Disparities in adult asthma outcomes among disaggregated data among Asian Americans in the National Health Interview Survey

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Background: Asthma is a chronic lung disease affecting 8% of US adults, with significant disparities among racial and ethnic groups. The Asian American population is diverse, yet asthma research often aggregates data, potentially obscuring group-specific differences. Disaggregated data reveal that although Asian Americans overall appear to have lower asthma prevalence than non-Hispanic Whites, certain subgroups, like Filipino adults, have higher rates. Asthma outcomes are influenced by genetics, environmental exposures, and social determinants, although the specific impact of these factors remains unclear.

Objective: The objective was to better describe asthma outcomes among disaggregated Asian American groups.

Methods: We analyzed 2006-18 National Health Interview Survey data on asthma prevalence among non-Hispanic White and disaggregated Asian American adults. Logistic regression was used to calculate adjusted odds ratios (ORs) for Asian American asthma outcomes compared to non-Hispanic Whites, accounting for demographic, health, and socioeconomic factors.

Results: Asthma prevalence varied among adults: non-Hispanic White (n = 33,764), Chinese (n = 310, OR = 0.54), Filipino (n = 603, OR = 1.03), Asian Indian (n = 236, OR = 0.43), and other Asians (n = 601, OR = 0.61). Over half had poor asthma control: 62% non-Hispanic White, 53.5% Chinese (OR = 0.72), 50.2% Filipino (OR = 0.64), 54.8% Asian Indian (OR = 0.75), and 59.2% other Asian (OR = 0.82). Filipino adults showed higher asthma prevalence (OR = 1.37) but better control (OR = 0.74). Chinese (OR = 0.39) and Asian Indian (OR = 0.48) adults had fewer emergency department visits. Sociodemographic and health factors significantly affected symptoms, attacks, and emergency department visits.

Conclusion: Asthma prevalence and control varied widely among Asian American populations. Sociodemographic and health factors influenced poor asthma control more than racial group. (J Allergy Clin Immunol Global 2025;4:100458.)

Key words: Asthma prevalence, Asian American, National Health Interview Survey, health disparities, disaggregation, asthma outcomes

Asthma is a complex chronic lung disease characterized by reversible airway inflammation that affects 8% of US adults.[1] Asthma prevalence and mortality vary widely among racial and ethnic groups.[2-4] The Asian American population is a heterogeneous group from 6 major Asian countries and 20 smaller countries, with the 6 groups accounting for roughly 84% of the US population.[5,6] However, asthma research usually aggregates Asian American asthma outcomes, potentially masking significant group-level differences that would influence care, with only a few studies disaggregating Asian American asthma outcome data.[7-9] For instance, when aggregated, the Asian American population appears to have half the asthma prevalence of the non-Hispanic White population, yet when disaggregated, Filipino adults have almost double the asthma prevalence of Chinese adults (11% vs 6%).[1]

Among the Asian American population, it is not known whether race and ethnicity or environmental factors are significant drivers of asthma outcomes. Asthma outcomes are influenced by genetics, pre- and postnatal exposures, and socioeconomic, demographic, and health-related factors. Physical exposures from poor housing, birthplace, air pollution, and the psychosocial environment—a person's neighborhood, socioeconomic status, family relationships, and social networks —uniquely influence allergen and particulate exposure and affect asthma outcomes.[10-16] In addition, a 2022 National Health and Nutrition Examination Survey study found that of adults who were not born in the United States and had high odds of current asthma lived in the United States for 10 years or longer.[7,17] Although some Asian American groups have overall higher socioeconomic status, others have high levels of poverty, unemployment, and lack of insurance compared to the non-Hispanic White group.[18] The impact of these social health determinants on asthma prevalence or outcomes is not known.

We examined asthma prevalence and control among disaggregated Asian American adults using NHIS data from 2006 to 2018 compared to non-Hispanic White adults.

NHIS did not provide publicly available disaggregated data for Asian Americans beyond 2018.[19] Asthma control included current asthma symptoms, asthma exacerbations, and asthma-related emergency department (ED) visits. We then examined asthma prevalence and control outcomes related to demographics (age, sex, race, nativity, education, income, insurance) and health factors (smoking, diabetes, body mass index [BMI]).

METHODS

We analyzed National Health Interview Survey (NHIS) data from 2006 to 2018 to examine self-reported asthma prevalence and control among non-Hispanic White and disaggregated Asian American adults 18 years or older. NHIS is a nationwide US household survey that interviews 35,000 heads of household yearly about their health and health behaviors. NHIS did not provide publicly available disaggregated Asian data after 2018.[19]

We assessed asthma prevalence and outcomes among 5 NHIS-categorized racial and ethnic groups: non-Hispanic White, Chinese, Filipino, Asian Indian, and other Asians, which includes Japanese, Korean, Vietnamese, and unlisted subgroups. All participants self-reported their race and ethnicity. Mixed-race individuals were excluded from the study. Because of sample size constraints, disaggregated NHIS data for the other Asian group is not publicly available. Respondents (N = 273,587) were asked, "Have you ever been told by a doctor or other health professionals that you had asthma?" Participants with asthma (yes, n = 34,323) then described their asthma control: current asthma symptoms (yes, n = 21,603) ("Do you still have asthma?"), one or more asthma attacks/episodes within 12 months (yes, n = 10,569), and one or more ED or urgent care visits for asthma within 12 months (yes, n = 2,340). From 1997 to 2009, "ED asthma visits" were assessed only if participants shared that they both had asthma and prior asthma attacks. After 2009, "ED asthma visits" was asked independently. We excluded individuals with missing information on sex, age, education, and BMI.

We adjusted for demographic covariates, including age (18-25 years, 26-44 years, 45-64 years, 65 years and older), sex (female, male), and US-born status (vs non–US born). Socioeconomic covariates comprised educational attainment (less than high school, high school diploma/GED, some college, bachelor's degree or more), annual family income (less than $35,000, $35,000 to $74,999, and $75,000 or more), and health insurance (no insurance, Medicaid, Medicare, private insurance). We included health-related variables related to asthma, including diabetes (prediabetes or diabetes = yes), BMI, tobacco use (never smoked, former smoker, current smoker), and number of doctor visits per year (0, 1-3, or 4+, based on visit distribution). BMI categories were defined according

to World Health Organization guidelines for non-Hispanic White (<18.5 kg/m^2 underweight, 18.5-24.9 kg/m^2 healthy weight, 25-29.9 kg/m^2 overweight, ≥30 kg/m^2 obese) and Asia-Pacific guidelines for the Asian population (BMI is 1.5 kg/m^2 less than non-Hispanic White per category).

