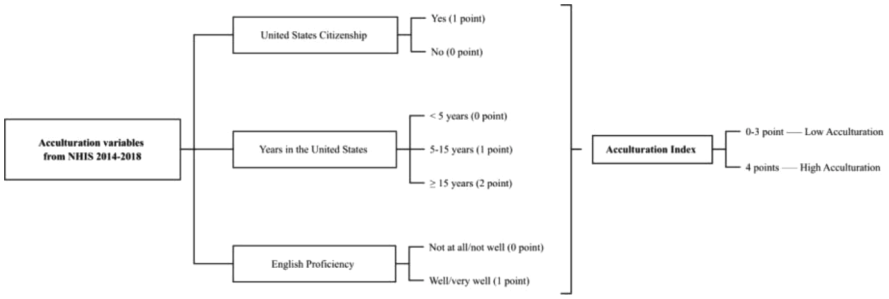

Fig. 1. Acculturation index based on acculturation variables from the National Health Interview Survey, 2014–2018.

income level compared with other Asian subgroups ($p<0.01$) (Table 1). The presence of CV risk factors was common in the study population with 9.7% (95% CI: 8.8, 11.0) with diabetes, 27.2%

(25.8, 29.0) with high cholesterol, 25.3% (24.1, 26.0) with hypertension, 19.4% (18.2, 21.0) with obesity, and 50.6% (49.0, 52.0) with sufficient physical activity (not shown).

Risk factors differed by Asian subgroup (Table 1). The prevalence of diabetes ranged from 4.8% (3.6, 6.3) among Chinese adults to 12.1% (9.9, 14.5) among Asian Indian adults ($p<0.01$). The prevalence of hypertension ranged from 19.5% (17.3, 21.8) among Chinese adults to 33.7% (30.5, 37.1) among Filipino adults ($p<0.01$). The prevalence of sufficient physical activity ranged from 47.2% (42.5, 51.9) among other Asian adults to 55.6% (52.5, 58.7) among Asian Indian adults ($p<0.05$). Tobacco use was lowest among Asian Indian adults at 3.9% (2.9, 5.0) and highest among other Asian adults at 10.3% (8.6, 12.1) ($p<0.01$). The age-standardized prevalence of CVD risk factors stratified by Asian subgroup and according to acculturation level are shown in Fig. 2. High acculturation was only associated with sufficient physical activity levels for Chinese individuals ($p<0.01$). We did not find significant differences between high and low acculturation for the age-standardized prevalence of diabetes, high cholesterol, hypertension, obesity, or tobacco use for other Asian subgroups.

The statistical interaction between acculturation among Asian subgroups was significant for diabetes, high cholesterol, hypertension, and sufficient physical activity (p-values all <0.05), but not for obesity ($p = 0.121$) or tobacco use ($p = 0.123$), leading to stratified analyses. High vs. low acculturation was associated with higher odds of high cholesterol by 66% for Asian Indian adults (OR=1.66, 95% CI: 1.18, 2.37) and 53% for other Asian adults (OR=1.53, 95% CI: 1.14, 2.05) (Table 2). High vs. low acculturation was associated with 65% higher adjusted odds of obesity among Filipino adults (OR=1.65, 95% CI: 1.10, 2.49). High vs. low acculturation was associated with higher odds of sufficient physical activity by 55% among Chinese adults (OR=1.55, 95%: 1.10, 1.20) and 59% among Filipino adults (OR=1.59, 95% CI: 1.11, 2.27).

High vs. low acculturation was not associated with diabetes, hypertension, or tobacco use in any Asian subgroup in all adjusted models.

4. Discussion

In this analysis representing 7.5 million immigrant adults in the US, we found marked heterogeneity among Asian subgroups in the association between acculturation level and CV risk factors. We found that high acculturation is associated with high cholesterol in Asian Indian and other Asian adults, obesity in Filipino adults, and sufficient physical activity in Chinese and Filipino adults. This analysis demonstrates the need to better characterize the differential health risks among Asian subgroups to inform culturally specific health interventions. These observations are consistent with recently published work showing differences in CV mortality among Asian-American subgroups: Asian Indians had the highest risk of CV due to ischemic heart disease and heart failure, while the highest cerebrovascular disease mortality rate occurred among Vietnamese individuals [8].

