# Cardiovascular Health and Disease Among Asian-Americans (from the National Health and Nutrition Examination Survey)

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**Variable propensity toward cardiovascular disease in the different ethnicities in the United States has been reported. We aimed to characterize the prevalence trends of cardiovascular health, as defined by the American Heart Association's Life's Simple 7 metrics, and cardiovascular diseases amongst Asian-Americans. We used the National Health and Examination Nutrition Survey from 2011 to 2016 to capture self-identified American-born Asian-Americans and foreign-born Asian-Americans. The prevalence trends of cardiovascular health metrics and diseases were evaluated in Asian-Americans and also compared between American-born and foreign-born Asian-Americans. Results were presented as weighted percentages and odds ratios with 95% confidence intervals. From 2011-2012 to 2015-2016, the prevalence of Asian-Americans reporting no physical activity increased from 21.5% to 32.4% (p for linear trend = 0.001) and the prevalence of Asian-American participants reporting a healthy diet decreased from 44.1% to 36.8% (p for quadratic trend = 0.02). There was a concomitant decline in the prevalence of Asian-Americans with normal weight (body mass index <25 kg/m$^2$) from 60.5% from 2011-2012 to 55.3% in 2015-2016 (p for linear trend = 0.04). The prevalence of congestive heart failure and chronic kidney disease increased from 2011-2012 to 2015-2016. Foreign-born Asian-Americans had lower odds of having a non-healthy diet and blood pressure compared with American-born Asians. In conclusion, in the National Health and Examination Nutrition Survey 2011 to 2016 cycles, Asian-Americans exhibited a declining prevalence of healthy weight and an increasing prevalence of poor diet, physical activity levels, congestive heart failure, and chronic kidney disease. Foreign-born Asian-Americans also exhibited a different cardiometabolic risk profile compared with American-born Asian-Americans.**  **(Am J Cardiol 2019;124:270−277)**

Cardiovascular disease (CVD) confers a significant morbidity and mortality burden worldwide and this burden continues to rise.[1] There is also a variable propensity toward CVD in the different ethnic subgroups in America. However, the CVD burden in Americans originating from the Asian continent ("Asian-Americans") remains particularly poorly characterized, although Asian-Americans are one of the fastest growing ethnic minorities in the United States.[2,3]

We aimed to characterize the prevalence trends of cardiovascular health, as defined by the American Heart Association's Life's Simple 7 metrics, and cardiovascular diseases amongst Asian-Americans. We also hypothesized that the prevalence of ideal cardiovascular health varied between American-born Asian-Americans and foreign-born Asian-Americans. We present the results of an investigation that used the National Health and Examination Nutrition Survey (NHANES) data from 2011-2012 to 2015-2016 to evaluate our hypotheses.

## Methods

The NHANES data, a nationally representative multistage cross-sectional survey of the nonmilitary and noninstitutionalized population of the United States, was used as the data source.[4] The National Center for Health Statistics releases the NHANES data once every 2 years. Each survey cycle collects self-reported and directly measured information from survey participants. Each participant undergoes a series of questionnaires in a detailed in-home interview followed by information collection on health conditions, behaviors, dietary intake, and physical examination during mobile examination. Each participant also provides their blood for laboratory tests.

The NHANES seeks health status assessment of certain population by oversampling subgroup participants.[5] From 2011 onwards, NHANES started oversampling Asian-Americans.[6] The process for oversampling Asian-Americans included recruiting staff fluent in English and different Asian languages and training the staff for cultural competency.[6] The NHANES materials, except the questionnaire administered at home interviews, were translated into Asian languages.[6]

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Local interpreters were recruited to assist the Asian-American participants in completing the questionnaires.[6]

We used the data from participants of 3 NHANES cycles spanning from 2011-2012 to 2015-2016. To identify the study population, we implemented the following exclusion criteria: (1) participants aged less than 20 years of age; (2) participants with self-reported race other than "Asian"; (3) participants who were pregnant or breastfeeding at the time of survey; and (4) lack of information on all 7 cardiovascular health metrics assessed using the American Heart Association's Life's Simple 7 components.

Covariates such as age, sex (male/female), and insurance status (Yes/No) were self-reported. Self-reported Asian-Americans were further categorized into American born, foreign origin who lived <10 years, 10 to 19 years, and ≥20 years in the United States. The poverty income ratio (a ratio based on family income and poverty guidelines) and self-reported years of education were also provided in each NHANES cycle. We categorized the poverty income ratio in 3 categories: (1) less than 1.30; (2) between 1.30 and 3.49; and (3) 3.50 or higher. These corresponded to low, moderate, and high socioeconomic status, respectively. Educational status was categorized as follows: less than 12 years of education, some college education, and college degree or higher.