We examined the prevalence of asthma across different racial and ethnic groups. To ensure representativeness, we applied population sampling weights provided by NHIS, which accounted for nonresponse and complex clustered sampling designs. These weights accurately represented the total number of noninstitutionalized civilians in the United States annually. Weighted rates were calculated to generate nationally representative estimates.

We performed bivariate and multivariate logistic regression with asthma prevalence and control (current symptoms, asthma attacks, ED visits) as dependent variables. Akaike information criterion analysis explored the association in outcomes between race and other covariates, and goodness of fit. We conducted a stepwise multivariate analysis (see Table E1 in the Online Repository available at www.jaci-global.org), with unadjusted data (model 1), then adding sex and age as independent variables (model 2), then adding sociodemographic (US born, education, health insurance, family income [model 3]), and finally adding health variables (tobacco, diabetes, BMI and doctors' visits in the past year [model 4]). Specifically, we assessed how race and ethnicity related to asthma diagnosis and current asthma symptoms while considering these factors. All analyses were conducted in RStudio v4.2.0.

Statistically significant differences in this population-level study were determined using nonoverlapping confidence intervals. Because we used deidentified public data, this study was considered not human-subject research by the Stanford institutional review board (protocol 61782).

RESULTS
NHIS participant characteristics

Between 2006 and 2018, the NHIS survey collected 639,618 responses to the asthma questionnaire. The adjusted percentages of individuals diagnosed with asthma varied among racial groups (Table I): 8% for non-Hispanic White adults, 4% for Chinese adults, 6.6% for Filipino adults, 3.4% for Asian Indian adults, and 5% for other Asian adults. Female patients constituted the majority in all racial groups except for Asian Indian, where 46.1% of respondents were women. A significant proportion of Asian American demographics were foreign born, surpassing the non-Hispanic White group. Regardless of race, most patients had health insurance coverage, were nonsmokers, were current alcohol drinkers, and had a high prevalence of obesity, with Filipino adults having the highest rate at 57.1%.

Asthma outcomes varied among Asian adults previously diagnosed with asthma. Chinese and Filipino adults had lower proportions of current asthma (44% to 60%) compared to non-Hispanic White adults, while Asian Indian and other Asian adults had proportions ranging from 47.8% to 64.5%. Chinese adults (21.9%) had lower proportions of asthma attacks compared to other races (27.1% to 31.2%) and ED visits (2%) compared to other races (4.6% to 6.7%)

Factors associated with asthma-related outcomes

Table II presents the weighted prevalence and bivariate odds ratios (ORs) for asthma prevalence, control, and key covariates. Race, sex, age, marital status, and nativity influenced poor asthma

TABLE I. Weighted baseline demographic characteristics of 35,514 adults with history of asthma, NHIS, 2006-18