Dietary changes related to assimilation strategies may lead to differences in CV health factors among these Asian subgroups. Dietary considerations and food choices affect CV health, as one out of every five premature deaths may be attributed to poor diet [25]. Asian immigrant diets have been observed to change pre- and post- immigration to a more Western-style dietary pattern, exemplified by a significantly higher consumption of fat and cholesterol post- immigration [26]. Highly acculturated Asian Americans have higher consumption of ultra-processed foods [7], which is associated with increased body mass index and dyslipidemia [27,28]. As the Asian American population grows, and the population of US born Asian-identifying individuals grows concurrently, it will be important to understand how acculturation across generations influences CV risk factors and health behaviors.

While tobacco use did not differ significantly by acculturation among the Asian subgroups in this study, trends towards higher tobacco use among highly acculturated other Asians, which includes Koreans, is consistent with what has been documented in the literature: a study of Koreans living in California found that acculturated Korean women were more likely to smoke compared to their bicultural or traditional counterparts [29]. Heterogeneity in tobacco use exists among Asian subgroups [30], with US born Filipinos more likely to report daily smoking compared to foreign born Filipinos (12.6% vs. 7.5%). Furthermore, acculturation has been linked to an overall increase in smoking patterns among Asian American subgroups in California, possibly due to greater social acceptance towards smoking [31].

Favorably, our study identified a higher likelihood of sufficient physical activity among Chinese and Filipino respondents who had a higher level of acculturation. This is consistent with a multi-ethnic study that found that more years spent in the US was associated with decreased odds of sedentary lifestyle [32]. These findings underscore ways in which acculturation may lend to protective benefits for Asian immigrants. In contrast, a previous study looking at Asian and Hispanic immigrant adolescents found that acculturation was associated with decreased physical activity levels [33]. Effective strategies to increase physical activity among Asian Americans should take into account cultural practices and behaviors specific to the country of origin for Asian immigrants, such as what constitutes adequate physical activity or a proper diet, since they may influence CV risk factors. Analyzing health risks by Asian subgroups due to this cultural variability is necessary in order to assess underlying reasons for these differences.

The nature of NHIS survey design and data has given rise to several limitations in our study. The NHIS cross-sectional design also limits our ability to discern if CV risk factor incidence occurred prior to or following migration to the US. Asian subgroup sample sizes were small, reducing the power of this study to detect additional differences between groups. Additionally, the NHIS is only conducted in English and Spanish; underestimation of CV risk factors in Asian subgroups is possible due to selection bias and may not include individuals with lower acculturation levels. Susceptibility to information and social desirability bias may be present due to the self-reporting nature of this survey. While our study is able to discern differences in CV risk factors by disaggregated Asian subgroups, the NHIS only has publicly available

Table 1
Characteristics of Asian Immigrants in the National Health Information Survey 2014–2018.