To assess the prevalence of CVD, a composite of self-reported cardiovascular conditions such as heart failure, coronary artery disease, angina, history of myocardial infarction, and history of stroke were used. Estimated glomerular filtration rate less than 60 ml/min/1.73 $m^2$, ascertained using the Chronic Kidney Disease Epidemiology Collaboration equation,[7] was used to estimate the prevalence of chronic kidney disease.

The definitions of the American Heart Association's Life's Simple 7 were used to characterize the cardiovascular health metrics (Table 1).[8] The cardiovascular health metrics contain health behaviors (smoking status, body mass index [BMI], physical activity, and healthy diet score) and health factors (total cholesterol, blood pressure, and fasting plasma glucose). Each metric was further categorized as ideal, intermediate, and poor.[8]

The self-reported smoking metric was used to characterize the smoking status into current, former, and never. The duration in vigorous and/or moderate intensity activities spent on weekly basis was used to categorize the physical activity in ideal, intermediate, and poor. The anthropometric parameters obtained during the mobile examination were used to calculate BMI. Each of survey participants were further categorized into the ideal (BMI <25 kg/$m^2$), intermediate (BMI 25−29.9 kg/$m^2$), and poor (BMI ≥30 kg/$m^2$) BMI categories. The healthy diet score was calculated in a manner that was described previously.[9,10] In brief, an average of 2 24-hour dietary recalls of each dietary component (i.e., fruits and vegetables, fish, whole grain, sodium, and added sugar) were used to estimate the healthy diet score.[9,10]

During the mobile examination, each survey participant had up to 4 blood pressure measurements. An average of the first 2 blood pressure measurements and/or self-reported use of antihypertensive medications were used to categorize blood pressure in the ideal (blood pressure <120/<80 mm Hg), intermediate (systolic blood pressure 120−139 mm Hg and/or diastolic blood pressure 80−89 mm Hg or treated for <120/<80 mm Hg), or poor (systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥90 mm Hg) categories. Total cholesterol and fasting plasma glucose were measured on each of the survey participants from blood samples collected during the mobile examination. Total cholesterol (nonfasting) was categorized as ideal (<200 mg/dl), intermediate (200−239 mg/dl or treated to goal), or poor (>240 mg/dl). Fasting plasma glucose was categorized as ideal (fasting blood glucose of <100 mg/dl), intermediate (fasting blood glucose of 100−125 mg/dl or treated to goal), or poor (fasting blood glucose ≥126 mg/dl).

All of the statistical analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC). To generate the national estimates for Asian-Americans, the statistical weights accounting for fasting subgroup and the complex sample design [sampling unit (SDMVPSU) and sampling strata (SDMVSTRA)] were used. The linear regression model was used to estimate the characteristics and prevalence of cardiovascular and chronic kidney disease for our study population. Multivariable linear regression models including age, sex, insurance status, income, and education categories were used to assess the factors associated with cardiovascular and kidney disease in Asian-Americans.

Multivariable linear regression models including age, sex, insurance status, income, and education categories, were used to estimate the prevalence of cardiovascular health metrics of Asian-Americans from NHANES 2011-2012 to 2015-2016. Orthogonal polynomial regression for equal time intervals including the aforementioned covariates and Bonferroni correction for multiple comparisons was performed to assess linear and quadratic trends in cardiovascular health metrics in Asian-Americans from NHANES 2011-2012 to 2015-2016. Furthermore, multivariable logistic regression models including age, sex, insurance status, income, and education categories were used to estimate the odds of nonideal cardiovascular health metrics in the foreign born Asian-Americans as compared with Asian-Americans who born in the United States. A 2-sided p value of <0.05 was used to assess the statistical significance.

To assess the robustness of our trend estimates for cardiovascular health metrics in Asian-Americans, sensitivity analyses were conducted using the lower suggested obesity cutoff for Asian-Americans (BMI ≥25)[11] and the 2017 guidelines for high blood pressure.[12] Another sensitivity analysis was done to evaluate the risk factors that were most strongly associated with cardiovascular and chronic kidney disease in Asian-American participants. Multivariable linear and orthogonal polynomial regression models including age, sex, insurance status, income, and education categories were utilized to estimate the weighted prevalence and trends in cardiovascular health in Asian-Americans.

