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Association of U.S. birth, duration of residence in the U.S., and atherosclerotic cardiovascular disease risk factors among Asian adults

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ABSTRACT

Introduction: Prior studies have shown a direct association between U.S. birth and duration of residence with atherosclerotic cardiovascular disease (ASCVD) though, few have specifically focused on Asian Americans.
Methods: We utilized cross-sectional data from the 2006 to 2015 National Health Interview Survey. We compared prevalent cardiovascular risk factors and ASCVD among Asian American individuals by U.S. birth and duration of time spent in the U.S.
Results: The study sample consisted of 18,150 Asian individuals of whom 20.5 % were Asian Indian, 20.5 % were Chinese, 23.4 % were Filipino, and 35.6 % were of other Asian ethnic groups. The mean (standard error) age was 43.8 (0.21) years and 53 % were women. In multivariable-adjusted logistic regression models, U.S. birth was associated with a higher prevalence odds ratio (95 % confidence interval) of current smoking 1.31 (1.07,1.60), physical inactivity 0.62 (0.54,0.72), obesity 2.26 (1.91,2.69), hypertension 1.33 (1.12,1.58), and CAD 1.96 (1.24,3.11), but lower prevalence of stroke 0.28 (0.11,0.71). Spending greater than 15 years in the U.S. was associated with a higher prevalence of current smoking 1.65 (1.24,2.21), obesity 2.33 (1.57,3.47), diabetes 2.68 (1.17,6.15), and hyperlipidemia 1.72 (1.09,2.71).
Conclusion: Heterogeneity exists in cardiovascular risk factor burden among Asian Americans according to Asian ethnicity, U.S. birth, and duration of time living in the U.S.

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1. Introduction

Atherosclerotic cardiovascular disease (ASCVD) remains the leading cause of death in the United States (U.S.). In 2018, coronary artery disease (CAD) was the leading cause of deaths attributable to CVD, followed by stroke and hypertension. (vs et al., 2021) Prior studies of Black and White adults have demonstrated variability in cardiovascular disease mortality depending on birthplace such that foreign-born adults were found to have lower cardiovascular mortality rates than their counterparts born in the U.S. (Fang et al., 1997; Fang et al., 1996) Furthermore, birthplace and U.S. length of residence are associated with CAD, stroke, and cardiovascular disease risk factors, including hypertension, obesity, and diabetes mellitus. (Fang et al., 2006; Fang et al., 2012; Shamshirgaran et al., 2013; Oza-Frank and Narayan, 2010).

Asian American individuals are the fastest growing ethnic group in the U.S. For the first time, in the Census 1960, census respondents chose their own race and 980,000 individuals self-identified as Asian. According to data from the Pew Research Center, the nation's Asian population rose to 11.9 million by 2000, nearly doubled to 22.4 million by 2019, and is projected to reach 46 million by the year 2056. (Budiman, 0000) Asian Americans trace their roots to more than 20 countries in East and Southeast Asia and the Indian subcontinent, each with unique histories, languages and other cultural characteristics, which can affect cultural integration, adoption of Western lifestyle, and accrual of cardiovascular risk factors and ASCVD as they establish their roots in the U. S. (Al-Sofiani et al., 2020; Dodani and Dong, 2011).

Some groups of Asian Americans such as Asian Indians are predisposed to early development of ASCVD. (Gupta et al., 2002; Zaman et al., 2001; Mendis and Ekanayake, 1994) This inherent high risk may be exacerbated during the process of acculturation among Asian immigrants. (Al-Sofiani et al., 2020) With the increasing number of individuals of Asian descent in the U.S. and heterogenous cardiovascular disease risk factor profiles among Asian Americans, (Satish et al., 2021; Rodriguez et al., 2019) there is a need to examine health disparities among various Asian subgroups using a racial and cultural framework (Wong et al., 2019) that examines Asian American health within the context of cultural integration. This analysis may identify high-risk Asian American subgroups (Palaniappan et al., 2010) and shed light on how acculturation in Asian individuals may be associated with cardiovascular risk factors and ASCVD. (Choi et al., 2018).

In this study, we used data from the National Health Interview Survey (NHIS) to examine self-reported prevalence of cardiovascular risk factors and ASCVD among Asian adults according to U.S. birth and length of residence in the U.S.

2. Methods

2.1. Study population

The NHIS is a nationally representative health survey that has been conducted continuously since 1957 by the National Center for Health Statistics of the Centers for Disease Control and Prevention among civilian non-institutionalized individuals and constitutes the main source of information on the health of the U.S. popualtion. (National Center, 0000) The present analysis included data from the 2006 to 2015 NHIS datasets. Detailed information on the survey design and methods can be found here: http://www.cdc.gov/nchs/nhis.htm. Individuals who self-identified as Asian and without missing information on race were included in this analysis. The study was exempt from Institutional Review Board approval since it utilized deidentified data from a publicly available dataset.