Characteristics	Weighted Percentages (95% CI)			
	Asian Indian (n = 1626)	Chinese (n = 1377)	Filipino (n = 1094)	Other Asian (n = 1954)
Weighted Population	1256,348	905,169	741,078	1329,127
Frequency*	(1134,234.9, 1378,462.1)	(803,610.1, 1006,728.2)	(656,553.3, 825,601.9)	(1213,173.2, 1445,081.1)
Female*	49.3 (45.9, 52.7)	54.7 (51.5, 57.8)	60.4 (56.4, 64.3)	54.1 (51.1, 57.1)
Age*				
18–44	60.6 (56.9, 64.3)	50.9 (47.0, 54.8)	38.6 (35.0, 42.3)	45.1 (41.8, 48.4)
45–64	29.7 (26.5, 33.0)	32.9 (29.7, 36.1)	40.9 (36.9, 44.9)	36.8 (34.0, 39.8)
65–74	6.6 (5.2, 8.2)	9.5 (7.7, 11.6)	15.0 (12.6, 17.8)	11.6 (9.9, 13.5)
≥ 75	3.1 (2.2, 4.4)	6.7 (5.2, 8.6)	5.5 (4.0, 7.4)	6.5 (5.2, 8.0)
Married*	80.4 (77.8, 82.7)	65.8 (62.5, 69.0)	68.1 (64.4, 71.7)	69.2 (66.6, 71.7)
Education*				
< High School	5.2 (3.7, 7.0)	11.1 (8.5, 14.2)	4.3 (3.0, 6.0)	15.4 (13.1, 17.9)
High School/GED	10.8 (8.9, 13.0)	15.9 (12.7, 19.6)	15.2 (12.3, 18.6)	19.6 (17.0, 22.3)
Some College	6.0 (4.4, 7.8)	9.2 (7.3, 11.3)	16.5 (13.7, 19.6)	11.0 (9.2, 12.9)
> College	77.9 (74.5, 81.0)	62.8 (58.4, 67.0)	63.6 (59.6, 67.4)	53.2 (49.9, 56.5)
Annual Income*				
≤ $34,999	14.3 (12.2, 16.7)	29.9 (26.7, 33.3)	15.2 (12.8, 17.8)	27.4 (24.5, 30.4)
$35,000 - $74,999	19.2 (16.7, 21.9)	18.1 (15.4, 20.9)	22.4 (19.3, 25.6)	27. 2 (24.7, 29.8)
$75,000 - $99,999	12.5 (10.5, 14.6)	8.5 (6.8, 10.4)	13.9 (11.6, 16.5)	8.9 (7.3, 10.7)
≥ $100,000	44.2 (40.6, 47.8)	32.3 (28.6, 36.1)	39.3 (35.2, 43.5)	26.7 (23.8, 29.9)
Health Insurance*				
Private	16.1 (13.7, 18.8)	29.3 (25.3, 33.5)	31.5 (27.5, 35.7)	33.1 (29.9, 36.4)
Public	77.8 (74.7, 80.6)	63.4 (59.1, 67.6)	59.2 (55.0, 63.4)	56.2 (53.1, 59.3)
Uninsured	6.0 (4.5, 7.7)	6.5 (5.0, 8.4)	8.2 (6.0, 11.0)	10.3 (8.5, 12.2)
CV Risks‡				
Diabetes Mellitus*	12.1 (9.9, 14.5)	4.8 (3.6, 6.3)	11.7 (9.2, 14.5)	9.9 (8.4, 11.6)
High Cholesterol*	28.1 (25.0, 31.4)	21.3 (19.0, 23.7)	30.5 (27.3, 33.8)	27.8 (25.5, 30.2)
Hypertension*	24.8 (22.1, 27.6)	19.5 (17.3, 21.8)	33.7 (30.5, 37.1)	23.8 (21.9, 25.8)
Obesity*	26.3 (23.5, 29.1)	10.7 (8.7, 13.0)	24.8 (20.9, 29.0)	17.0 (14.9, 19.3)
Sufficient Physical Activity†	55.6 (52.5, 58.7)	51.3 (47.8, 54.9)	47.2 (42.5, 51.9)	47.5 (44.2, 50.8)
Tobacco Use*	3.9 (2.9, 5.0)	6.2 (4.6, 8.1)	8.1 (6.0, 10.7)	10.3 (8.6, 12.1)
US Citizen*	52.4 (48.5, 56.4)	57.1 (53.3, 60.9)	73.5 (69.9, 76.8)	66.0 (63.0, 69.0)
Years in the US*				
< 5 years	19.8 (17.2, 22.7)	16.6 (14.0, 19.4)	8.0 (5.7, 10.8)	11.1 (9.3, 13.1)
5–15 years	30.8 (28.1, 33.7)	25.5 (22.5, 28.6)	24.1 (20.1, 28.5)	19.8 (17.5, 22.2)
> 15 years	49.3 (45.6, 53.0)	58.0 (54.4, 61.5)	67.9 (63.7, 71.9)	69.1 (66.2, 71.9)
English proficiency*				
Not at all/ not well	7.4 (5.8, 9.4)	29.5 (25.3, 33.9)	4.6 (3.1, 6.6))	29.3 (26.2, 32.6)
Well/very well	92.6 (90.6, 94.2)	70.5 (66.1, 74.7)	95.4 (93.4, 96.9)	70.7 (67.4, 73.8)

Note: "Other Asian" refers to Japanese, Korean, Vietnamese, and other Asian respondents. Proportions for each Asian subgroup may not add up to 100% due to rounding.
Abbreviation: 95% CI: 95% Confidence Interval, CV: Cardiovascular.
* denotes Rao-Scott chi-square test is significant at $p < 0.01$.
† denotes Rao-Scott chi-square test is significant at $p < 0.05$.
‡ CV risk factor prevalence were age-standardized by direct method to the 2010 US standard population.

data for the three largest Asian subgroups in the United States, so we are unable to make further comparisons among other Asians including Japanese, Koreans, and Vietnamese where the association between CV risk and acculturation remains poorly characterized. We acknowledge that while Asian subgroup-stratified analyses were secondary and intended to be hypothesis-generating, there is a possibility of type I error in our study. To address this, we used a Bonferroni correction and found that some findings were still significant.