## Results

Table 2 outlines the demographic and socioeconomic characteristics of Asian-American participants in the NHANES surveys from 2011-2012 to 2015-2016. The

Table 1
American Heart Association's life's simple 7 cardiovascular health metrics: Definitions of ideal, intermediate, and poor cardiovascular risk factors and behaviors

| Cardiovascular health metric | Ideal (Score = 2) | Intermediate (Score = 1) | Poor (Score = 0) |
|---|---|---|---|
| *Behavioral factors* | | | |
| Smoker | Never or stopped >12 months ago | Former (stopped ≤12 months earlier) | Current |
| Physical activity (minutes/week) | ≥150 moderate, ≥75 vigorous, or ≥150 moderate + vigorous | 1-149 moderate, 1-74 vigorous, or 1-149 moderate + vigorous | None |
| Body mass index (kg/m$^2$) | <25 | 25-29.9 | ≥30 |
| Diet* (components) | 4 or 5 | 2 or 3 | 0 or 1 |
| *Health factors* | | | |
| Total cholesterol (mg/dl) | <200 without treatment | 200−239 or treated to <200 | ≥240 |
| Blood pressure (mm Hg) | <120/<80 without treatment | SBP 120-139, DBP 80-89, or treated to <120/<80 | SBP ≥140 or DBP ≥90 |
| Fasting plasma glucose (mg/dl) | <100 without treatment | 100-125 or treated to <100 | ≥126 |

DBP = diastolic blood pressure; kg/m$^2$ = kilograms per eters square; mg/dl = milligrams per deciliter; min = minutes; mm Hg = millimeters of mercury; SBP = systolic blood pressure.

* The American Heart Association's healthy diet category contains 5 components: consumption of fruits and vegetables (≥4.5 cups/day), fiber-rich whole grain (≥3 one ounce servings/day), sodium (<1500 mg/day), sugar-sweetened beverages (≤36 oz/week), and fish (≥2 3.5-oz servings/week). The modified healthy diet category also consists of 5 components: consumption of fruits and vegetables (≥4.5 cups/day), whole grain (≥ 3 oz/day), sodium (<1500 mg/day), added sugar (<37.5 g/day for men, <25 g/day for women), and fish (≥2 times/week).

flow chart for participant selection of Asian-Americans is outlined in Figure 1.

The mean age across the 3 survey periods was approximately 45 years. Males and females were almost equally represented across the 3 survey periods. The proportion of American born Asian-American participants varied between 10% and 18% across the survey periods. The Asian-Americans belonging to the highest socioeconomic stratum were the most prevalent across all 3 study periods. The proportion of Asian-American participants in the low, middle, and high socioeconomic strata remained similar across the survey periods. College graduation was the most prevalent educational attainment stratum across all 3 survey periods (Table 2). The proportion of Asian-American participants that reported having health insurance increased from 79% (95% confidence intervals [CI] 75% to 83%) in the 2011-2012 survey period to 89% (95% CI 85% to 94%) in the 2015 to 2016 survey period (Table 2).

The overall prevalence of participants with a history of CVD ranged from 4.1% to 5.2% during the survey periods (Table 3). The prevalence of Asian-American participants with a history of heart failure increased from 0.7% in the 2011 to 2012 survey period to 1.3% in the 2015 to 2016 survey period. The prevalence of Asian-Americans with a history of stroke declined from 1.7% in the 2011 to 2012 study period to 1.0% in 2015 to 2016 (Table 3). The prevalence of