Characteristic	Non-Hispanic White	Chinese	Filipino	Asian Indian	Other Asian*
	No. (%) [95% confidence interval] for:				
No. of subjects	33,764	310	603	236	601
Sex					
Male	13,735 (40.2) [39.6-40.8]	153 (49.7) [49.1-50.3]	266 (42.4) [37.4-47.4]	137 (57.0) [49.6-64.4]	269 (45.0) [40.1-49.9]
Female	21,413 (59.7) [59.1-60.3]	169 (50.3) [49.7-50.9]	381 (57.6) [52.6-62.6]	111 (43.0) [35.6-50.4]	354 (55.0) [50.1-59.9]
Age					
18-25 years	4820 (14.9) [14.2-15.5]	77 (26.5) [20.2-32.8]	89 (15.8) [12.0-19.6]	59 (22.0) [15.9-28.1]	92 (24.0) [19.6-28.4]
26-44 years	11,161 (31.6) [30.9-32.3]	113 (39.0) [32.5-45.5]	246 (37.5) [33.3-41.7]	110 (45.0) [37.7-52.3]	210 (27.0) [22.7-31.3]
45-64 years	11,889 (33.4) [32.8-34.1]	68 (17.0) [12.2-21.8]	110 (30.0) [25.4-34.6]	51 (21.0) [16.4-25.6]	183 (34.0) [29.5-38.5]
65+ years	7,278 (20.0) [19.4-20.6]	64 (17.0) [12.5-21.5]	202 (16.0) [12.6-19.4]	28 (12.0) [7.2-16.8]	138 (15.0) [11.3-18.7]
US-born status					
US born	31,892 (92.3) [91.9-92.7]	158 (50.2) [44-56.3]	272 (43.0) [38.0-48.0]	57 (25.0) [18.8-31.2]	285 (44.0) [39.4-48.6]
Not US born	3,256 (7.7) [7.3-8.1]	164 (49.8) [43.6-56.0]	375 (57.0) [52.0-62.0]	191 (75.0) [68.8-81.2]	338 (56.0) [51.4-60.6]
Educational attainment					
No high school diploma	4,669 (12.0) [11.5-12.5]	21 (5.00) [2.4-7.6]	68 (9.00) [6.4-11.6]	17 (6.00) [2.8-9.2]	88 (13.0) [9.7-16.3]
High school diploma/GED	20,409 (58.2) [57.5-58.9]	115 (35.7) [33.1-38.3]	308 (46.6) [41.6-51.6]	71 (30.0) [23.3-36.7]	310 (49.0) [43.8-54.2]
Bachelor's degree or higher	10,070 (29.8) [29.0-30.5]	186 (58.9) [56.3-61.5]	271 (44.0) [39.2-48.8]	160 (64.0) [57.3-70.7]	225 (39.0) [34.3-43.7]
Health insurance					
No	4,850 (13.8) [13.3-14.3]	29 (9.00) [5.4-12.6]	67 (10.4) [7.1-13.7]	30 (12.0) [7.1-16.9]	81 (13.0) [9.6-16.4]
Medicaid	3,023 (8.6) [8.1-9.1]	13 (4.00) [1.5-6.5]	36 (5.5) [3.00-8.00]	13 (5.00) [2.3-7.7]	62 (10.0) [6.8-13.2]
Medicare	4,569 (13.0) [12.5-13.5]	31 (9.00) [5.6-12.4]	55 (8.5) [5.9-11.1]	12 (5.00) [1.2-8.8]	87 (14.0) [10.5-17.5]
Private insurance	22,706 (64.5) [63.7-65.3]	249 (79.0) [74.2-83.8]	489 (75.0) [70.6-79.4]	193 (79.0) [73.1-84.9]	398 (63.0) [56.4-69.8]
Tobacco usage					
Never smoked	18,527 (52.3) [51.6-53.0]	255 (79.7) [75.0-84.4]	430 (66.0) [61.6-70.4]	208 (84.0) [78.3-89.7]	410 (66.0) [61.5-70.5]
Former smoker	9,295 (26.5) [25.9-27.1]	44 (12.6) [8.6-16.6]	134 (21.0) [17.0-25.0]	21 (9.00) [4.7-13.3]	125 (20.0) [16.3-23.7]
Current smoker	7,326 (21.1) [20.5-21.7]	23 (7.00) [3.8-10.2]	83 (13.0) [10.1-15.9]	19 (7.00) [3.2-10.8]	88 (14.0) [10.4-17.6]
Diabetes					
No	30,776 (88.2) [87.8-88.6]	301 (95.0) [92.9-97.1]	568 (89.0) [86.3-91.7]	211 (90.0) [85.9-94.1]	545 (86.0) [82.7-89.3]
Yes	4,372 (11.8) [11.4-12.2]	21 (4.6) [2.5-6.7]	79 (11.0) [8.3-13.7]	27 (10.0) [5.9-14.1]	78 (14.0) [10.7-17.3]
BMI†					
Underweight	572 (1.70) [1.5-1.8]	14 (5.60) [2.4-8.8]	11 (1.00) [0.20-1.8]	8 (2.00) [0.10-3.9]	34 (5.00) [3.00-7.00]
Healthy weight	10,374 (30.5) [29.9-31.2]	118 (35.6) [29.1-42.1]	143 (23.0) [19.2-26.8]	67 (25.0) [18.7-31.3]	196 (31.0) [26.9-35.1]
Overweight	11,117 (31.7) [31.1-32.2]	74 (24.0) [18.5-29.5]	126 (19.5) [15.9-23.1]	52 (21.2) [15.3-27.1]	103 (17.0) [13.3-20.7]
Obese	13,085 (36.1) [35.5-36.7]	116 (34.7) [29.1-40.3]	367 (56.0) [51.8-60.2]	121 (52.0) [45.1-58.9]	290 (47.0) [42.4-51.6]
No. of doctor visits					
0	3,976 (11.1) [10.7-11.5]	50 (15.6) [11.3-19.9]	86 (14.6) [11.0-18.2]	39 (16.0) [10.8-21.2]	82 (14.0) [10.7-17.3]
1-3	12,485 (35.6) [35.0-36.2]	148 (46.6) [40.4-52.8]	313 (48.7) [44.0-53.4]	112 (44.0) [36.8-51.2]	253 (42.0) [37.2-46.8]
4+	18,687 (53.3) [52.7-53.9]	124 (37.8) [37.2-38.4]	248 (36.6) [36.1-37.1]	97 (39.8) [39.2-40.4]	288 (52.8) [52.2-53.4]
Current asthma symptoms					
Yes	21,727 (61.4) 60.7-62.0]	174 (53.0) 46.1-59.9]	331 (49.3) 44.4-54.2]	137 (55.5) 47.8-63.2]	357 (59.8) 55.3-64.5]
No	13,096 (37.6) 37.0-38.3]	145 (46.1) 39.3-52.9]	312 (50.2) 45.3-55.2]	110 (44.2) 36.5-51.9]	262 (39.5) 35.0-44.0]
≥1 Asthma attacks/ episodes in past 12 months					
Yes	10,829 (30.8) 30.2-31.4]	74 (21.9) 16.6-27.2]	178 (26.8) 22.5-31.0]	68 (30.0) 21.8-38.2]	166 (26.4) 22.1-30.7]
No	24,259 (69.0) 68.4-69.6]	248 (78.1) 72.8-83.4]	469 (73.2) 69.0-77.5]	180 (70.0) 61.8-78.2]	456 (73.3) 64.0-77.6]
Asthma ED visits in past 12 months					
Yes	2,404 (6.65) 6.33-6.96]	7 (2.00) 0.45-3.54]	42 (5.94) 3.87-8.02]	10 (4.56) 1.45-7.68]	41 (6.69) 4.34-9.04]
No	27,217 (75.1) 74.3-75.9]	256 (82.0) 77.4-86.6]	488 (75.6) 71.1-80.1]	203 (83.1) 77.2-89.1]	479 (76.3) 72.3-80.2]

*Included Korean, Japanese, Vietnamese, and other Asian subgroups.
†Asian subgroups accounted for Asian BMI according to World Health Organization guidelines.

outcomes. Within the Asian American subgroups, Chinese, Asian Indian, and other Asian adults had significantly lower odds of being diagnosed with asthma than non-Hispanic White adults. Chinese, Filipino, and Asian Indian adults demonstrated significantly lower odds of current asthma than non-Hispanic White adults. Chinese and Filipino adults had significantly lower odds of asthma attacks, while the Chinese subgroup had lower odds of ED visits due to asthma. Other Asian adults did not show significant differences in key covariates compared to non-Hispanic White adults for the 3 asthma outcome variables.