2.2. Assessment of covariates

The primary or main race reported by participants was self-reported based on the question "What race or races do you consider yourself to be?" If more than one race was selected, participants were asked to choose a race that best represents them. Asian Americans in the present study included Chinese, Filipinos, and Asian Indians. Participants who identified as Japanese, Vietnamese, Korean or other Asian subgroups were classified as "Other Asians". Because visa documentation was not a requirement for participating in the NHIS survey, foreign-born immigrants included people who were naturalized citizens, legal permanent residents, those with visas such as students and temporary undocumented immigrants, refugees, and workers. (Oza-Frank and Narayan, 2010; Commodore-Mensah et al., 2018).

Information on whether a survey respondent was born in the U.S. was obtained with the question, "Were you born in the United States?" Respondents were classified as "U.S.-born," representing those born in the 50 U.S. states or "foreign-born," representing those born outside of the U.S. People born outside of the U.S. were also asked, "About how long have you been in the United States?" Responses were categorized in NHIS as < 5, $5-<10$, $10-<15$, ≥ 15 years.

Demographic characteristics included age, gender, education, and income. Healthcare coverage was assessed using, *"Are you covered by any kind of health insurance or some other kind of health care plan (include health insurance obtained through employment or purchased directly as well as government programs like Medicare and Medicaid that provide Medical care or help pay medical bills)?*" Not receiving medical care due to cost was assessed using, *"During the past 12 months, was there any time when you needed medical care, but did not get it because you couldn't afford it?"* Delayed care due to cost was assessed using, *"During the past 12 months, have you delayed seeking medical care because of worry about the cost?"*.

To assess smoking status, respondents were first asked whether they ever smoked 100 cigarettes in a lifetime. Participants who answered, "Yes", were then asked if they now smoke every day, on some days, or not at all. Current smoking was defined as those who now smoke every day or on some days. Physical activity was defined according to the 2019 American College of Cardiology/American Heart Association primary prevention of cardiovascular disease guideline as ≥ 150 min per week of moderate-intensity physical activity, or ≥ 75 min per week of vigorous-intensity physical activity, or ≥ 150 min per week of moderate and vigorous physical activity. (Arnett et al., 2019) Those who did not meet these criteria were classified as being physically inactive. Self-reported information on weight and height was collected at the time of the health interview and body mass index was then calculated as weight in kilograms divided by height in meters squared. Obesity was defined as body mass index ≥ 30 kg/m^2. Diabetes mellitus was defined by affirmative answer to the question "Have you ever been told by a doctor or other health professional that you had diabetes?". Hyperlipidemia was defined if participants reported ever being told by a doctor or other health professional that their blood cholesterol level was high. Hypertension was defined if participants answered yes to the question, "Have you ever been told by a doctor or other health professional that you had hypertension also called high blood pressure?" CAD was defined if participants reported ever having angina pectoris, being told they had coronary heart disease, or a heart attack. Stroke was identified if participants reported ever been told they had a stroke. ASCVD was defined as a composite of CAD or stroke.

2.3. Statistical analysis

The NHIS uses a complex multistage probability design which includes clustering, stratification, and differentiation with an oversampling of Blacks (primarily African Americans), Hispanics, and Asians. Sampling weights were used to produce national estimates that are representative of the adult, civilian, noninstitutionalized U.S. population. These weights included design, ratio, non-response and post-stratification adjustments.

Study population characteristics were summarized using mean (standard error) and numbers (weighted percentages) and compared by Asian ethnic group. Study characteristics were also compared by U.S.

birth (U.S.- vs foreign-born) and duration of time spent in the U.S. among foreign born adults (<5, 5−<10, 10−<15, ≥15 years). Age and gender distribution was compared for each Asian ethnicity by U.S. birth and duration of time spent in the U.S. As there were significant age and gender differences, the weighted prevalence of cardiovascular risk factors and ASCVD was age and gender-adjusted using post-estimation commands after running logistic regression models.

Multivariable-adjusted logistic regression models were used to study the association of U.S. birth with cardiovascular risk factors and ASCVD. Among those not born in the U.S., similar regression analyses were performed for the duration of time spent in the U.S. (<5 years as the reference category) with cardiovascular risk factors and ASCVD. Results were adjusted for age, gender, ethnicity, education, income, healthcare coverage, no care due to cost, and delayed care due to. Collinearity between covariates was assessed using variance inflation factor testing. To test model calibration, "goodness-of-fit" of the observed and expected disease conditions within estimated risk decile groups was compared using the Hosmer–Lemeshow test.