Table 2
Characteristics of Asian-American adults from NHANES 2011 to 2016

| | NHANES 2011-2012 | | NHANES 2013-2014 | | NHANES 2015-2016 | |
|---|---|---|---|---|---|---|
| Characteristic | No. | Prevalence (95% CI) | No. | Prevalence (95% CI) | No. | Prevalence (95% CI) |
| Age (years) | 581 | 44 (41-46) | 530 | 45 (42-47) | 527 | 45 (42-48) |
| Male | 301 | 49 (46-51) | 251 | 45 (41-50) | 268 | 48 (45-51) |
| Female | 280 | 51 (49-54) | 279 | 55 (50-59) | 259 | 52 (49-55) |
| American born Asian-American participants | 103 | 18 (12-25) | 67 | 14 (10-18) | 52 | 10 (8-13) |
| Foreign origin participants who have lived in the US for <10 years | 142 | 26 (17-34) | 117 | 24 (16-31) | 160 | 31 (24-38) |
| Foreign origin participants who have lived in the US for 10−19 years | 119 | 20 (17-24) | 126 | 24 (20-29) | 100 | 19 (14-23) |
| Foreign origin participants who have lived in the US for ≥20 years | 211 | 36 (30-42) | 217 | 38 (30-46) | 211 | 40 (34-46) |
| *Family poverty income ratio* | | | | | | |
| ≥3.50 | 235 | 43 (35-52) | 239 | 46 (37-56) | 194 | 40 (34-45) |
| 1.30-3.49 | 158 | 28 (23-33) | 169 | 31 (25-39) | 164 | 29 (21-37) |
| <1.30 | 188 | 29 (21-36) | 122 | 23 (16-29) | 169 | 31 (22-41) |
| *Education* | | | | | | |
| ≤12 years | 152 | 25 (18-31) | 141 | 25 (17-33) | 158 | 28 (21-34) |
| Some college | 130 | 22 (15-29) | 117 | 23 (18-27) | 94 | 17 (13-21) |
| College graduate | 297 | 53 (47-59) | 272 | 52 (43-61) | 275 | 55 (47-63) |
| Active health insurance | 454 | 79 (75-83) | 444 | 84 (80-88) | 467 | 89 (85-94) |

NHANES = National Health and Nutrition Examination Survey.

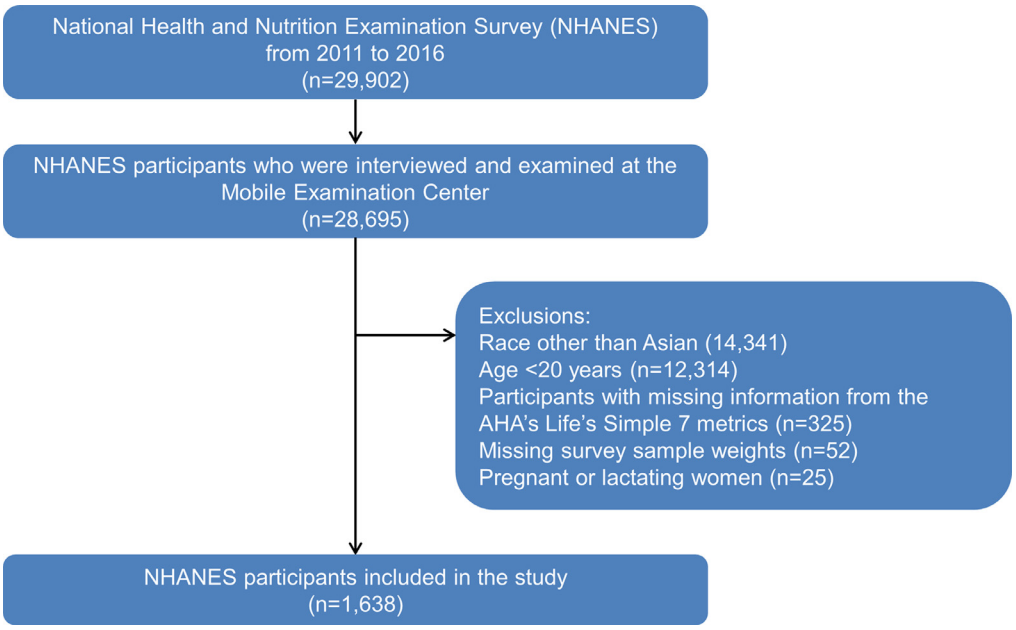


Figure 1. Flow chart for participant selection.

participants with chronic kidney disease increased from 4.1% in the 2011 to 2012 study period to 5.0% in the 2015 to 2016 study period (Table 3). The prevalence of participants with angina, a history of myocardial infarction, and coronary artery disease remained stable across the 3 NHANES study periods (Table 3).

The prevalence of CVD health metrics is outlined in Table 4. The prevalence of Asian-American participants reporting an absence of physical activity increased markedly from 21.5% (95% CI 17.5% to 25.4%) to 32.4% (95% CI 27.5% to 37.3%) (p for linear trend = 0.001). The prevalence of Asian-American participants reporting a healthy diet (i.e., ≥2 components) decreased from 44.1% (95% CI 38.1 to 50.0%) in 2011 to 2012 to 36.8% (95% CI 32.8% to 40.9%) in 2015 to 2016 (p for quadratic trend = 0.02). Along with the decline in physical activity and healthy diet, there was a concomitant decline in the prevalence of participants with normal weight (BMI <25 kg/m$^2$) from 60.5% (95% CI 56.0% to 65.1%) in 2011 to 2012 to 55.3% (95% CI 51.5% to 59.1%) (p for linear trend = 0.04) (Table 4). The prevalence of Asian-American former smokers decreased from 8.3% (95% CI 5.8% to 10.8%) in 2011 to 2012 to 4.9% (95% CI 3.2% to 6.6%) in 2015 to 2016 (p for linear trend = 0.03). The prevalence of other cardiovascular health metrics in Asian-American participants remained unchanged across the 3 survey periods (Table 4).