One potential source of bias in our novel summative acculturation index is the inclusion of citizenship status. In a sensitivity analysis using an acculturation score without inclusion of citizenship status, our results demonstrated even stronger associations between acculturation and CV risk. In bivariable, age-standardized analyses, high vs. low acculturation was associated with increased age-standardized obesity prevalence among Filipino immigrant adults and age-standardized sufficient physical activity prevalence among both Asian Indian and other Asian immigrant adults. We also found consistent and stronger associations in multivariable logistic regression results (Supplemental Table). After we removed citizenship status, high vs. low acculturation was associated with greater odds of hypertension among Chinese immigrant adults and greater odds of sufficient physical activity and tobacco use among other Asian immigrant adults. These results support the use of a summative score to assess the impact of acculturation factors. Future studies should explore the specific pathways of citizenship on the heterogeneous associations between acculturation and CV risk by Asian subgroups.

Acculturation is a multidimensional process that accounts for various domains of behavioral, cognitive, and emotional adaptive functioning [34]. Due to the limited variables available in the NHIS and our cross-sectional study design, it is difficult to capture the complex nature of individual cultural adaptation processes or how one engages with the various types of acculturation strategies (assimilation, separation, integration, and marginalization) directly and longitudinally [35]. There has been scarce research on enculturation, the process of learning of one's own culture, and associations with any CV risk factors among the Asian American population. Furthermore, NHIS evaluates a participant at a single time point without long-term follow up of respondents. Since acculturation is a fluid and dynamic process, this survey cannot capture changes that may occur over time, such as improvement in English proficiency [36]. One strength of our index is that it assesses the multifactorial effect of immigration to the US based on previous measures of acculturation level (e.g., duration living in the US and English proficiency level). Sensitivity analyses with each individual acculturation variable reflected similar trends as our summative acculturation index (results not shown). We acknowledge that studying the complex process of acculturation requires more granular information we lack in the NHIS but studied elsewhere, including but not limited to diet [37], religion [38], social networks [39], generational status, and cultural practices [40]. Our acculturation index also assumes a linear progression (low to high acculturation), whereas other scales, such as the Suinn-Lew Asian Self-Identity Acculturation Scale, Short Acculturation Scale for Korean Americans, and Short Acculturation Scale for Filipino Americans, may capture more culturally-specific acculturation states (traditional, bicultural, and acculturated) [41]. While these more ethnically-specific models may more accurately capture the acculturation process, they need to be expanded to include the many Asian subgroups living in the United States.