Interaction testing between U.S. birth and duration of time spent in the U.S. with gender was evaluated using multiplicative interaction terms in multivariable-adjusted models as aforementioned.

Analyses were conducted using Stata version 16.1 (StataCorp, College Station, Texas). A p-value < 0.05 was considered statistically significant.

3. Results

The study sample consisted of 18,150 Asian American individuals representing approximately 14 million adults of whom 20.5 % were Asian Indian (2.9 million), 20.5 % were Chinese (3.0 million), 23.4 % were Filipino (3.1 million), and 35.6 % (5.0 million) were of other Asian ethnic groups.

Asian Indian individuals were younger, less likely to be women, have a college education, or an annual income <$25 k compared with other Asian ethnic groups. They were also less likely to currently smoke cigarettes, or have hypertension. The prevalence of most cardiovascular risk factors, CAD, stroke, and combined ASCVD was highest among Filipinos (**Supplementary Table 1**).

Compared with foreign individuals, Asian adults born in the U.S. were younger, less likely to be women, and more likely to be Filipino. Most Asian Americans born outside the U.S. who spent < 5 years in the U.S. were Asian Indians. With increasing duration of time spent in the U.S., there was a decrease in proportion of Asian Indians but an increase in all other Asian groups. Those who spent ≥ 15 years in the U.S. were more likely to be uneducated but had a higher income. (Table 1).

Among foreign-born individuals, Filipinos were the oldest and had the highest proportion of women, while among U.S.-born individuals, Asian-Indians were the youngest. Asian Indians were the youngest and least likely to be women regardless of duration of time spent in the U.S (**Supplementary Table 2).**

The age and gender-adjusted prevalence of cardiovascular risk factors and ASCVD by U.S. birth and duration of time spent in the U.S. is demonstrated in Tables 2 and 3, respectively. Compared with foreign-born Asian adults, those born in the U.S. were more likely to currently smoke (13.4 % vs 9.0 %) and be obese (19.2 % vs 10.7 %), but less likely to be physically inactive (44.6 % vs 55.3 %), have diabetes (5.4 % vs 8.5 %) or hyperlipidemia (20.3 % vs 25.3 %). Results for other risk factors and ASCVD were numerically similar (Table 2). Similar trends were noted in ethnic stratified analyses.

The prevalence of cigarette smoking was lower with increasing duration of time spent in the U.S. up until 15 years where it was higher. The prevalence of physical inactivity increased between < 5 and 5−<10 years but then remained relatively unchanged. There was a graded increase in the prevalence of other cardiovascular risk factors and ASCVD with increasing duration of time spent in the U.S (Table 3). Similar trends were noted in ethnic stratified analyses.

Table 1
Characteristics of the study population by U.S. birth and duration of time spent in the U.S.

	Place of Birth		Duration of Time in U.S.			
	Foreign-Born (n = 13,486)	U.S.-Born (n = 4,599)	<5 Years (n = 2,299)	5−<10 Years (n = 1,866)	10−<15 Years (n = 1,653)	≥15 Years (n = 7,522)
Current age, years	45.2 (0.3)	39.6 (0.5)	33.0 (0.4)	37.4 (0.4)	40.8 (0.4)	51.0 (0.3)
Women (%)	7,281 (53.4)	2,375 (50.0)	1,144 (54.3)	1,002 (54.3)	914 (54.4)	4,126 (52.6)
Asian Ethnicity (%)						
Asian Indian	3,072 (24.7)	307 (7.2)	854 (39.5)	581 (33.3)	468 (30.7)	1,149 (18.0)
Chinese	3,023 (21.0)	831 (18.8)	576 (21.6)	400 (20.1)	413 (24.3)	1,586 (20.2)
Filipino	2,664 (19.8)	1,496 (35.3)	252 (12.1)	321 (18.0)	288 (16.6)	1,767 (22.7)
Other Asians	4,727 (34.5)	1,965 (38.7)	617 (26.7)	564 (28.9)	484 (28.5)	3,020 (39.2)
Education less than college (%)	3,847 (27.6)	1,174 (25.3)	414 (20.8)	451 (24.6)	468 (29.0)	2,469 (29.5)
Income <$25 K (%)	2,468 (33.6)	834 (35.1)	596 (53.6)	438 (41.0)	316 (32.8)	1,110 (27.9)

Continuous variables are summarized using mean (standard error) and categorical variables as count (percentage).

