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Assessing Racial and Gender Disparities in Asthma Education, Knowledge, and Healthcare Access Among Adolescents

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Video Abstract

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Purpose: Asthma is the most common chronic disease among adolescents, yet disparities exist in its diagnosis and management across racial and gender groups. This study aims to assess asthma knowledge, awareness, and healthcare access among adolescents, with a focus on racial and gender disparities. The goal is to identify gaps in asthma education and knowledge, as well as other barriers that may contribute to the underdiagnosis of asthma within these groups.
Patients and Methods: This cross-sectional survey included adolescents aged 10–18 years, with responses collected through Qualtrics. A total of 90 participants were selected, with no restrictions based on asthma status. Written informed consent was obtained from parents of participants under 18, while participants who were 18 years old provided their own written consent in accordance with IRB guidelines. Participants' knowledge of asthma symptoms, triggers, and healthcare access was assessed using multiple-choice and Likert scale questions. Data were analyzed for demographic differences in asthma knowledge and healthcare access across racial and gender groups.
Results: The study found that asthma education was minimal, with only 8% of participants reporting prior formal asthma education. Despite this, 53.4% of participants considered themselves knowledgeable about asthma, 59.5% could identify three or more asthma symptoms, and 50.6% identified more than three triggers. Racial disparities were evident, with Asian adolescents having a significantly lower asthma diagnosis rate compared to other racial groups (6.5% vs 47.4%, P<0.01), a lower rate of self-reported asthma knowledge (45.1% vs 64.9%, P=0.08), and lower odds of finding healthcare access "extremely easy" (OR=0.179, 95% CI: 0.076–0.455, P=0.00018). Although there was no difference in the rate of previous asthma diagnoses, males were more likely to seek medical help compared to females (OR=2.55, 95% CI: 1.037–6.268, P=0.032).
Conclusion: This study highlights significant gaps in asthma education, perception of healthcare access, and healthcare seeking behaviour particularly among Asian adolescents and females, and underscores the need for targeted interventions to address racial and gender disparities in asthma diagnosis and care.

Keywords: childhood asthma, chronic respiratory disease, allergens, triggers

Introduction

Asthma poses a significant health challenge for pediatric populations in the United States, affecting approximately 4.6 million adolescents[1] and is a leading cause of extensive school absenteeism and frequent visits to emergency departments and hospitalizations.[2] Allergic asthma, the most common asthma among children, often persists into adulthood and frequently accompanied by comorbidities such as mental health disorders, anxiety, obesity, and allergic conditions like allergic rhinitis, complicating disease management.[3,4] Research shows that effective asthma education programs for adolescents diagnosed with the disease can lead to a decrease in disease severity, hospitalizations, emergency room (ER) visits and associated healthcare costs.[5–8]

Despite advances in treatment and management, asthma outcomes in the US remain marked by racial, gender, and socioeconomic disparities. African Americans and Latinos from low socioeconomic backgrounds, bear

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a disproportionately higher disease burden compared to non-Latino Whites.[1,8,9] While national data report a lower prevalence of asthma among Asian and Pacific Islander population,[1,8] these groups paradoxically experience greater disease severity and higher asthma-related mortality.[10,11] Some regional studies in the United States and the United Kingdom have identified high asthma prevalence and unmet care needs in Asian populations, while national surveys in the US continue to report low prevalence.[12–15] This inconsistency highlights a significant data gap and limits our ability to develop culturally appropriate policies for diagnosis and management of the disease. Both the US Department of Health and Human Services Office of Minority Health and the United States Environmental Protection Agency acknowledge the limited data and variability in asthma prevalence reported in various surveys involving Asian adolescents in the U.S.[16,17] Understanding regional and cultural contributors to underdiagnosis is essential for addressing these disparities.

In New York City, underdiagnosis rates are especially high among Asian adolescents and females,[13,18] who also report the lowest asthma prevalence[1,8] suggesting a gap between actual disease and clinical recognition. Several factors may contribute to this underdiagnosis, including limited asthma knowledge, delayed care, healthcare access barriers, as well as provider bias.[8,18,19] Cultural and ethnic influences may also prevent parents and adolescents from recognizing or reporting symptoms and its management.[20,21] Although these factors have been noted, the literature examining these factors specifically among Asian adolescents remains particularly sparse. However, the relative impact of each of these factors remains unclear. While prior research among Latino and African American adolescents has identified limited symptom knowledge as a key barrier to diagnosis,[18] little is known about whether similar dynamics occur in Asian population.