The adjusted odds of nonideal cardiovascular health in foreign-born Asian-American participants who had resided in the United States for <10 years, 10 to 19 years, and >20 years were also compared with prevalence odds of nonideal cardiovascular health in American-born Asian-American participants (Table 5). Across all strata, foreign-born Asian-American participants had lower odds of having a nonhealthy diet (i.e., <2 components) [odds ratio (OR) 0.51; 95% CI 0.35 to 0.74 in <10 years; OR 0.48; 95% CI 0.34 to 0.67 in 10 to 19 years, and OR 0.56; 95% CI 0.41 to 0.76 in >20 years]. All foreign-born Asian-American participants also had lower odds of having elevated blood pressure (≥120/≥80 mm Hg) (OR 0.55; 95% CI 0.36 to 0.82 in <10 years; OR 0.56; 95% CI 0.41 to 0.76 in 10 to 19 years, and OR 0.71; 95% CI 0.51 to 0.99 in >20 years) as compared with the referent American-born Asian-Americans. Foreign-born Asian-Americans who had lived in the United States for <10 years or 10 to 19 years also had lower odds for being current smokers than American born Asian-Americans. However, foreign-born Asian-American participants who had lived in the United States for ≥20 years had no difference in the prevalence of current smoking compared with American-born Asian-Americans. Foreign-born Asian-Americans participants who had lived in the United

Table 3
Prevalence of cardiovascular disease: Extrapolation of NHANES data to Asian-American adults

| Variable | 2011-2012 | 2013-2014 | 2015-2016 |
|---|---|---|---|
| Cardiovascular disease | | | |
| Overall* | 4,094 (4.1%) | 5,188 (5.2%) | 4,106 (4.1%) |
| Heart failure | 664 (0.7%) | 725 (0.7%) | 1,350 (1.3%) |
| Coronary artery disease | 1,752 (1.8%) | 1,857 (1.9%) | 1,882 (1.9%) |
| Angina pectoris | 751 (0.8%) | 1,165 (1.2%) | 603 (0.6%) |
| Prior myocardial infarction | 1,117 (1.1%) | 1,749 (1.7%) | 1,470 (1.5%) |
| Prior stroke | 1,687 (1.7%) | 1,624 (1.6%) | 1,034 (1.0%) |
| Kidney disease | | | |
| Chronic kidney disease (eGFR <60 ml/min/1.73 m$^2$)† | 4,084 (4.1%) | 3,765 (3.8%) | 4,972 (5.0%) |

* Numbers are presented in estimated prevalence of cardiovascular disease (i.e., heart failure, coronary artery disease, angina, history of myocardial infarction, history of stroke) per 100,000 Asian-American adults with percentage.

† The estimated glomerular filtration rate was determined by the Chronic Kidney Disease-Epidemiology Collaboration equation.

Table 4
Adjusted weighted prevalence of cardiovascular health metrics amongst Asian-American adults in NHANES 2011 to 2016