Results for multivariable-adjusted logistic regression models are displayed in Table 4. The variance inflation factor ranged between 1 and 2 indicating very little collinearity between the covariates in our models. Goodness of fit analyses demonstrated that models evaluating U.S. birth were well-calibrated for ASCVD (including CAD and stroke) while those for duration of time in the U.S. were well-calibrated for both ASCVD and cardiovascular risk factors with the exception of hyperlipidemia (**Supplementary Table 3**).

U.S. birth was associated with a higher prevalence odds ratio (95 % confidence interval) of current smoking 1.31 (1.07,1.60), obesity: 2.26 (1.91,2.69), hypertension 1.33 (1.12,1.58), and CAD 1.96 (1.24,3.11), but lower prevalence odds of physical inactivity: 0.62 (0.54,0.72) and stroke 0.28 (0.11,0.71). Compared with those who spent < 5 years in the U.S., those who lived ≥ 15 years had a higher prevalence odds ratio of cigarette smoking: 1.65 (1.24,2.21), obesity: 2.33 (1.57,3.47), diabetes: 2.68 (1.17,6.15), and hyperlipidemia: 1.72 (1.09,2.71). There was no consistent graded increase in prevalence odds ratios of cardiovascular risk factors and ASCVD for each category of duration time spent in the U.S.

Results for gender-stratified analyses are presented in Table 4. Women born in the U.S. were more likely to smoke and be obese but less likely to be physically inactive compared with women born outside the U.S. Men born in the U.S. were more likely to be obese, have hypertension and CAD, but less likely to be physically inactive and or have prior stroke compared with men born outside the U.S. The p-value for interaction between gender and U.S. birth was significant for current smoking, physical inactivity and hypertension. Women who spent ≥ 15 years in the U.S. were more likely to be smoke and have diabetes while men who spent ≥ 15 years in the U.S. were more likely to smoke, be obese, have hypertension or hyperlipidemia compared with those who spent < 5 years in the U.S. The p-value for interaction between gender and duration of time spent in the U.S. was significant for current smoking and diabetes.

Table 2
Age- and gender-adjusted prevalence (standard error) of cardiovascular risk factors and atherosclerotic cardiovascular disease stratified by U.S. birth.

	Smoking	Inactivity	Obesity	DM	HLD	HTN	CAD	Stroke	ASCVD
Foreign-Born									
All Asians	8.95 (0.33)	55.33 (0.63)	10.68 (0.33)	8.50 (0.29)	25.28 (0.85)	22.03 (0.53)	3.19 (0.17)	1.59 (0.13)	4.06 (0.21)
Asian Indian	5.58 (0.49)	53.25 (1.17)	12.46 (0.87)	9.42 (0.73)	24.09 (1.77)	17.23 (0.98)	3.00 (0.35)	1.08 (0.23)	3.69 (0.43)
Chinese	6.07 (0.48)	55.43 (1.29)	6.18 (0.60)	4.57 (0.41)	20.89 (1.46)	18.62 (1.06)	3.19 (0.38)	1.17 (0.23)	3.50 (0.41)
Filipino	10.54 (0.77)	54.57 (1.29)	16.07 (0.94)	12.31 (0.77)	31.02 (1.87)	35.12 (1.19)	4.26 (0.42)	2.06 (0.39)	5.31 (0.58)
Other Asians	12.22 (0.64)	57.20 (1.03)	9.05 (0.54)	8.06 (0.46)	25.58 (1.48)	20.03 (0.78)	2.72 (0.25)	1.95 (0.25)	3.95 (0.32)
U.S.-Born									
All Asians	13.38 (0.81)	44.62 (1.22)	19.15 (0.83)	5.39 (0.43)	20.29 (1.10)	20.99 (0.88)	3.46 (0.36)	1.21 (0.19)	4.22 (0.38)
Asian Indian	6.80 (1.81)	36.33 (3.69)	8.47 (1.78)	1.77 (0.75)	8.79 (2.89)	5.82 (1.59)	0.37 (0.26)	0.39 (0.19)	0.37 (0.26)
Chinese	4.86 (0.97)	43.68 (1.93)	11.86 (1.29)	3.27 (0.67)	18.64 (2.58)	18.41 (1.68)	1.53 (0.46)	0.62 (0.11)	1.80 (0.41)
Filipino	17.80 (1.47)	47.86 (1.92)	26.14 (1.46)	6.62 (0.82)	21.42 (1.96)	23.54 (1.38)	5.10 (0.72)	1.52 (0.46)	5.83 (0.81)
Other Asians	14.70 (1.14)	43.65 (1.78)	18.29 (1.22)	5.95 (0.58)	22.81 (1.76)	22.7 (1.37)	3.47 (0.52)	1.41 (0.23)	4.63 (0.47)

Results are presented as percentages (standard error).
Asbbreviations: DM (diabetes mellitus); HLD (hyperlipidemia); HTN (hypertension); CAD (coronary heart disease); ASCVD (atherosclerotic cardiovascular disease).