This pilot study aims to investigate asthma knowledge, education, symptom recognition, healthcare-seeking behaviors, and barriers to care among Asian adolescents in the U.S. The goal is to identify gaps in asthma education and knowledge, as well as other barriers that may contribute to the underdiagnosis of asthma within these groups. We surveyed adolescents aged 10–18 years to investigate asthma education and related factors, comparing these findings to those from other racial groups with higher asthma diagnosis rates. The study focused on evaluating participants' prior asthma education, self-perceived knowledge of asthma, ability to recognize symptoms and triggers, health care seeking behaviors, and potential barriers such as insurance coverage, medical costs, and access to medication. Our analysis also assessed whether there are racial and gender differences in these contributing factors, and whether these differences may help explain disparities in asthma diagnosis. By identifying patterns across racial and gender groups, this study seeks to clarify contributors to asthma underdiagnosis and inform the development of targeted, culturally sensitive interventions to improve asthma outcomes in adolescents.

Methods

Study Design and Participants Selection

This cross-sectional survey study aimed to evaluate asthma education, knowledge, awareness, healthcare access, and care seeking behaviour among adolescents aged 10–18 years. Survey response was collected using Qualtrics, an online survey platform, and participants were reached through community organizations, personal connection, and online forums. Participants were recruited between June and November 2024.

The survey was distributed via Qualtrics using multiple dissemination strategies: printed flyers with Qualtrics QR codes at various community events and children's programs, direct emails and text messages with Qualtrics link shared through personal networks and community leaders. These approaches were designed to include a diverse sample of adolescents from a range of socioeconomic and racial backgrounds. Written informed consent was obtained for all participants, in accordance with Institutional Review Board (IRB) guidelines. Parental consents were obtained for individuals who were below 18 years old, while participants who were 18 years old provided their own written consent.

Inclusion criteria required participants to be adolescents aged 10–18 years who could read and understand English. Importantly, participants were included in the study regardless of their asthma status to ensure a comprehensive understanding of asthma knowledge and awareness across the general adolescent population. Participants were excluded if they failed to provide self/parental consent, did not meet the inclusion criteria, or completed less than 40% of the questionnaire.

Prior to full distribution, the survey instrument was pilot tested with 10 adolescents to ensure clarity, comprehension, and ease of completion. The final version of the survey took approximately 5–10 minutes to complete.

Measures

The structured survey included questions across four main domains: demographics, health and asthma history, asthma education, and asthma knowledge. Survey items for demographic portion were adapted from existing validated tools, while items assessing asthma knowledge and awareness developed by the research team to ensure contextual relevance for the target adolescent population. The survey was pilot tested with 10 adolescents to evaluate item comprehension and ease of completion. Minor modifications were made based on their feedback. Post hoc reliability analysis was conducted using data from the final sample of 90 participants to assess internal consistency of the survey items intended to measure asthma knowledge, perceived healthcare access, and healthcare-seeking behavior.

Demographic variables included age (open-ended, 10–18 years), gender, and race/ethnicity. Gender categories included male, female, non-binary, other, and prefer not to say, following best practices for inclusive demographic data collection as recommended by survey design guidelines for diverse populations.[22] Race/ethnicity was assessed using categories based on the US Office of Management and Budget (OMB) 1997 standards: White/Caucasian, Black/African American, Hispanic/Latino, Asian, Native American/Alaska Native/Pacific Islander, and Other.[23]

Socioeconomic status was measured by self-reported annual household income, with options ranging from less than $20,000 to more than $100,000, including an option for "prefer not to disclose." Parental education level was reported using categories from less than high school to doctoral or professional degree, with an additional "prefer not to say" category.

Health and asthma history variables included self-reported asthma diagnosis (yes, no, prefer not to answer), family history of asthma (yes, no, prefer not to answer), and current health insurance coverage. Insurance coverage was assessed with multiple response options reflecting different sources of coverage: through a parent or guardian's job, through a government program, privately purchased by the family, do not have an insurance or do not prefer disclosing. Participants also reported their perceived ease of healthcare access on a 5-point Likert scale ranging from "Extremely easy" to "Extremely difficult."

Asthma education was evaluated through two items: whether participants had received prior formal asthma education (yes, no, not sure), and whether they were interested in learning more about asthma (yes, no, maybe).

Asthma knowledge was assessed using both perceived and factual measures. Perceived knowledge was measured by asking participants how knowledgeable they felt about asthma, using a 4-point scale: very knowledgeable, somewhat knowledgeable, not very knowledgeable, and do not know anything about asthma. Factual knowledge was assessed through a combination of yes/no and open-ended questions related to asthma symptoms, causes, and appropriate responses to an asthma episode, ability to identify asthma symptoms and asthma triggers.