| | NHANES 2011-2012* | | NHANES 2013-2014* | | NHANES 2015-2016* | | p Value† | |
|---|---|---|---|---|---|---|---|---|
| Cardiovascular health metric | Number | Prevalence (95% CI) | Number | Prevalence (95% CI) | Number | Prevalence (95% CI) | Linear | Quadratic |
| *Smoking* | | | | | | | | |
| Current | 64 | 10.1 (7.5-12.7) | 48 | 8.8 (6.5-11.1) | 57 | 9.7 (5.3-14.2) | 0.92 | 0.69 |
| Former | 55 | 8.3 (5.8-10.8) | 51 | 8.8 (6.3-11.3) | 29 | 4.9 (3.2-6.6) | 0.03 | 0.50 |
| Never | 481 | 81.6 (77.9-85.3) | 447 | 82.4 (78.9-86.0) | 458 | 85.4 (81.8-88.9) | 0.14 | 0.84 |
| *Physical activity* | | | | | | | | |
| None | 124 | 21.5 (17.5-25.4) | 127 | 22.8 (17.5-28.0) | 171 | 32.4 (27.5-37.3) | 0.001 | 0.80 |
| Intermediate | 203 | 34.8 (31.0-38.6) | 178 | 32.5 (27.7-37.2) | 168 | 29.7 (26.9-32.6) | 0.03 | 0.51 |
| Ideal | 273 | 43.7 (38.7-48.7) | 241 | 44.8 (40.9-48.6) | 205 | 37.8 (33.2-42.5) | 0.10 | 0.73 |
| *Body mass index (kg/m$^2$)* | | | | | | | | |
| ≥30 | 66 | 11.4 (7.9-15.0) | 69 | 12.8 (10.1-15.5) | 69 | 13.7 (10.7-16.8) | 0.31 | 0.59 |
| 25-29.9 | 167 | 28.0 (23.4-32.6) | 169 | 29.4 (25.8-33.0) | 170 | 31.0 (26.6-35.3) | 0.22 | 0.37 |
| <25 | 367 | 60.5 (56.0-65.1) | 308 | 57.8 (53.9-61.7) | 305 | 55.3 (51.5-59.1) | 0.04 | 0.21 |
| *Healthy diet score* | | | | | | | | |
| 0-1 components | 329 | 55.9 (50.0-61.9) | 354 | 64.3 (60.3-68.3) | 343 | 63.2 (59.1-67.2) | 0.05 | 0.02 |
| ≥2 components | 271 | 44.1 (38.1-50.0) | 192 | 35.7 (31.7-39.7) | 201 | 36.8 (32.8-40.9) | | |
| *Total cholesterol (mg/dl)* | | | | | | | | |
| >240 | 62 | 9.1 (7.3-12.4) | 68 | 11.6 (8.5-14.7) | 60 | 10.5 (6.9-14.0) | 0.74 | 0.39 |
| 200-239 | 247 | 42.1 (35.9-48.4) | 219 | 38.9 (34.3-43.5) | 213 | 39.7 (36.0-43.3) | 0.40 | 0.35 |
| <200 | 291 | 48.0 (41.5-54.5) | 259 | 49.5 (44.5-54.5) | 271 | 49.8 (45.4-54.3) | 0.61 | 0.68 |
| *Blood pressure (mm Hg)* | | | | | | | | |
| ≥140/≥90 | 83 | 15 (12.5-17.6) | 83 | 15.4 (13.8-17.1) | 84 | 16.5 (12.0-21.0) | 0.60 | 0.66 |
| 120-139/80-89 | 201 | 33.7 (30.6-37.0) | 172 | 30.1 (27.2-32.9) | 193 | 35.6 (30.3-40.8) | 0.23 | 0.21 |
| <120-80 | 316 | 51.3 (48.0-54.6) | 291 | 54.5 (51.8-57.2) | 267 | 47.9 (43.4-52.4) | 0.10 | 0.33 |
| *HbA1c (Percentage)* | | | | | | | | |
| >6.5% | 68 | 11.0 (8.4-13.6) | 62 | 11.5 (8.4-14.6) | 66 | 12.5 (9.3-15.8) | 0.80 | 0.65 |
| 5.7%-6.4% | 165 | 27.1 (22.7-31.4) | 155 | 27.9 (24.9-31.4) | 139 | 25.7 (22.7-28.6) | 0.48 | 0.98 |
| <5.7% | 367 | 62.0 (56.0-67.9) | 329 | 60.6 (56.4-64.7) | 339 | 61.8 (57.6-66.0) | 0.67 | 0.79 |

CI = confidence interval; kg/m$^2$ = kilograms per meter Square; mg/dl = milligrams per deciliter; mm Hg = millimeters of mercury.
* Weighted prevalence adjusted age, sex, education attainment, family income to poverty ratio, and insurance status.
† The orthogonal polynomial model including age, sex, education attainment, family income to poverty ratio, insurance status and Bonferroni correction for multiple testing was used to assess the linear and quadratic trend p-value across the survey years.

States for 10 to 19 years had 1.83 times the odds of having an elevated HbA1c (i.e., ≥5.7%) compared with American-born Asian-Americans (Table 5). There were no differences in odds for poor physical activity levels, BMI ≥25 kg/m2, and total cholesterol ≥200 mg/dl between the American-born Asian-Americans and the 3 strata of foreign-born Asian-Americans (Table 5).