Table 3
Age- and gender-adjusted prevalence of cardiovascular risk factors and atherosclerotic cardiovascular disease stratified by duration spent living in the U.S.

	Smoking	Inactivity	Obesity	DM	HLD	HTN	CAD	Stroke	ASCVD
<5 Years									
All Asians	8.23 (0.65)	54.60 (1.53)	8.32 (0.77)	3.12 (0.75)	9.14 (1.33)	8.15 (0.77)	1.19 (0.25)	0.33 (0.17)	1.26 (0.25)
Asian Indian	5.94 (0.88)	52.56 (2.48)	8.52 (1.30)	3.88 (1.70)	10.09 (2.30)	7.01 (1.15)	0.72 (0.24)		
Chinese	8.41 (1.57)	55.79 (2.95)	6.25 (1.19)	1.35 (0.59)	5.67 (1.63)	6.18 (1.33)	1.72 (0.63)	0.73 (0.47)	1.86 (0.64)
Filipino	8.42 (2.12)	49.33 (3.72)	8.45 (2.03)	4.73 (1.53)	12.30 (4.41)	15.6 (3.20)	1.16 (0.59)		
Other Asians	11.4 (1.41)	59.03 (2.56)	9.65 (1.53)	2.70 (0.96)	9.40 (2.63)	8.07 (1.57)	2.02 (0.76)	0.65 (0.53)	2.16 (0.77)
5–<10 Years									
All Asians	7.72 (0.76)	58.54 (1.76)	8.19 (0.82)	4.26 (0.58)	14.38 (1.67)	11.58 (0.89)	1.28 (0.31)	1.03 (0.35)	1.88 (0.32)
Asian Indian	5.81 (1.23)	53.25 (2.92)	9.93 (1.91)	3.15 (0.93)	16.61 (2.80)	8.59 (1.25)	0.96 (0.38)	0.55 (0.32)	1.16 (0.43)
Chinese	5.08 (1.26)	57.89 (3.57)	4.18 (1.05)	1.74 (0.82)	9.06 (3.11)	8.84 (1.75)	0.87 (0.47)	0.16 (0.16)	0.71 (0.36)
Filipino	9.66 (1.84)	61.44 (2.92)	11.15 (1.95)	10.11 (1.96)	18.41 (4.18)	23.37 (2.88)	3.17 (1.43)	2.91 (1.57)	5.25 (1.14)
Other Asians	10.55 (1.58)	63.22 (2.91)	7.15 (1.40)	3.69 (1.04)	13.08 (2.79)	9.53 (1.33)	0.75 (0.37)	0.99 (0.57)	1.41 (0.63)
10–<15 Years									
All Asians	7.11 (0.84)	57.71 (1.53)	8.72 (0.90)	4.67 (0.64)	18.17 (2.00)	14.25 (1.12)	1.99 (0.42)	0.73 (0.24)	2.36 (0.46)
Asian Indian	4.78 (1.09)	57.82 (2.88)	10.57 (1.94)	7.87 (1.50)	20.79 (3.34)	14.97 (2.31)	1.65 (0.66)	1.01 (0.58)	2.28 (0.79)
Chinese	5.73 (1.23)	55.76 (3.08)	3.66 (1.09)	1.44 (0.64)	12.25 (3.37)	10.60 (1.65)	2.09 (0.85)	0.81 (0.45)	2.44 (0.93)
Filipino	10.42 (3.04)	53.49 (3.45)	17.21 (2.80)	5.59 (1.59)	22.10 (4.88)	21.53 (3.21)	2.04 (0.87)	0.55 (0.45)	2.58 (0.98)
Other Asians	8.88 (1.47)	61.71 (2.73)	6.11 (1.12)	3.48 (0.85)	17.90 (4.27)	12.36 (1.75)	2.24 (0.79)	0.45 (0.34)	2.24 (0.79)
≥15 Years									
All Asians	9.91 (0.43)	53.88 (0.77)	12.02 (0.48)	11.81 (0.50)	33.45 (1.12)	29.81 (0.73)	4.42 (0.27)	2.21 (0.17)	5.69 (0.31)
Asian Indian	5.65 (0.70)	51.41 (1.72)	16.03 (1.40)	15.80 (1.42)	35.50 (2.87)	27.43 (1.59)	5.94 (0.73)	1.94 (0.44)	7.24 (0.89)
Chinese	5.60 (0.60)	54.24 (1.51)	6.78 (0.92)	7.09 (0.74)	31.34 (2.49)	26.73 (1.48)	4.42 (0.61)	1.63 (0.34)	4.96 (0.66)
Filipino	11.14 (0.95)	53.65 (1.64)	17.57 (1.33)	15.00 (1.05)	36.72 (2.46)	42.20 (1.47)	5.16 (0.70)	2.35 (0.45)	6.36 (0.82)
Other Asians	13.39 (0.88)	54.97 (1.16)	9.66 (0.72)	10.56 (0.62)	31.67 (1.86)	25.31 (1.01)	3.29 (0.33)	2.55 (0.31)	4.97 (0.42)