TABLE II. Bivariate analysis of patient characteristics in relationship to current asthma, asthma attacks/episodes, and asthma ED visits among adults with history of asthma, NHIS, 2006-18

	OR (95% confidence interval) for:			
Characteristic	Ever had asthma	Current asthma symptoms	≥1 Asthma attack/episode in past 12 months	Asthma ED visits in past 12 months
Race				
Non-Hispanic White	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Chinese	0.54 (0.48-0.60)	0.72 (0.58-0.90)	0.67 (0.51-0.86)	0.31 (0.13-0.61)
Filipino	1.03 (0.95-1.12)	0.64 (0.55-0.75)	0.85 (0.71-1.01)	0.97 (0.70-1.32)
Asian Indian	0.43 (0.38-0.49)	0.75 (0.58-0.97)	0.85 (0.64-1.11)	0.56 (0.28-1.00)
Other Asian*	0.61 (0.56-0.66)	0.82 (0.70-0.97)	0.82 (0.68-0.97)	0.97 (0.69-1.32)
Sex				
Male	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Female	1.39 (1.36-1.42)	1.90 (1.82-1.98)	1.84 (1.76-1.93)	1.92 (1.75-2.11)
Age group				
18-25 years	1.53 (1.47-1.59)	0.53 (0.49-0.57)	0.75 (0.69-0.81)	1.18 (1.09-1.28)
26-44 years	1.16 (1.12-1.19)	0.65 (0.61-0.69)	1.16 (1.09-1.24)	1.03 (0.97-1.11)
45-64 years	1.17 (1.13-1.21)	0.99 (0.93-1.05)	1.51 (1.42-1.600)	1.03 (0.96-1.10)
65+ years	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
US-born status				
US born	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Not US born	0.52 (0.51-0.54)	0.85 (0.80-0.91)	1.03 (0.96-1.11)	1.80 (1.61-2.00)
Educational attainment				
No high school diploma	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
High school diploma/GED	1.15 (1.11-1.19)	0.69 (0.64-0.74)	0.84 (0.78-0.89)	0.49 (0.44-0.54)
Bachelor's degree or higher	1.05 (1.0-1.09)	0.56 (0.52-0.60)	0.75 (0.70-0.81)	0.28 (0.24-0.32)
Health insurance				
No	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Medicare	2.11 (2.0-2.22)	1.98 (1.79-2.19)	1.55 (1.41-1.71)	1.79 (1.53-2.09)
Medicaid	1.19 (1.14-1.25)	1.60 (1.46-1.75)	1.00 (0.91-1.10)	1.0 (0.85-1.18)
Private	1.21 (1.17-1.26)	1.02 (0.95-1.09)	0.85 (0.79-0.92)	0.52 (0.45-0.59)
Tobacco usage				
Never smoked	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Former smoker	1.20 (1.17-1.24)	1.14 (1.08-1.20)	1.14 (1.08-1.20)	1.18 (1.08-1.31)
Current smoker	1.30 (1.27-1.34)	1.16 (1.1-1.23)	1.21 (1.14-1.28)	1.50 (1.35-1.66)
Diabetes				
No	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Yes	1.44 (1.39-1.49)	1.75 (1.63-1.88)	1.43 (1.34-1.52)	1.62 (1.46-1.80)
BMI†				
Underweight	1.06 (0.97-1.16)	1.31 (1.11-1.55)	1.17 (0.98-1.40)	1.83 (1.35-2.43)
Healthy weight	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Overweight	1.03 (1.0-1.06)	1.10 (1.04-1.16)	1.12 (1.05-1.18)	1.16 (1.03-1.30)
Obese	1.50 (1.46-1.54)	1.50 (1.43-1.58)	1.54 (1.46-1.63)	1.79 (1.61-1.98)
No. of doctor visits				
0	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
1-3	1.35 (1.30-1.40)	1.50 (1.40-1.61)	1.34 (1.23-1.45)	1.44 (1.19-1.75)
4+	2.61 (2.51-2.70)	2.54 (2.37-2.73)	2.52 (2.33-2.74)	3.26 (2.73-3.93)

Survey logistic regression analysis was used to determine associations between asthma outcomes and race and ethnicity. Total sample size for current asthma was 20,924; for ≥1 asthma attack/episode in past 12 months, 10,522; and for asthma ED visit in past 12 months, 2,345.
*Included Korean, Japanese, Vietnamese, and other Asian subgroups.
†Asian subgroups accounted for Asian BMI according to World Health Organization guidelines.

Being female increased the risk for all asthma outcomes: asthma prevalence (OR = 1.24-1.31), current asthma (1.14-2.02), asthma attacks (1.32-2.17), and asthma ED visits (1.01-1.57). Individuals aged 25 and above had an increased likelihood of all poor asthma outcomes. Being born in the United States increased the risk of current asthma symptoms while decreasing the likelihood of ED visits due to asthma. Among socioeconomic factors, higher levels of education, including completing high school (0.52-0.74) or higher education, provide protection against poor asthma control, resulting in asthma attacks (0.70-0.89) and

ED visits (0.24-0.54). Having Medicare insurance increased risks in the population with poor asthma control compared to having no health insurance, while Medicaid showed higher odds for current asthma symptoms but no difference in asthma attacks and ED visits. Private insurance offered protective odds in asthma attacks (0.79-0.82) and ED visits (0.45-0.59).

Former and current smokers have higher odds of asthma prevalence and poor control. Persons with diabetes also face higher odds of all poor asthma control. Both underweight and high-BMI individuals have higher odds of asthma

TABLE III. Multivariable logistic regression analysis of asthma-associated outcomes of disaggregated Asian and non-Hispanic White adults ≥18 years old, NHIS, 2006-18