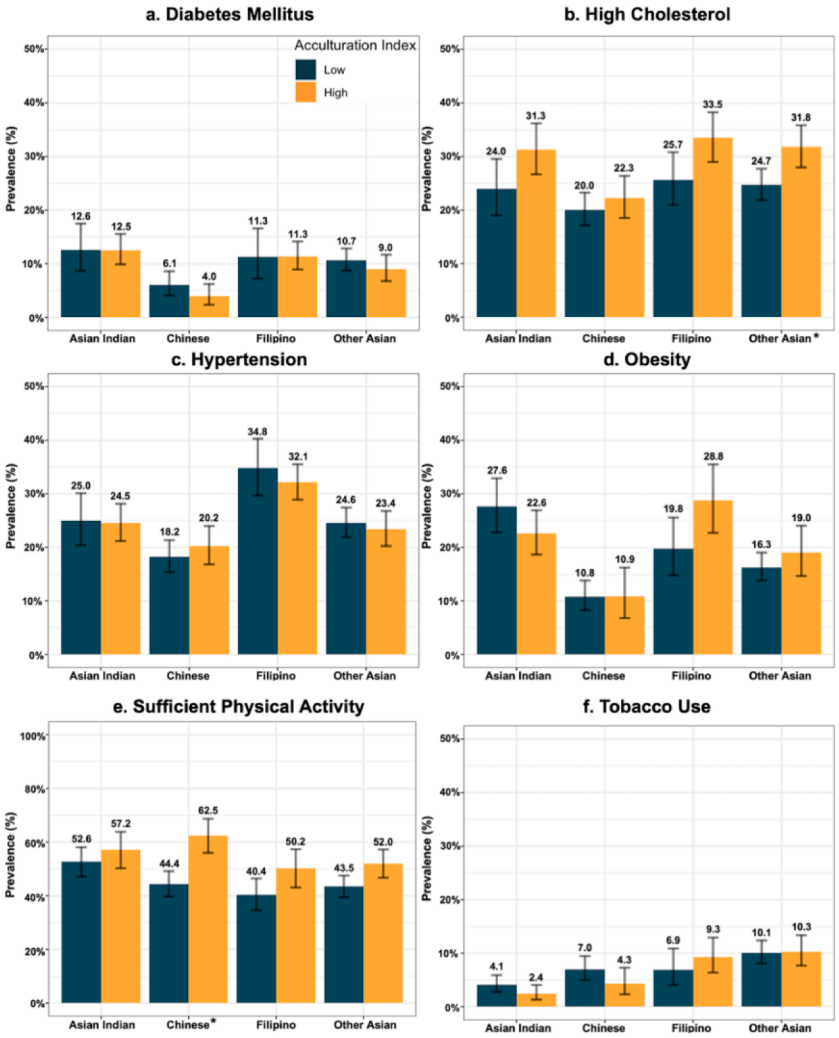

Fig. 2. Age-standardized distribution of CV risk factors across acculturation levels in the National Health Interview Survey, 2014–2018. "Other Asian" refers to Japanese, Korean, Vietnamese, and other Asian respondents. *denotes a Rao-Scott chi-square significant p-value <0.05. Acculturation remained significantly associated with sufficient physical activity levels among Chinese immigrant adults under Bonferroni correction.

5. Conclusion

This study highlights that significant heterogeneity exists among Asian subgroups in the association between acculturation level and CV risk. We demonstrate the need for both more research and oversampling of Asian respondents in the NHIS to better understand why these differences exist and to develop ethnic-specific acculturation models that can be applied to inform targeted and culturally specific interventions that lead to improvements in CV risk factor profiles.

Disclosure

The authors have no conflicts of interests. The views expressed in this manuscript are those of the authors and do not necessarily represent the views of the American Heart Association.

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CRediT authorship contribution statement

Yuemeng LI: Conceptualization, Methodology, Software, Formal analysis, Data curation, Writing – original draft, Visualization. **Alicia ZHU:** Conceptualization, Methodology, Software, Formal analysis, Data curation, Writing – original draft, Visualization. **Austin LE:** Conceptualization, Methodology, Software, Formal analysis, Data curation, Writing – original draft, Visualization. **Jaiveer SINGH:** Project administration. **Latha P. PALANIAPPAN:** Writing – review & editing, Supervision, Funding acquisition. **Malathi SRINIVASAN:** Writing – review & editing, Supervision, Funding acquisition. **Nilay S. SHAH:** Writing – review & editing. **Sally S. WONG:** Writing – review & editing. **Tali ELFASSY:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Supervision, Funding acquisition. **Javier VALERO-ELIZONDO:** Conceptualization, Methodology, Resources, Data curation, Supervision. **Eugene YANG:** Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing, Supervision, Funding acquisition.

Table 2
High vs. low acculturation by Asian subgroups for each CV risk factor, NHIS 2014–2018.