Results are presented as percentages (standard error).
Asbbreviations: DM (diabetes mellitus); HLD (hyperlipidemia); HTN (hypertension); CAD (coronary heart disease); ASCVD (atherosclerotic cardiovascular disease).

4. Discussion

In a contemporary and representative sample of individuals of Asian descent living in the U.S., there was heterogeneity in cardiovascular risk factor profile depending on U.S. birth. For foreign-born Asian individuals, duration of residence in the U.S. was also associated with a distinct profile pertaining to ASCVD risk factors and established ASCVD.

Prior studies have shown heterogeneity in cardiovascular risk factor profile among Asian subgroups with a trend towards higher prevalence of diabetes mellitus in Asian Indians, higher prevalence of hypertension among Filipinos, and generally low risk factor burden among Chinese. (Satish et al., 2021; Koirala et al., 2021; Dong, 2021) These differences can likely be attributed to varying degrees of acculturation as a result of cultural practices, history, language, time prior to moving to the U.S. and biological factors that are unique to each ethnic group. (Needham et al., 2017; Lieber et al., 2001; Vargas and Jurado, 2015) Indeed Asian ethnic groups have different predilections to acculturation (embracing host cultural norms including values, attitudes and beliefs) versus enculturation (resocialization to ethnic cultural norms) though using U.S. birth and duration of time spent in the U.S. as proxies may not fully capture the dimensions of these constructs. (Kim et al., 2014; Zhang and Moradi, 2012).

It is therefore important to evaluate the prevalence of cardiovascular risk factors in different Asian subgroups according to acculturation patterns. For example, the prevalence of diabetes mellitus was highest among Filipinos up until 10 years after which the prevalence was highest among Asian Indians. Indeed, Asian Indians are prone to developing diabetes mellitus, (Narayan and Kanaya, 2020; Satish et al., 2021; Kanaya et al., 2014; Patel et al., 2021) and this risk may increase with longer time spent living in the U.S.

After adjustment for sociodemographic factors, U.S.-born individuals had a higher risk of cigarette smoking, obesity, hypertension and CAD. Adults born in the U.S. are more likely to adopt a Western lifestyle, (Rodriguez et al., 2020) which may predispose to cardiovascular risk factor burden and concomitant CAD. U.S. birth was associated with a lower prevalence of physical inactivity which was also observed for each of the Asian subgroups. Differences in physical activity among foreign-born Asian Americans may result in part from acculturation, social and cultural norms, rigid gender roles, and difficulty defining mainstream approaches to physical activity. (Jose et al., 2014) A prior study found higher physical activity levels amongst third-generation Asian immigrants compared with their first-generation counterparts. (Afable-

Table 4
Odds ratios (95% confidence interval) for the association of U.S. birth and duration of time spent living in the U.S. with cardiovascular risk factors and atherosclerotic cardiovascular disease in the overall study population and stratified by gender.