Characteristic	Ever had asthma		Current asthma symptoms		≥1 Asthma attack/episode in past 12 months		Asthma ED visits in past 12 months	
	No.	aOR (95% CI)	No.	aOR (95% CI)	No.	aOR (95% CI)	No.	aOR (95% CI)
Race								
Non-Hispanic White	32,623	1.0 (Ref)	20,141	1.0 (Ref)	10,120	1.0 (Ref)	2,250	1.0 (Ref)
Chinese	301	0.90 (0.79-1.02)	161	1.04 (0.81-1.35)	67	0.80 (0.59-1.08)	7	0.39 (0.15-0.82)
Filipino	593	1.37 (1.24-1.52)	298	0.74 (0.62-0.90)	161	0.90 (0.72-1.11)	36	0.78 (0.50-1.16)
Asian Indian	233	0.69 (0.59-0.80)	128	1.16 (0.87-1.56)	66	1.08 (0.78-1.49)	10	0.48 (0.20-0.98)
Other Asian*	573	0.89 (0.80-0.98)	335	1.07 (0.88-1.30)	155	0.90 (0.72-1.10)	37	0.84 (0.56-1.22)
Sex								
Male	13,460	1.0 (Ref)	7,009	1.0 (Ref)	3,115	1.0 (Ref)	592	1.0 (Ref)
Female	20,863	1.27 (1.24-1.31)	14,054	1.68 (1.59-1.77)	7,454	1.66 (1.57-1.76)	1,748	1.64 (1.47-1.84)
Age								
18-25 years	4,830	1.0 (Ref)	2,489	1.0 (Ref)	1,062	1.0 (Ref)	247	1.0 (Ref)
26-44 years	11,121	0.70 (0.67-0.73)	6,287	1.17 (1.08-1.26)	3,404	1.45 (1.33-1.58)	704	1.09 (0.92-1.29)
45-64 years	11,515	0.59 (0.57-0.62)	7,699	1.54 (1.42-1.67)	4,209	1.61 (1.48-1.77)	920	1.12 (0.94-1.29)
65+ years	6,857	0.38 (0.35-0.41)	4,588	1.25 (1.08-1.44)	1,894	0.89 (0.77-1.04)	469	0.84 (0.65-1.10)
US-born status								
US born	30,286	1.0 (Ref)	18,716	1.0 (Ref)	9,317	1.0 (Ref)	1,918	1.0 (Ref)
Not US born	4,037	0.55 (0.53-0.58)	2,347	0.77 (0.70-0.83)	1,252	0.96 (0.87-1.05)	422	1.74 (1.50-2.02)
Educational attainment								
No high school diploma	4,526	1.0 (Ref)	3,169	1.0 (Ref)	1,583	1.0 (Ref)	566	1.0 (Ref)
High school diploma/GED	19,669	1.08 (1.03-1.12)	1,2150	0.78 (0.71-0.85)	6,113	0.92 (0.85-1.01)	1,360	0.62 (0.54-0.71)
Bachelor's degree or higher	10,128	1.16 (1.10-1.22)	5,744	0.70 (0.63-0.77)	2,873	0.87 (0.78-0.96)	414	0.42 (0.36-0.50)
Health insurance								
No	4,008	1.0 (Ref)	2,259	1.0 (Ref)	1,259	1.0 (Ref)	314	1.0 (Ref)
Medicaid	2,674	1.46 (1.38-1.54)	1,924	1.40 (1.25-1.56)	1,108	1.06 (0.95-1.19)	382	1.06 (0.89-1.26)
Medicare	3,589	1.27 (1.18-1.36)	2,442	1.19 (1.04-1.36)	1,144	0.97 (0.85-1.12)	314	0.87 (0.70-1.10)
Private insurance	17,132	0.95 (0.91-0.99)	9,697	0.89 (0.83-0.97)	4,793	0.72 (0.67-0.79)	749	0.53 (0.46-0.62)
Tobacco usage								
Never smoked	18,374	1.0 (Ref)	11,008	1.0 (Ref)	5,369	1.0 (Ref)	1,105	1.0 (Ref)
Former smoker	8,845	1.17 (1.14-1.21)	5,556	0.96 (0.90-1.03)	2,826	1.08 (1.01-1.15)	632	1.09 (0.96-1.24)
Current smoker	7,104	1.19 (1.15-1.23)	4,499	1.02 (0.95-1.09)	2,374	1.04 (0.97-1.12)	603	1.21 (1.06-1.37)
Diabetes								
No	30,066	1.0 (Ref)	17,992	1.0 (Ref)	8,961	1.0 (Ref)	1,903	1.0 (Ref)
Yes	4,257	1.20 (1.15-1.26)	3,071	1.18 (1.07-1.29)	1,608	1.01 (0.92-1.10)	437	0.91 (0.78-1.06)
BMI†								
Underweight	582	0.96 (0.86-1.06)	368	1.11 (0.90-1.36)	180	1.14 (0.92-1.41)	53	1.65 (1.15-2.31)
Healthy weight	10,115	1.0 (Ref)	5,753	1.0 (Ref)	2,677	1.0 (Ref)	504	1.0 (Ref)
Overweight	10,583	1.11 (1.07-1.14)	6,261	1.06 (1.00-1.13)	3,029	1.10 (1.02-1.18)	611	1.09 (0.94-1.26)
Obese	13,043	1.46 (1.41-1.51)	8,681	1.26 (1.18-1.34)	4,683	1.33 (1.24-1.42)	1,172	1.46 (1.28-1.66)
No. of doctor visits								
0	3,960	1.0 (Ref)	1,847	1.0 (Ref)	797	1.0 (Ref)	126	1.0 (Ref)
1-3	12,326	1.31 (1.25-1.36)	6,994	1.40 (1.29-1.52)	3,111	1.39 (1.26-1.53)	557	1.77 (1.43-2.21)
4-5	5,422	1.76 (1.67-1.85)	3,521	1.73 (1.57-1.91)	1,752	1.82 (1.63-2.04)	375	2.46 (1.94-3.12)
6+	12,615	2.22 (2.13-2.32)	8,701	1.84 (1.69-2.01)	4,909	2.25 (2.03-2.49)	1,282	3.45 (2.79-4.31)

Multivariable logistic regression analysis was used to calculate adjusted OR (aOR) of asthma-associated outcomes after controlling for covariates by race and ethnicity. *CI*, Confidence interval.

*Included Korean, Japanese, Vietnamese, and other Asian subgroups.

†Asian subgroups accounted for Asian BMI according to World Health Organization guidelines.

control. Underweight individuals have a higher risk than overweight individuals for current asthma and ED visits but not compared to obese individuals, while there is no heightened risk for underweight individuals and asthma attacks.

Factors associated with asthma

Table III presents adjusted ORs between asthma outcomes and covariates. After accounting for other factors, Filipino adults had lower odds of current asthma symptoms than non-Hispanic White adults. Chinese and Asian Indian adults had lower ED visit odds

than non-Hispanic White adults. Women remained vulnerable to poor asthma outcomes even after adjusting for other factors. Age also played a significant role, with the youngest age group (18-25 years) having better protection against current asthma symptoms. The oldest group (65+ years) had fewer poor asthma outcomes than the 45-64 age group and had better outcomes than the 26-44 age group in asthma attacks and ED visits. Compared to native populations, nonnative populations had lower odds of current asthma but an increase in ED visits. Educational attainment and health insurance continued to be significant factors in asthma outcomes. Completing high school or pursuing higher education

provided better protection against all poor asthma outcomes. Private health insurance was associated with lower rates of all asthma outcomes, while Medicaid and Medicare patients had higher rates of current asthma than individuals without insurance.