Participants were also asked about perceived barriers to asthma diagnosis and care, including options such as cost or lack of insurance, fear or embarrassment, difficulty accessing healthcare, and lack of awareness of asthma. The full survey instrument is provided in Appendix A.

Sample Size

A total of 120 adolescents initially completed the survey. After applying exclusion criteria—age above 18, lack of written consent/parental consent, or less than 40% survey completion—90 participants were included in the final analysis. A power analysis was not conducted prior to data collection as this study was exploratory in nature, and the sample size was based on available recruitment capacity. The study utilized a convenience sample of adolescents meeting inclusion criteria; while sufficient for exploratory analysis, future research with larger, representative samples is warranted.

Data Analysis and Statistical Methods

Statistical analysis was performed using the Jamovi desktop software, available at http://www.jamovi.org.[24] Means and medians were calculated for continuous variables, while categorical variables were presented as percentages. Normality was tested for continuous variables using the Shapiro–Wilk test. Fisher's exact test was used to compare categorical

variables, while the *t*-test was used to compare continuous variables with a normal distribution. Relationships between two or more variables were assessed using regression analysis.

Ethical Considerations

This study was conducted in accordance with the principles of the Declaration of Helsinki. The study was approved by the Institutional Review Board (IRB) at Hofstra University (HUIRB Approval Ref#: 20240524-BIO-HCL-PAN-1). Parental consent was obtained for participants under 18 years of age, written consent was obtained from participants who were 18 years old and all participants were provided informed assent before completing the survey. Participants were assured of the confidentiality and anonymity of their responses, and they had the option to withdraw from the study at any time.

Results

Asthma Education and Knowledge Gaps

The study included 90 participants with a median age of 13.5 (16.0–11.3) years. The sample comprised 46.7% males, 52.2% 47 females, and 1.1% participant who declined to specify their gender. Racially, 57.8% participants identified as Asian, while the remaining 42.2% belonged to other racial groups, including White (23.3%), Black/African American (7.8%), Hispanic/Latino (10%), and Other (1.1%) (Table 1). English was the primary language for 62.2% of participants. Most attended public schools (84.3%), with smaller proportions enrolled in private (9.0%) or charter schools (6.7%) (Table 1).

Table 1 Participant Demographics, Asthma Knowledge, and Healthcare Access Among Adolescents

Categories	Frequency
Age	
Median age	13.5 (16.0–11.3) years
Gender	
Male	42/90 (46.7%)
Female	47/90 (52.2%)
Race	
Asian	52/90 (57.8%)
Other races*	38/90 (42.2%)
*White/ Caucasian	21/38 (23.3%)
*Black/African American	7/38 (7.8%)
*Hispanics/Latino	9/38 (10%)
*Other	1/38 (1.1%)
Primary language	
English	56/90 (62.2%)
Other languages	34/90 (37.8%)
Annual Household Income	
Less than 60k	27/90 (30%)
60–100 K	11/90 (12.2%)
More than 100K	19/90 (21.1%)
Prefer not to disclose	33/90 (36.7%)
School Type	
Public school	75/90 (84.3%)
Charter school	6/90 (6.7%)
Private school	8/90 (9.0%)
Previous asthma diagnosis	21/89 (23.6%)
Family or friends with asthma	50/88 (56.8%)

(*Continued*)

Table 1 (Continued).