	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3‡ OR (95% CI)
Diabetes Mellitus			
Asian Indian†	1.07 (0.66, 1.75)	1.16 (0.69, 1.95)	1.16 (0.69, 1.97)
Chinese†	0.60 (0.32, 1.12)	0.70 (0.33, 1.48)	0.70 (0.32, 1.52)
Filipino†	1.14 (0.65, 2.02)	0.94 (0.53, 1.69)	1.02 (0.58, 1.80)
Other Asian	0.80 (0.54, 1.18)	1.11 (0.71, 1.73)	1.12 (0.72, 1.75)
High Cholesterol			
Asian Indian	1.63 (1.17, 2.28)*	1.58 (1.11, 2.23)*	1.57 (1.11, 2.37)*
Chinese	1.22 (0.87, 1.70)	1.07 (0.71, 1.60)	1.09 (0.72, 1.63)
Filipino	1.69 (1.14, 2.50)*	1.44 (0.96, 2.18)	1.43 (0.94, 2.16)
Other Asian	1.48 (1.13, 1.95)*	1.47 (1.09, 1.99)*	1.48 (1.10, 2.01)*
Hypertension			
Asian Indian	1.14 (0.80, 1.62)	1.14 (0.77, 1.70)	1.14 (0.76, 1.69)
Chinese	1.23 (0.84, 1.81)	1.35 (0.87, 2.09)	1.36 (0.88, 2.10)
Filipino	0.96 (0.65, 1.43)	0.88 (0.57, 1.35)	0.93 (0.61, 1.44)
Other Asian	0.86 (0.63, 1.20)	1.03 (0.73, 1.46)	1.03 (0.73, 1.46)
Obesity			
Asian Indian	0.85 (0.61, 1.18)	0.92 (0.65, 1.31)	0.92 (0.64, 1.30)
Chinese†	0.97 (0.61, 1.53)	1.16 (0.72, 1.85)	1.17 (0.73, 1.88)
Filipino	1.59 (1.08, 2.33)*	1.62 (1.07, 2.43)*	1.62 (1.07, 2.45)*
Other Asian	1.05 (0.77, 1.44)	1.21 (0.89, 1.65)	1.24 (0.91, 1.70)
Sufficient Physical Activity			
Asian Indian	1.11 (0.81, 1.51)	0.96 (0.69, 1.32)	0.96 (0.69, 1.33)
Chinese	1.93 (1.37, 2.70)**	1.54 (1.08, 2.19)*	1.54 (1.09, 2.19)*
Filipino	1.67 (1.18, 2.38)*	1.57 (1.09, 2.25)*	1.58 (1.10, 2.27)*
Other Asian	1.43 (1.13, 1.82)*	1.16 (0.91, 1.49)	1.18 (0.92, 1.50)
Tobacco Use			
Asian Indian†	0.62 (0.32, 1.21)	0.65 (0.32, 1.29)	0.65 (0.33, 1.29)
Chinese†	0.64 (0.37, 1.13)	1.09 (0.57, 2.08)	1.12 (0.59, 2.10)
Filipino†	1.40 (0.67, 2.92)	1.29 (0.60, 2.81)	1.37 (0.64, 2.93)
Other Asian	0.99 (0.67, 1.48)	1.32 (0.86, 2.03)	1.30 (0.86, 1.98)

Note: "Other Asian" refers to Japanese, Korean, Vietnamese, and other Asian respondents. OR: Odds ratio.
CI: Confidence interval.
Model 1: CV risk factor ~ acculturation + age + sex.
Model 2: Model 1 + education + income + marital status + insurance status + seen a general doctor in the past 12 months.
Model 3: Model 2 + tobacco use + physical activity.
* denotes significant p-value<0.05.
** denotes significant p-value under Bonferroni correction.
† denotes a stratified sample size with insufficient power based on recommendations for analyzing the NHIS data [24].
‡ When modeling tobacco use or physical activity as the outcome, we omitted it as a covariate in that model.

Declaration of interests

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Eugene Yang reports a relationship with Measure Labs that includes: consulting or advisory and equity or stocks. Eugene Yang reports a relationship with Genentech that includes: consulting or advisory. Eugene Yang reports a relationship with Amgen Inc that includes: funding grants. I serve as a member of the editorial board for the American Journal of Preventive Cardiology (EY).

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ajpc.2022.100437.