Health outcome variables remained significant in our multivariate regression analysis. Current smokers had increased odds of ED visits, while former smokers had higher odds of asthma attacks. Diabetic patients remained vulnerable, with significantly higher odds of current asthma, asthma attacks, and ED visits. Overweight and obese individuals also had high and significant odds in all 3 outcomes. However, in contrast to the bivariate analysis, underweight individuals no longer faced significantly elevated odds of current asthma and asthma attacks but remained at risk for ED visits.

DISCUSSION

Using NHIS data from 2006 to 2018, we found that Asian American adults were 30% to 40% less likely to report having asthma than non-Hispanic White adults. Among Asian subgroups, Filipino adults had the highest asthma prevalence but better asthma control, while Chinese and Asian Indian adults had lower odds of ED asthma visits than non-Hispanic White adults.

Women and older adults had higher odds of current asthma symptoms, asthma attacks, and ED visits, with the poorest asthma control among those aged 45-64. Nativity is a significant factor related to asthma, with foreign-born individuals being less likely to be diagnosed with asthma and experiencing better asthma control but having higher odds of ED visits. Higher educational attainment was associated with a higher likelihood of asthma diagnosis, but within each asthma category, there was a lower likelihood of symptoms, attacks, and ED visits, indicating better control. Health insurance, such as Medicare and Medicaid, was associated with a higher likelihood of asthma diagnosis and poorer asthma control, especially among those with Medicaid. People with diabetes, smokers, and individuals with higher BMI had increased odds of worse asthma outcomes across all groups. Doctor visits were associated with an increased likelihood of asthma diagnosis, symptoms, asthma attacks, and ED visits in the past 12 months.

Racial/ethnic trends among asthma outcomes

Heterogeneous patterns found in the Asian American subgroups are consistent with previous studies on asthma prevalence; different ethnic groups have other presentations of asthma and asthma severity.[2] Aggregate Asian American adult asthma rates are known to be lower than non-Hispanic White adults, and our study shows that most Asian American subgroups have lower asthma rates than non-Hispanic White adults. We found that Filipino adults have the highest rates of diagnosis compared to all other Asian American groups, perhaps as a result of higher genetic and lifestyle risks among Filipino populations.[1,8] People in China and India report much higher asthma rates than what we found in our study, especially for non–US-born people.[20,21] Whether these lower reporting rates in the United States are due to underreporting, lack of awareness, or truly lower rates by Asian subgroups remains unknown.[20-23] Heterogeneous patterns within the Asian American population have been demonstrated to be associated with genetic and lifestyle factors, including health behaviors and beliefs.[22]

Health behaviors and beliefs also influence asthma control.[22,24] The underlying reasons for heterogeneity in asthma prevalence and control that we found between Asian American subgroups are largely unstudied but may be due to differences in beliefs, attitudes, health care–seeking behaviors, and experiences among ethnic groups, which may influence willingness to adhere to asthma management and use preventive medications.[18,22]

Age, sex, and asthma

Women experience a higher prevalence and severity of asthma and an increased likelihood of associated outcomes such as exacerbations and hospitalizations.[10,25] This association between sex and asthma is particularly evident in older women, who face a greater burden of asthma throughout their lifetime.[10,25] Our study reinforces these findings by showing similar patterns in the 4 asthma outcomes, indicating that older age, specifically between 45 and 64 years, and sex are strong predictors of asthma diagnosis and poorer control (including increased asthma symptoms, exacerbations, and ED visits). The age at which asthma develops also plays a role in the risk and control of the disease, with older age at onset, especially among obese Asian women without a family history of asthma, leading to a worse prognosis and increased likelihood of airflow limitations.[10] This suggests that older individuals may have overall worse asthma control compared to younger individuals. Worsening asthma outcomes in women compared to men, and correlations between increasing age and asthma severity align with previous research, underscoring the complexity of asthma and the influence of health-related factors on the disease.[7,10,12,22]

Nativity

Asthma rates between US-born individuals and their counterparts indicated in previous literature support our findings. Foreign-born individuals in our study showed a decreased likelihood of asthma diagnosis and better control. Because of various factors, immigrants have a better life expectancy and health outcomes than those born in the United States.[26]

Additionally, socioeconomic status also affects the differences observed between US-born and foreign-born individuals, with less insurance coverage and high unemployment rates contributing to the higher likelihood of underreporting of health outcomes among foreign-born individuals.[23] Also, there may be variations in acculturation among different Asian American groups.[27] Language barriers and routine doctors' visits also affected health outcomes between US-born individuals and their counterparts.[28] The results presented can be interpreted as acculturation factors affecting asthma outcomes. As a population undergoes acculturation, their health outcomes often change, with US-born individuals being more acculturated than foreign-born individuals. However, acculturation factors alone do not account for the differences between the two groups. Many foreign-born individuals have also been noted not to seek out outpatient medical treatment or report milder symptoms, and instead visit the ED for adverse asthma outcomes.[3,22] Similarly, we observed a higher likelihood of immigrants visiting the ED for asthma. Differences in asthma burdens have been demonstrated to be strongly associated with nativity status but cannot only be laid at the feet of acculturation factors. As such, we cannot determine whether lower self-reported asthma rates are due to underreporting and/or underdiagnosis among non–US-born Asians. There is a strong suggestion that asthma is underdiagnosed within the immigrant population, so it remains crucial to study the macro- and micro-level factors to further clarify the complex nature of asthma.