Categories	Frequency
Formal Asthma Education	
Yes	7/87 (8%)
No	68/87 (78.2%)
Not sure	12/87 (13.8%)
Rate your knowledge about asthma	
Knowledgeable (Answer very knowledgeable and somewhat knowledgeable)	47/88 (53.4%)
Asthma-Knowledge Assessment	
Identify asthma is chronic respiratory condition	82/84 (97.6%)
Know asthma is triggered by allergen	50/81 (61.7%)
Good knowledge of Symptoms	
Can identify 3 or more symptoms	50/84 (59.5%)
Symptoms identified	
Cough	68/84 (80.9%)
Shortness of breath	83/84 (98.8%)
Chest tightness	70/84 (83.3%)
Sneezing	13/84 (15.4%)
Good Knowledge of asthma triggers	
Identify 3 or more allergens	41/81 (50.6%)
Triggers identified	
Pollens and other tree allergens	49/81 (60.5%)
Air Pollution	55/81 (67.9%)
Exercise	37/81 (45.7%)
Cockroach, mice, household leakage and dirt	15/81 (18.5%)
Pets	34/81 (41.9%)
If you have symptoms like shortness of breath, cough, chest tightness or wheezing and sneezing, what is the first thing you should do?	
Consult Your Doctor	8/83 (9.6%)
Ignore it	1/83 (1.2%)
Inform Parent	72/83 (86.7%)
Wait and see	2/83 (2.4%)
How likely are you to seek medical help if you experience asthma symptoms?	
Extremely Likely	34/84 (40.5%)
Somewhat Likely	33/83 (39.3%)
Neither likely nor unlikely	8/84 (9.5%)
Somewhat unlikely	3/84 (3.6%)
Extremely unlikely	6/84 (7.1%)
In your opinion, what barriers might prevent students from seeking medical help for breathing problems or asthma symptoms?	
Cost/Lack of insurance	51/83 (61.4%)
Fear or Embarrassment	51/83 (61.4%)
Difficulty accessing health care	41/83 (49.4%)
Lack of awareness	73/83 (88%)
Do you have insurance?	
From Parents Employer	42/89 (47.2%)
Medicaid/Medicare	9/89 (10.1%)
My Family Buys it	14/89 (15.7%)
I have it but do not know how	9/89 (10.1%)
No	2(2.2%)
Do not Know	13/89 (14.6%)

(*Continued*)

Table 1 (Continued).

Categories	Frequency
Ease of access to health care	
Extremely Easy	34/89 (38.2%)
Somewhat easy	33/89 (37.1%)
Neither Easy nor difficult	14/89 (15.7%)
Somewhat difficult	6/89 (6.7%)
Extremely difficult	2/89 (2.2%)

Regarding household income, 30.0% reported earnings above $100,000, 12.2% between $60,000–$100,000, and 21.1% below $60,000, while 36.7% chose not to disclose their income (Table 1).

Formal asthma education was reported by only 8% of participants. However, more than half (53.4%) considered themselves knowledgeable about asthma, and fewer than 60% being able to identify three or more asthma symptoms or triggers (Table 1). Nearly all participants (97.6%) recognized asthma as a chronic respiratory condition. While 98.8% identified shortness of breath and 83.3% recognized chest tightness as symptoms, fewer participants identified coughing (80.9%) or sneezing (15.4%) as potential asthma-related symptoms. Regarding asthma triggers, only 61.7% were aware that allergens could trigger asthma, and just 50.6% could name three or more common triggers. Although air pollution (67.9%), and pollen and other tree allergens (60.5%) were more frequently cited, fewer participants identified indoor triggers such as cockroach, mice, household leakage and dirt (18.5%). These findings suggest that while general awareness of asthma exists, significant gaps remain in recognizing specific symptoms and common environmental triggers linked to indoor air quality.

When experiencing asthma-like symptoms, most participants indicated they would inform a parent (86.7%). However, only 40.5% reported being "extremely likely" to seek medical help when experiencing symptoms (Table 1).

Health insurance coverage was reported by 83.1% of participants, with coverage primarily through a parent's employer (47.2%), Medicaid/Medicare (10.1%), or private purchase (15.7%). A small proportion (2.2%) were uninsured, while 14.6% were unsure of their insurance status. Despite the high rate of insurance coverage, participants identified several barriers to seeking medical care for respiratory symptoms. The most frequently reported barriers included lack of awareness (88%), fear or embarrassment (61.4%), cost or lack of insurance (61.4%), and difficulty accessing healthcare (49.4%) (Table 1).

Racial Disparities in Asthma Diagnosis, Knowledge, and Healthcare Access Among Adolescents

Significant racial differences were observed in asthma diagnosis rates and healthcare access among adolescents. Only 6.5% of Asian participants reported having been diagnosed with asthma, compared to 47.4% of adolescents from other racial groups ($P < 0.01$). Formal asthma education rates were low across all groups, with 8% of Asian participants and 8.1% of their peers reporting prior asthma education (Table 2).

Despite similar exposure to asthma education, fewer Asian participants (45.1%) considered themselves "knowledgeable" about asthma compared to their peers (64.9%, $P = 0.08$), with the p-value approaching significance ($P = 0.05$). Recognition of asthma as a chronic disease was nearly universal in both groups (100% vs 94.4%, $P = 0.18$), as was awareness of allergens as asthma triggers (59.6% vs 64.7%, $P = 0.81$) (Table 2). However, the ability to identify at least three asthma symptoms—an indicator of strong symptom knowledge—was slightly lower among Asian participants (66.7%) than their peers (83.3%, $P = 0.13$, Table 2), though the difference was not statistically significant. There were no statistically significant differences between Asian adolescents and their peers in the identification of asthma symptoms or common asthma triggers.