References

[1] Mc Namara K, Alzubaidi H, Jackson JK. Cardiovascular disease as a leading cause of death: how are pharmacists getting involved? Integr Pharm Res Pract 2019;8:1–11. https://doi.org/10.2147/IPRP.S133088.
[2] Budiman A, Ruiz NG. Asian americans are the fastest-growing racial or ethnic group in the U.S. Pew Research Center; March 10, 2021. PublishedAccessed March 22, 2022, https://www.pewresearch.org/fact-tank/2021/04/09/asian-americans-are-the-fastest-growing-racial-or-ethnic-group-in-the-u-s/.
[3] Bureau UC. Census illuminates racial and ethnic composition of the country. Census.gov; 2020. Accessed June 3, 2022, https://www.census.gov/library/stories/2021/08/improved-race-ethnicity-measures-reveal-united-states-population-much-more-multiracial.html.
[4] Phinney JS, Horenczyk G, Liebkind K, Vedder P. Ethnic Identity, Immigration, and Well-Being: an Interactional Perspective. J Soc Issues 2001;57(3):493–510. https://doi.org/10.1111/0022-4537.00225.
[5] Rodriguez F, Echeverría SE, Pentakota SR, Amadi C, Hastings KG, Palaniappan LP. Comparison of Ideal Cardiovascular Health Attainment and Acculturation among Asian Americans and Latinos. Ethn Dis 2019;29(2):287–96. https://doi.org/10.18865/ed.29.2.287.
[6] Commodore-Mensah Y, Selvin E, Aboagye J, et al. Hypertension, overweight/obesity, and diabetes among immigrants in the United States: an analysis of the 2010-2016 National Health Interview Survey. BMC Public Health 2018;18(1):773. https://doi.org/10.1186/s12889-018-5683-3.
[7] Pachipala K, Shankar V, Rezler Z, et al. Acculturation and Associations with Ultra-processed Food Consumption among Asian Americans: NHANES, 2011–2018. J Nutr April 7, 2022:nxac082. https://doi.org/10.1093/jn/nxac082. Published online.
[8] Shah NS, Xi K, Kapphahn KI, et al. Cardiovascular and Cerebrovascular Disease Mortality in Asian American Subgroups. Circ Cardiovasc Qual Outcomes 2022. https://doi.org/10.1161/CIRCOUTCOMES.121.008651.
[9] Guadamuz JS, Kapoor K, Lazo M, et al. Understanding Immigration as a Social Determinant of Health: cardiovascular Disease in Hispanics/Latinos and South Asians in the United States. Curr Atheroscler Rep 2021;23(6):25. https://doi.org/10.1007/s11883-021-00920-9.
[10] Dodani S, Dong L. Acculturation, coronary artery disease and carotid intima media thickness in South Asian immigrants–unique population with increased risk. Ethn Dis 2011;21(3):314–21.
[11] NHIS - Methods. Published June 14, 2021. Accessed March 23, 2022. https://www.cdc.gov/nchs/nhis/methods.htm.
[12] Daviglus ML, Talavera GA, Avilés-Santa ML, et al. Prevalence of major cardiovascular risk factors and cardiovascular diseases among Hispanic/Latino individuals of diverse backgrounds in the United States. JAMA 2012;308(17):1775–84. https://doi.org/10.1001/jama.2012.14517.
[13] Hopgood DA, Haile ZT, Conley S, Chertok IRA. Association between acculturation and sociodemographic factors and cardiovascular disease among immigrants to the United States. Public Health Nurs Boston Mass 2021;38(1):47–55. https://doi.org/10.1111/phn.12825.
[14] Yoshida Y, Fonseca VA. Diabetes control in Asian Americans — Disparities and the role of acculturation. Prim Care Diabetes 2021;15(1):187–90. https://doi.org/10.1016/j.pcd.2020.01.010.
[15] Casillas A, Liang LJ, Vassar S, Brown A. Culture and Cognition—The Association Between Acculturation and Self-reported Memory Problems Among Middle-aged and Older Latinos in the National Health and Nutrition Examination Survey (NHANES), 1999 to 2014. J Gen Intern Med 2022;37(1):258–60. https://doi.org/10.1007/s11606-021-06608-9.