Socioeconomic disparities

Educational attainment and health insurance. The Asian American population possesses heterogeneity within a socioeconomic background, and health care access and educational attainment are fundamental contributors to the asthma burden among vulnerable populations.[2] Lower educational attainment contributes to the asthma burden by perpetuating socioeconomic disparities and increasing the likelihood of asthma prevalence and symptoms.[2] It has also been linked to decreased health literacy that may contribute to poor asthma understanding, control, and reduced likelihood of treatment by a health professional, as well as increased dependence on asthma medications and ED visits or hospitalizations.[22] Our findings were also consistent with educational attainment associated with a higher likelihood of diagnosis and control. Increased asthma prevalence, exacerbation, and ED visits or hospitalizations due to asthma have all been previously linked to lower income and educational attainment, suggesting that families with higher net worth and education have better access to asthma care.[7,22] Specifically, barriers introduced by health insurance can also influence access to asthma care and control.[28]

Existing literature demonstrates insurance to have limited patients with fewer specialist referrals and decreased access to preventative asthma treatment.[29] Specifically, patients with certain insurance plans, such as Medicaid, face restrictions, including the introduction of copayments or restricted access to preventative medications that perpetuate unequal access to asthma care. Our study found a higher likelihood of asthma diagnosis among those with health insurance such as Medicare and Medicaid and poorer asthma control, suggesting families with health insurance visit specialists but may still be restricted in asthma prevention and management.[29] The trends observed in our study suggest socioeconomic factors contribute to the existing asthma disparities and further perpetuate health burdens. Therefore, exploring these socioeconomic inequities within disaggregated Asian American subgroups should be studied to uncover barriers that may affect access to competent care and allow asthma burdens to persist within vulnerable populations.[2]

Behavioral health-related factors

Smoking. In addition to socioeconomic status, health-related factors such as smoking, diabetes, and BMI are known predictors of asthma.[30] Former and current smokers in our study demonstrate increased odds of diagnosis, while former and current smokers had increased odds for asthma attacks and ED visits, respectively. Combined with existing evidence, our study strengthens the link between asthma and smoking and strongly suggests that smoking is associated with asthma diagnosis, exacerbation, and control.[7,30]

Diabetes. Type 2 diabetes is strongly associated with an increased prevalence of asthma, even after adjusting for key covariates such as hyperlipidemia, smoking, age, and BMI.[31-33] Our results demonstrate a similarly expected trend; individuals with diabetes are more likely to be diagnosed with asthma and struggle to control their disease. Both diabetes types also signify a T_H1/T_H2 paradigm to consider when looking at patient vulnerabilities.[31-33]

BMI. There is a strong relationship between obesity and asthma within Asian American subgroups. Existing literature found Filipino, Chinese, and South Asian subgroups to report a strong association between the lifetime prevalence of asthma and BMI.[22,34] In our study, Filipino adults had the highest rates of obesity and were more likely to be diagnosed with asthma than any other racial/ethnic group. Additionally, our analysis found obese individuals are more likely to be diagnosed with asthma, have poor control, and visit the ED for asthma. This trend is consistent with the existing relationship between asthma prevalence and BMI, suggesting links to genetic, dietary, and lifestyle factors.[12,22,34-36] Asian BMI addresses the genetic variation between different ethnic groups; Asian patients typically have a higher body fat percentage at a lower BMI than non-Hispanic White patients.[34] The differences in asthma prevalence, diagnosis, and control observed in Filipino adults provide substantial evidence of the Asian American population as a heterogeneous group with vastly different lifestyles. Further investigating demographic, socioeconomic, and health-related factors may reveal the specific inequalities and reveal consequent health burdens of vulnerable populations.

Limitations

This study has several limitations. NHIS conducts interviews only in English and Spanish, limiting the information collected on asthma to those only able to speak one of these two languages, potentially excluding additional Asian American respondents, especially among non–English-speaking immigrants, older respondents, or respondents with low English-language proficiency.[19,28] NHIS stopped providing publicly available disaggregated Asian race data in 2018, limiting the ability to access more recent disaggregated Asian American health data because the restricted data center applications take 1 or 2 years for approval and can only be accessed through a complicated process.[9,19] While some studies indicate that Asian patients are less likely to receive medical care for asthma, asthma knowledge, care-seeking behaviors, and expectations for asthma control among Asian subgroups are not well described.[2] NHIS did not explore respondent's asthma knowledge or asthma self-care behaviors, thus limiting our understanding of the relative rates among Asian American subgroups for poor asthma control. Asthma prevalence and control among the Asian American adults in our study may be underestimated because those with few symptoms or limitations might not be aware of their asthma or may consider their less symptomatic asthma to be cured.[2] Furthermore, data published on Asian subgroups are not well reported in the existing literature.[9,19] Despite these limitations, as well as smaller sample sizes for Asian American asthma outcomes, the NHIS data represent the best available national sample of US adults for population studies.[19,37-39] As a disease primarily managed in the outpatient setting, it is essential to understand asthma's burden fully and to empower providers to provide holistic, competent, and quality care.

Conclusion

Asthma prevalence varies among disaggregated Asian populations, with specific asthma prevalence and control outcomes differing from non-Hispanic White adults. However, the reasons for these differences are not well characterized and necessitate additional, culturally tailored studies among Asian subgroups. The significant difference between the higher asthma rates in Asia and lower asthma rates among non–US-born Asian American

adults suggests that better outreach may be necessary to determine whether Asian adults in America have undiagnosed asthma. Because sociodemographic and economic factors substantially influence asthma outcomes in addition to race, more global interventions to improve asthma control may benefit Asian populations as well.

DISCLOSURE STATEMENT

Disclosure of potential conflict of interest: The authors declare that they have no relevant conflicts of interest.

Key messages

- Unique challenges are faced by specific Asian subgroups, warranting interventions to reduce asthma-related disparities.
- Tailored strategies can improve asthma management, access to care, and health outcomes, advancing health equity for Asian Americans.