Sensitivity analyses were conducted to examine the risk factors associated with cardiovascular and chronic kidney disease in Asian-Americans. Increasing age, total cholesterol 200 to 239 mg/dl, blood pressure ≥140/≥90 mm Hg, and HbA1c >6.5% were significantly associated with cardiovascular and chronic kidney disease in Asian-Americans (Supplemental Table 1). Another sensitivity analysis was done to evaluate the trends in the adjusted weighted prevalence of BMI and blood pressure using the lower proposed criteria in Asian-American participants in the survey periods. The prevalence of blood pressure ≥130/≥90 mm Hg rose considerably from 2011-2012 to 2015-2016 (Supplemental Table 2).

## Discussion

We report that Asian-American participants in the 2011 to 2016 NHANES exhibited an increasing prevalence of poor physical activity, congestive heart failure, and chronic kidney disease, and a declining prevalence of healthy weight (BMI <25 kg/m$^2$). We also noted lower odds for poor diet and elevated blood pressure in foreign-born Asian-Americans across all strata in comparison to American-born Asian-Americans. These trends occurred although Asian-American participants largely belonged to the middle and high socioeconomic strata, had relatively high levels of educational attainment, and had improvements in health insurance coverage. Finally, we noted a rising prevalence of poor blood pressure (≥130/≥90 mm Hg) in our sensitivity analyses.

There may be important social explanations for our findings. Ng et al previously described a declining physical activity in Chinese adults due to rapid urbanization leading to sedentary occupations and housing structures that were not conducive to physical activity.[13] Asian-American participants' high socioeconomic and educational statuses may also have had similar effects on their physical activity. Assimilation into the American culture may also be associated with important shifts in health behaviors across residence strata. Abraido-Lanza et al previously found that acculturation of Latino immigrants led to higher alcohol intake and increased prevalence of current smoking.[14] We posit that the lower adjusted odds of current smoking in foreign-born Asian-American participants living in America for ≤19 years that were later lacking in foreign-born

Table 5
Adjusted odds of individual cardiovascular health metrics amongst Asian-American adults in NHANES 2011 to 2016

| Demographic | Current smoker | No/moderate physical activity | BMI ≥25 kg/m$^2$ | Healthy diet (<2 components) | Total cholesterol (≥200 mg/dl) | Blood pressure (≥120/≥80 mm Hg) | HbA1c (≥5.7%) |
|---|---|---|---|---|---|---|---|
| American born Asian-American participants | | | | Reference | | | |
| Foreign origin participants who have lived in the US for <10 years | 0.51 (0.33-0.80) | 1.39 (0.98-1.97) | 0.80 (0.54-1.19) | 0.51 (0.35-0.74) | 1.08 (0.71-1.63) | 0.55 (0.36-0.82) | 1.21 (0.65-2.24) |
| Foreign origin participants who have lived in the US for 10-19 years | 0.58 (0.34-0.99) | 1.04 (0.71-1.51) | 0.74 (0.50-1.10) | 0.48 (0.34-0.67) | 1.11 (0.71-1.75) | 0.56 (0.41-0.76) | 1.83 (1.07-3.13) |
| Foreign origin participants who have lived in the US for ≥20 years | 0.72 (0.44-1.17) | 1.03 (0.78-1.35) | 0.83 (0.53-1.30) | 0.56 (0.41-0.76) | 1.27 (0.80-2.03) | 0.71 (0.51-0.99) | 1.49 (0.85-2.60) |

CI = confidence interval; kg/m$^2$ = kilograms per meter square;, mg/dl = milligrams per deciliter; mm Hg = millimeters of mercury.
Data were presented as odds ratios with 95% confidence intervals.
Ideal cardiovascular components and American-born Asian adults were used as the reference group.
A multivariable logistic regression model including age, sex, education attainment, family income to poverty ratio, and insurance status was used.

Asian-American participants who have lived in the US for ≥20 years (Table 5) may have been due to a similar acculturation of risky health behaviors in Asian-Americans. Finally, we noted a rise in the prevalence of Asian-American participants reporting health insurance coverage. This likely coincided with the vast uptake of health insurance that occurred with the institution of the Affordable Care Act.[15] We consider this an important healthcare milestone.