	Smoking	Physical Inactivity	Obesity	DM	HLD	HTN	CAD	Stroke	ASCVD
Overall									
Foreign-born	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
U.S.-born	**1.31 (1.07,1.60)**	**0.62 (0.54,0.72)**	**2.26 (1.91,2.69)**	0.91 (0.66,1.26)	1.03 (0.80,1.32)	**1.33 (1.12,1.58)**	**1.96 (1.24,3.11)**	**0.28 (0.11,0.71)**	1.49 (0.97,2.31)
U.S. Duration									
<5 years	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
5−<10 years	1.25 (0.87,1.80)	**1.35 (1.05,1.73)**	1.56 (0.97,2.51)	2.25 (0.93,5.41)	**1.66 (1.01,2.74)**	0.73 (0.48,1.13)	0.53 (0.20,1.41)	–	0.68 (0.26,1.79)
10−<15 years	1.11 (0.78,1.59)	1.07 (0.83,1.38)	1.30 (0.80,2.10)	1.94 (0.82,4.57)	1.65 (0.97,2.80)	0.88 (0.57,1.35)	0.41 (0.16,1.08)	0.76 (0.14,4.12)	0.52 (0.22,1.22)
≥15 years	**1.65 (1.24,2.21)**	0.82 (0.65,1.03)	**2.33 (1.57,3.47)**	**2.68 (1.17,6.15)**	**1.72 (1.09,2.71)**	1.25 (0.86,1.81)	0.76 (0.39,1.48)	–	0.98 (0.52,1.85)
Women									
Foreign-born	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
U.S.-born	**2.47 (1.84,3.31)**	**0.69 (0.56,0.84)**	**2.37 (1.81,3.11)**	1.13 (0.67,1.92)	1.08 (0.72,1.63)	1.09 (0.84,1.42)	2.04 (0.95,4.38)	0.55 (0.13,2.31)	1.65 (0.79,3.45)
U.S. Duration									
<5 years	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
5−<10 years	0.91 (0.38,2.18)	1.38 (0.93,2.04)	1.18 (0.59,2.36)	**70 (10,483)**	2.43 (0.84,7.03)	0.63 (0.29,1.36)	0.38 (0.04,3.48)	–	0.42 (0.04,3.92)
10−<15 years	0.64 (0.25,1.65)	1.14 (0.79,1.66)	0.83 (0.41,1.69)	**39 (6,277)**	**3.81 (1.25,11.60)**	0.58 (0.28,1.22)	0.12 (0.01,1.58)	0.57 (0.09,3.77)	0.31 (0.05,2.00)
≥15 years	**2.79 (1.32,5.88)**	0.81 (0.57,1.15)	1.41 (0.77,2.59)	**54 (8,350)**	2.41 (0.76,7.59)	0.96 (0.51,1.82)	0.34 (0.06,1.90)	–	0.56 (0.12,2.61)
Men									
Foreign-born	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
U.S.-born	0.99 (0.77,1.29)	**0.55 (0.46,0.67)**	**2.16 (1.69,2.77)**	0.78 (0.53,1.14)	1.00 (0.70,1.44)	**1.57 (1.24,1.98)**	**2.04 (1.22,3.40)**	**0.18 (0.04,0.80)**	1.53 (0.92,2.53)
U.S. Duration									
<5 years	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
5−<10 years	1.32 (0.91,1.95)	1.32 (0.97,1.79)	**2.06 (1.12,3.72)**	1.44 (0.53,3.91)	1.64 (0.91,2.96)	0.85 (0.55,1.32)	0.62 (0.19,2.00)	1.22 (0.22,6.63)	0.86 (0.26,2.91)
10−<15 years	1.24 (0.84,1.85)	1.03 (0.72,1.47)	1.80 (0.97,3.33)	1.49 (0.60,3.69)	1.11 (0.56,2.21)	1.19 (0.75,1.89)	0.61 (0.22,1.71)	0.18 (0.02,1.30)	0.66 (0.25,1.78)
≥15 years	**1.49 (1.08,2.04)**	0.84 (0.62,1.12)	**3.38 (1.99,5.75)**	2.08 (0.84,5.15)	**1.78 (1.04,3.05)**	**1.51 (1.01,2.26)**	1.06 (0.41,2.76)	–	1.32 (0.51,3.41)
p-interaction U.S. birth	<0.001	0.003	0.28	0.23	0.93	0.01	0.65	0.32	0.64
p-interaction duration in U.S.	0.003	0.87	0.71	0.01	0.08	0.60	0.73	–	0.92

Results are adjusted for age, gender, ethnicity, education, income, healthcare coverage, no care due to cost, delayed care due to cost. *Gender stratified analyses are not adjusted for gender.
P-interaction refers to the p-value for interaction between gender and U.S. birth and duration of time in the U.S.
Asbbreviations: DM (diabetes mellitus); HLD (hyperlipidemia); HTN (hypertension); CAD (coronary heart disease); ASCVD (atherosclerotic cardiovascular disease). Bolded items are significant.

Munsuz et al., 2010) These patterns were generally consistent for men and women. Unexpectedly, being born in the U.S. was associated with a lower risk of prevalent stroke. The prevalence of stroke was low in the overall study sample (1.5 %) which likely hindered our ability to perform meaningful analyses especially when evaluating subgroups. In the present study, living over 15 years in the U.S. was associated with a higher prevalence of current smoking, obesity, diabetes mellitus and hyperlipidemia with similar trends for men and women. Consistent with our results, a prior analysis from the 2010–2014 NHIS survey of 54,984 U.S. immigrants from Asia and other regions found that living over 10 years in the U.S. was associated with a higher likelihood of cardiometabolic risk factors. (Commodore-Mensah et al., 2016) Spending a longer time living in the U.S. increases the likelihood of living a Western lifestyle with unfavorable dietary patterns and exercise habits which can result in accumulation of cardiovascular risk factors and development of cardiovascular risk factors and ASCVD. (Wong et al., 2013; Kandula et al., 2008; Lutsey et al., 2008).