[16] O'Brien MJ, Alos VA, Davey A, Bueno A, Whitaker RC. Acculturation and the Prevalence of Diabetes in US Latino Adults, National Health and Nutrition Examination Survey 2007–2010. Prev Chronic Dis 2014;11:E176. https://doi.org/10.5888/pcd11.140142.
[17] Palaniappan LP, Wong EC, Shin JJ, Fortmann SP, Lauderdale DS. Asian Americans have greater prevalence of metabolic syndrome despite lower body mass index. Int J Obes 2011;35(3):393–400. https://doi.org/10.1038/ijo.2010.152. *2005*.
[18] Jih J, Mukherjea A, Vittinghoff E, et al. Using appropriate body mass index cut points for overweight and obesity among Asian Americans. Prev Med 2014;65:1–6. https://doi.org/10.1016/j.ypmed.2014.04.010.
[19] American Heart Association Recommendations for Physical Activity in Adults and Kids. www.heart.org. Accessed June 20, 2022. https://www.heart.org/en/healthy-living/fitness/fitness-basics/aha-recs-for-physical-activity-in-adults.
[20] Li C, Ford ES, Zhao G, Wen XJ, Gotway CA. Age adjustment of diabetes prevalence: use of 2010 US Census data 根据年龄调整的糖尿病患病率:使用美国2010年人口普查数据. J Diabetes 2014;6(5):451–61. https://doi.org/10.1111/1753-0407.12122.
[21] Rao JNK, Scott AJ. The Analysis of Categorical Data from Complex Sample Surveys: chi-Squared Tests for Goodness of Fit and Independence in Two-Way Tables. J Am Stat Assoc 1981;76(374):221–30. https://doi.org/10.1080/01621459.1981.10477633.
[22] RStudio Team. RStudio: integrated Development for R. Published online 2020. http://www.rstudio.com/.
[23] StataCorp. Stata Statistical Software: release 16. Published online 2019.
[24] Precision standards guidelines for reporting MEPS-HC descriptive statistics. Accessed June 3, 2022. https://meps.ahrq.gov/survey_comp/precision_guidelines.shtml#Ftn1.
[25] Yu E, Malik VS, Hu FB. Cardiovascular Disease Prevention by Diet Modification: JACC Health Promotion Series. J Am Coll Cardiol 2018;72(8):914–26. https://doi.org/10.1016/j.jacc.2018.02.085.
[26] Yang W, Read M. Dietary pattern changes of Asian immigrants. Nutr Res 1996;16(8):1277–93. https://doi.org/10.1016/0271-5317(96)00137-6.
[27] Juul F, Martinez-Steele E, Parekh N, Monteiro CA, Chang VW. Ultra-processed food consumption and excess weight among US adults. Br J Nutr 2018;120(1):90–100. https://doi.org/10.1017/S0007114518001046.
[28] Pagliai G, Dinu M, Madarena MP, Bonaccio M, Iacoviello L, Sofi F. Consumption of ultra-processed foods and health status: a systematic review and meta-analysis. Br J Nutr 2021;125(3):308–18. https://doi.org/10.1017/S0007114520002688.
[29] Song YJ, Hofstetter CR, Hovell MF, et al. Acculturation and health risk behaviors among Californians of Korean descent. Prev Med 2004;39(1):147–56. https://doi.org/10.1016/j.ypmed.2004.01.013.
[30] Rao M, Bar L, Yu Y, et al. Disaggregating Asian American Cigarette and Alternative Tobacco Product Use: results from the National Health Interview Survey (NHIS) 2006–2018. J Racial Ethn Health Disparities 2021:1–9. https://doi.org/10.1007/s40615-021-01024-5. Published online April 28.
[31] An N, Cochran SD, Mays VM, McCarthy WJ. Influence of American Acculturation on Cigarette Smoking Behaviors Among Asian American Subpopulations in California. Nicotine Tob Res 2008;10(4):579–87. https://doi.org/10.1080/14622200801979126.
[32] Koya DL, Egede LE. Association Between Length of Residence and Cardiovascular Disease Risk Factors Among an Ethnically Diverse Group of United States Immigrants. J Gen Intern Med 2007;22(6):841–6. https://doi.org/10.1007/s11606-007-0163-y.
[33] Unger JB, Reynolds K, Shakib S, Spruijt-Metz D, Sun P, Johnson CA. Acculturation, Physical Activity, and Fast-Food Consumption Among Asian-American and Hispanic Adolescents. J Community Health 2004;29(6):467–81. https://doi.org/10.1007/s10900-004-3395-3.
[34] Acculturation: advances in theory, measurement, and applied research, xxvii. American Psychological Association; 2003. p. 260. https://doi.org/10.1037/10472-000.
[35] Han L, Berry JW, Zheng Y. The Relationship of Acculturation Strategies to Resilience: the Moderating Impact of Social Support among Qiang Ethnicity following the 2008 Chinese Earthquake. PLoS ONE 2016;11(10):e0164484. https://doi.org/10.1371/journal.pone.0164484.
[36] Fox M, Thayer Z, Wadhwa PD. Assessment of acculturation in minority health research. Soc Sci Med 2017;176:123–32. https://doi.org/10.1016/j.socscimed.2017.01.029. *1982*.
[37] Wu-Tso P, Yeh IL, Tam CF. Comparisons of dietary intake in young and old Asian Americans: a two-generation study. Nutr Res 1995;15(10):1445–62. https://doi.org/10.1016/0271-5317(95)02017-P.
[38] LeMay AR. Do You See What I See? 'Religion' and Acculturation in Filipino–Japanese International Families. Religions (Basel) 2022;13(2):93. https://doi.org/10.3390/rel13020093.
[39] Ali S. Understanding acculturation among second-generation South Asian Muslims in the United States. Contrib Indian Sociol 2008;42(3):383–411. https://doi.org/10.1177/006996670804200303.
[40] Schumann M, Bug M, Kajikhina K, et al. The concept of acculturation in epidemiological research among migrant populations: a systematic review. SSM - Popul Health 2020;10:100539. https://doi.org/10.1016/j.ssmph.2020.100539.
[41] Suinn RM, Ahuna C, Khoo G. The Suinn-Lew Asian Self-Identity Acculturation Scale: concurrent and Factorial Validation. Educ Psychol Meas 1992;52(4):1041–6. https://doi.org/10.1177/0013164492052004028.