These social explanations are likely linked to multiple biological explanations. The increase in poor physical activity and poor diet combined with the decline in ideal BMI that we identified in our investigation was likely implicated in the causation of metabolic dysregulation and metabolic syndrome. Metabolic dysregulation is a potent stimulant of many CVDs.[16] Thus, it is unsurprising that Asian-Americans had a rising prevalence of congestive heart failure and chronic kidney disease, both diseases with pathophysiologic processes involving metabolic dysregulation,[17,18] in an era where metabolic syndrome is reaching unprecedented levels worldwide.[19] Secondly, the rising prevalence of poor blood pressure that we identified may also be associated with the declining prevalence of ideal physical activity, healthy diet, and BMI. Finally, we noted a ~12% prevalence of HbA1c ≥6.5% in the Asian-American participants in the investigation. In comparison, the prevalence of diabetes is ~9.4% in the broader American population.[20] This excess prevalence of diabetes mellitus could possibly explain the rising prevalence of chronic kidney disease in Asian-American participants in our investigation.

Our investigation also adds to the existing data on cardiovascular health in Asian-Americans and Asians. To the best of our knowledge, our investigation is the first to employ NHANES data to explore cardiovascular trends in Asian-Americans. Additionally, we demonstrate that the prevalence of cardiovascular health and diseases varies according to the birth status of Asian-Americans and the duration of American residence. The INTERHEART study previously highlighted that metabolic disease is rampant in subjects of Asian ancestry.[21,22] We build upon this by outlining the prevalence of important cardiovascular health factors and diseases in Asian-American participants. Furthermore, we demonstrated that diabetes mellitus, suboptimal physical activity levels, obesity, and suboptimal diet are not only prevalent in subjects residing in Asia,[21,22] but also Asian-Americans. Our findings also strongly support that the "double burden of disease" exists in Asian-Americans—a simultaneous morbidity and mortality burden from a declining (but existing) prevalence of communicable diseases (such as hepatitis B) with a concomitant rise in the prevalence of noncommunicable diseases such as cardiometabolic pathologies, leading to a so-called "double burden of disease."

Our investigation has important public health implications. Our findings highlight the need to aggressively address cardiovascular risk factors and diseases in Asian-Americans. The previous findings that Asian-Americans have a higher burden of cerebrovascular, hypertensive, and ischemic heart diseases than other American ethnic subgroups also support aggressive preventive efforts.[23] Two important steps in this area were the recent

publication of the multisociety lipid guidelines[24] and physical activity guidelines.[25] The lipid guidelines identified South Asian ancestry as an important risk modifier. We believe that this should be generalized to aggressive blood pressure, diabetes, lipid, and physical activity screening for all Asian-Americans. The establishment of normative values and cardiovascular risk prediction models specific to Asians and Asian-Americans should be another important step in CVD prevention. We noted a higher prevalence of diabetes in Asian-Americans despite a relatively low prevalence of obesity.[26] Thus, our work supports the ongoing movement to redefine obesity and metabolic indices for Asian subjects, as they may differ from other ethnic subgroups.[26,27] Finally, our work highlights the importance of actively engaging Asian-Americans in health research. Others have previously described significant difficulty in enrolling Asian-Americans in the NHANES and broader health research.[6,28] This should be done by addressing cultural stigmas surrounding research participation, actively recruiting Asian-American participants through targeted campaigns, and supporting ongoing legislation to promote these efforts.[6,28]

Our investigation has important limitations. The NHANES data is a series of cross-sectional surveys. Therefore, incident measures of disease frequency cannot be obtained. Some diseases, such as congestive heart failure, are self-reported in the NHANES survey. This may lead to possible reporting and recall bias. However, previous NHANES data shows good validity of self-report for other cardiovascular diagnoses such as ischemic heart disease and stroke.[29] We were unable to identify cardiovascular prevalence trends in ethnic and racial subgroups within the Asian-American population due to small subgroup sample sizes and operational constraints.[6] This is an important limitation since different Asian ethnic subgroups have variance in their cardiovascular risk profiles.[22] We were also limited in our ability to identify trends in disease subtypes, such as chronic kidney disease stages. Regardless, we aimed for our investigation to provide a broad overview of cardiovascular outcomes in an area that is otherwise sparsely populated with contemporary American data.

In conclusion, we found that the prevalence of physical inactivity, suboptimal dietary patterns, congestive heart failure, and chronic kidney disease is rising in Asian-Americans. The prevalence of diabetes mellitus and hypertension is already higher than the general American population. This is balanced by relatively high socioeconomic, educational attainment, and health insurance attainment levels in Asian-Americans and a cardiometabolic risk profile that differs between American-born and foreign-born Asian-Americans. Further research should be undertaken to delineate trends in Asian-American subgroups and optimal cardiovascular preventive and treatment strategies in the Asian-American population.

## Disclosures

None of the authors had any conflicts of interest or financial disclosures to declare.

## Supplementary materials

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.amjcard.2019.04.026.


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