A study from the California Health Interview Survey found that Asian Americans as a whole were more likely to be overweight or obese and to have diabetes. However, in disaggregated analyses by Asian subgroups, Vietnamese Americans were more likely to report poor health, while Chinese and Japanese Americans were more likely to self-report overweight or obesity. Filipinos were most likely to report being overweight or obese, having hypertension, or diabetes. (Adia et al., 2020) A prior study by Alam et al found that low educational attainment was associated with lower likelihood of achieving ideal cardiovascular health among Asian Americans regardless of duration of time in the U.S. (Alam et al., 2021) Another study by Divney et al found that Asians with high acculturation were more likely to have hypertension compared to those with less acculturation with significant differences comparing men and women. (Divney et al., 2019) Kandala et al evaluated the association of neighborhood-level determinants with smoking patterns among Asians Americans according to gender and found that different contextual factors predicted smoking in women versus men. (Kandula et al., 2009) Lastly, Asian-Indian and Filipino populations have the highest years of life lost due to CHD while Filipino and Vietnamese have the highest years of life lost attributable to cerebrovascular disease. (Iyer et al., 2019).

The racial profile and socioeconomic status of Asian immigrants differed according to time spent in the U.S as seen in the present analysis. For example, most foreign-born Asian individuals who spent < 5 years in the U.S. were Asian Indians while those who lived ≥ 15 years

were Filipinos. This is also reflected in differences by U.S. birth where most Asian individuals born in the U.S. were Filipinos while most of those who were born outside were Asian-Indians. This is consistent with the fact that few Asian Indians migrated to the United States before the 1965 Immigration Act was passed while Filipinos migrated to the U.S. beginning in the 1760 s. Asian Americans who lived < 5 years in the U.S. were more educated but had a lower income compared with those who lived longer who were less educated and had a higher income. This suggests that Asian immigrants who arrived recently in the U.S. are a skilled and educated workforce compared with later generations are less educated but accrue more wealth over time.

There have been systematic issues in data collection for Asian Americans (Islam et al., 2010; Holland and Palaniappan, 2012) including missing or misclassified data and indiscriminate grouping of all Asian Americans under one group in data systems. (Yi et al., 2022; Yi, 2020) Each Asian American subgroup in this study has a distinct cardiovascular risk factor profile which differed according to U.S. birth and duration of time spent in the U.S. This highlights the importance of using disaggregated data rather than considering all Asians individuals as a monolith which may mask the heterogeneity in cardiovascular risk across Asian American subgroups. It is important to adopt a standardized assessment of acculturation in each Asian ethnic group. More research is required to understand how different acculturation strategies (Needham et al., 2017) or how specific aspects of acculturation in each Asian ethnicity may contribute to development of ASCVD. (Al-Sofiani et al., 2020; Palaniappan et al., 2010) Clinicians should consider asking patients of Asian descent about their birth country and how long they have lived in the U.S. given that these factors may predispose to burden of cardiovascular risk factors and ASCVD independent of socioeconomic status. Furthermore, different ethnic groups tend to settle in different geographies and neighborhoods which may have an effect on variability in ASCVD risk. (Dalton et al., 2017) Therefore, population-based solutions may be required to ameliorate the effects of neighborhood disadvantage on health outcomes, including ASCVD. Emphasizing healthy lifestyle habits using culturally-relevant message may also help improve adherence to therapeutic lifestyle recommendations and medication use. (Kalra et al., 2021; Cardio Smart, 0000).

Our results should be interpreted in the context of important limitations. All our variables were self-reported and may be prone to measurement error and recall bias. Birthplace and duration of time in the U.S. may not comprehensively capture the complex processes and types of acculturation including integration, assimilation, separation, and marginalization. The present study evaluated cigarette smoking as a tobacco product, but other cultural tobacco products were not assessed. (Changrani et al., 2006) NHIS data are limited to release data for all Asian subgroups due to confidentiality regulations on minimum sample size.y (National Center, 0000) Therefore, public use data are only provided for Asian Indian, Chinese, and Filipino, but not for smaller Asian populations such as Japanese, Korean, and Vietnamese. Small sample size likely underpowered our analyses to detect significant differences by Asian ethnicity especially in subgroup analyses. There is the possibility of survival bias especially in analyses of those who spent over 10 years in the U.S. Lastly, there is the possibility of residual confounding in any epidemiologic cohort study.

In conclusion, heterogeneity exists in cardiovascular risk factor burden among Asian Americans depending on Asian ethnicity, U.S. birth, and duration of time living in the U.S.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2022.101916.

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