REFERENCES

1. Barnes PM, Adams PF, Powell-Griner E. Health characteristics of the Asian adult population: United States, 2004-2006. Adv Data 2008;(394):1-22.
2. Gorman BK, Chu M. Racial and ethnic differences in adult asthma prevalence, problems, and medical care. Ethn Health 2009;14:527-52.
3. Law H, Oraka E, Mannino DM. The role of income in reducing racial and ethnic disparities in emergency room and urgent care center visits for asthma—United States, 2001-2009. J Asthma 2011;48:405-13.
4. Claudio L, Stingone JA, Godbold J. Prevalence of childhood asthma in urban communities: the impact of ethnicity and income. Ann Epidemiol 2006;16:332-40.
5. Satish P, Sadaf MI, Valero-Elizondo J, Grandhi GR, Yahya T, Zawahir H, et al. Heterogeneity in cardio-metabolic risk factors and atherosclerotic cardiovascular disease among Asian groups in the United States. Am J Prev Cardiol 2021;7:100219.
6. Dinh Q, McDavid J, Mariategue KD. Southeast Asian Americans in 2020: 45 years of resilience and resistance. Asian American Policy Review 2021;31:2-10, 90.
7. Grant T, Croce E, Matsui EC. Asthma and the social determinants of health. Ann Allergy Asthma Immunol 2022;128:5-11.
8. Becerra BJ, Scroggins CM, Becerra MB. Association between asthma and obesity among immigrant Asian Americans, California Health Interview Survey, 2001-2011. Prev Chronic Dis 2014;11:E209.
9. Jamal A, Srinivasan M, Kim G, Huang RJ, Palaniappan L. Why are we going backward? Barriers to disaggregated racial information in federal data sets. Am J Public Health 2023;113:852-5.
10. Chowdhury NU, Guntur VP, Newcomb DC, Wechsler ME. Sex and gender in asthma. Eur Respir Rev 2021;30:210067.
11. Sullivan K, Thakur N. Structural and social determinants of health in asthma in developed economies: a scoping review of literature published between 2014 and 2019. Curr Allergy Asthma Rep 2020;20:5-6.
12. Koebnick C, Fischer H, Daley MF, Ferrara A, Horberg MA, Waitzfelder B, et al. Interacting effects of obesity, race, ethnicity and sex on the incidence and control of adult-onset asthma. Allergy Asthma Clin Immunol 2016;12:50-8.
13. Gold DR, Wright R. Population disparities in asthma. Annu Rev Public Health 2005;26:89-113.
14. Gilmour MI, Jaakkola MS, London SJ, Nel AE, Rogers CA. How exposure to environmental tobacco smoke, outdoor air pollutants, and increased pollen burdens influences the incidence of asthma. Environ Health Perspect 2006;114:627-33.
15. Flores G, Snowden-Bridon C, Torres S, Perez R, Walter T, Brotanek J, et al. Urban minority children with asthma: substantial morbidity, compromised quality and access to specialists, and the importance of poverty and specialty care. J Asthma 2009;46:392-8.
16. Louisias M, Ramadan A, Naja AS, Phipatanakul W. The effects of the environment on asthma disease activity. Immunol Allergy Clin North Am 2019;39:163-75.
17. Han Y, Forno E, Celedón JC. Acculturation and asthma in Asian American adults. J Allergy Clin Immunol Pract 2022;10:2752-3.e1.
18. John DA, de Castro AB, Duran B, Martin DP. Nativity and occupational class disparities in uninsurance and routine preventive care use among Asian Americans. J Immigr Minor Health 2013;15:1011-22.
19. National Health Interview Survey (NHIS). About the National Health Interview Survey. March 3, 2022. Available at: https://www.cdc.gov/nchs/nhis/about_nhis.htm. Accessed December 19, 2024.
20. Kumar P, Ram U. Patterns, factors associated and morbidity burden of asthma in India. PLoS One 2017;12:e0185938.
21. Huang K, Yang T, Xu J, Yang L, Zhao J, Zhang X, et al. Prevalence, risk factors, and management of asthma in China: a national cross-sectional study. Lancet 2019;394(10196):407-18.
22. Davidson E, Liu JJ, Sheikh A. The impact of ethnicity on asthma care. Prim Care Respir J 2010;19:202-8.
23. Erosheva E, Walton EC, Takeuchi DT. Self-rated health among foreign- and US-born Asian Americans: a test of comparability. Med Care 2007;45:80-7.
24. Sadler GR, Ryujin L, Nguyen T, Oh G, Paik G, Kustin B. Heterogeneity within the Asian American community. Int J Equity Health 2003;2:12.
25. Tran HN, Siu S, Iribarren C, Udaltsova N, Klatsky AL. Ethnicity and risk of hospitalization for asthma and chronic obstructive pulmonary disease. Ann Epidemiol 2011;21:615-22.
26. Singh GK, Miller BA. Health, life expectancy, and mortality patterns among immigrant populations in the United States. Can J Public Health 2004;95:14.
27. Choi Y, Park M, Lee JP, Yasui M, Kim TY. Explicating acculturation strategies among Asian American youth: subtypes and correlates across Filipino and Korean Americans. J Youth Adolesc 2018;47:2181-205.
28. Chang E, Chan KS, Han H. Effect of acculturation on variations in having a usual source of care among Asian Americans and non-Hispanic whites in California. Am J Public Health 2015;105:398-407.
29. Canino G, McQuaid EL, Rand CS. Addressing asthma health disparities: a multilevel challenge. J Allergy Clin Immunol 2009;123:1209, 9.
30. Polosa R, Thomson NC. Smoking and asthma: dangerous liaisons. Eur Respir J 2013;41:716-26.
31. Hashemzadeh M, Movahed MR. The occurrence of asthma in hospitalized patients with type 2 diabetes mellitus. Intern Med J 2009;39:699-701.
32. Song Y, Klevak A, Manson JE, Buring JE, Liu S. Asthma, chronic obstructive pulmonary disease, and type 2 diabetes in the Women's Health Study. Diabetes Res Clin Pract 2010;90:365-71.
33. Thomsen SF, Duffy DL, Kyvik KO, Skytthe A, Backer V. Risk of asthma in adult twins with type 2 diabetes and increased body mass index. Allergy 2011;66:562-8.
34. Deurenberg P, Deurenberg-Yap M, Guricci S. Asians are different from Caucasians and from each other in their body mass index/body fat per cent relationship. Obes Rev 2002;3:141-6.
35. Beuther DA, Sutherland ER. Overweight, obesity, and incident asthma: a meta-analysis of prospective epidemiologic studies. Am J Respir Crit Care Med 2007;175:661-6.
36. Peters U, Dixon AE, Forno E. Obesity and asthma. J Allergy Clin Immunol 2018;141:1169-79.
37. Sun J, Frick KD, Liang H, Chow CM, Aronowitz S, Shi L. Examining cancer screening disparities by race/ethnicity and insurance groups: a comparison of 2008 and 2018 National Health Interview Survey (NHIS) data in the United States. PLoS One 2024;19:e0290105.
38. Zhao Y, Zheng-Lin Binbin, Wang B, Xi-Chun Hu, Jiang C. Insurance disparity in the United States cancer survivors' smoking rates: a trend study from NHIS, 2008-2017. J Clin Oncol 2019;37, abstract 1553.
39. Fleischer NL, Henderson AK, Wu Y, Liese AD, McLain AC. Disparities in diabetes by education and race/ethnicity in the US, 1973-2012. Am J Prev Med 2016;51:947-57.