Regarding healthcare access, Asian adolescents reported significantly greater difficulty compared to their peers ($P < 0.01$, Table 1). While 60.5% of other race participants (White, African American, Hispanic/Latino) described healthcare

Table 2 Asthma Knowledge, History, and Healthcare Access Between Asian and Other Race Adolescents

Categories	Asian N=51	Other races[†] N=36	P value
Frequency			
Number of Male	26/51 (51%)	16/38 (42.1%)	0.65
Number of Female	25/51 (49%)	22/38 (57.9%)	
Median age	13 (10–17)	16 (8–18)	<0.01
Annual Household Income			
Less than 60k	12/28 (42.9%)	5/25 (20%)	
60–100 K	7/28 (25%)	3/25 (12%)	
More than 100K	9/28 (32.1%)	17/25 (68%)	0.03
School Type			
Public school	45/51 (88.2%)	30/38 (78.9%)	0.44
Other	6 /51 (11.8%)	8/38 (21.1%)	
Previous Asthma Diagnosis	3/48 (6.5%)	18/38 (47.4%)	<0.01
Family and Friends with Asthma	27/51 (52.9%)	23/37 (62.2%)	0.39
Formal Asthma Education			
Yes	4/50 (8%)	3/37 (8.1%)	
No	39/50 (78%)	29/37 (78.3%)	1
Not sure	7/50 (14%)	5/37 (13.5%)	
Rate your knowledge about asthma			
Knowledgeable (Answer very knowledgeable and somewhat knowledgeable)	23/51 (45.1%)	24/37 (64.9%)	0.08
Asthma-Knowledge Assessment			
Identify asthma is Chronic Respiratory Condition	48/48 (100%)	34/36 (94.4%)	0.18
Know asthma is triggered by allergen	28/47 (59.6%)	22/34 (64.7%)	0.81
Good knowledge of Symptoms			
Can identify 3 or more symptoms	32/48 (66.7%)	30/36 (83.3%)	0.13
Symptoms identified			
Cough	36/48 (75%)	32/36 (88.8%)	0.10
Shortness of breath	48/48 (100%)	35/36 (97.2%)	0.24
Chest tightness	38/48 (75%)	32/36 (88.8%)	0.23
Sneezing	7/48 (14.5%)	6/36 (16.6%)	0.79
Good Knowledge of asthma triggers			
Identify 3 or more allergens	24/47 (51.1%)	17/34 (50%)	1.0
Triggers identified			
Pollens and other tree allergens	30/47 (63.8%)	19/34 (55.8%)	0.47
Air Pollution	33/47 (70.2%)	22/34 (64.7%)	0.60
Exercise	22/47 (46.8%)	15/34 (44.1%)	0.81
Cockroach, mice, household leakage and dirt	7/47 (14.8%)	8/34 (23.5%)	0.32
Pets	18/47 (38.2%)	16/34 (47%)	0.43
If you have symptoms like shortness of breath, cough, chest tightness or wheezing and sneezing, what is the first thing you should do?			
Consult Your Doctor	4/47 (8.5%)	4/36 (11.1%)	
Ignore it	0	1/36 (2.7%)	
Inform Parent	42/47 (89.3%)	30/36 (83.3%)	
Wait and see	1/47 (2.1%)	1/36 (2.7%)	0.78
How likely are you to seek medical help if you experience asthma symptoms?			
Extremely Likely	21/48 (43.7%)	13/36 (36.11)	
Somewhat Likely	19/48 (39.5%)	14/36 (38.8%)	
Neither likely nor unlikely	5/48 (10.4%)	3/36 (8.3%)	0.35
Somewhat unlikely	1/48 (2%)	5/36 (13.8%)	
Extremely unlikely	2/48 (4.1%)	1/36 (2.7%)	

(*Continued*)

Table 2 (Continued).

Categories	Asian N=51	Other races† N=36	P value
In your opinion, what barriers might prevent students from seeking medical help for breathing problems or asthma symptoms?			
Lack of insurance	30/47 (63.8%)	21/36 (58.3%)	0.65
Fear Embarrassment	29/47 (61.7%)	22/36 (61.1%)	1
Difficulty accessing health care	23/47 (48.9%)	18/36 (50%)	1
Lack of awareness	44/47 (93.6%)	29/36 (80.5%)	0.09
Do you have insurance?			
Yes	40/51 (78.4%)	34/38 (89.5%)	
No	2/51 (3.9%)	0	0.279
Prefer not to answer	9/51 (17.6%)	4/38 (10.5%)	
Ease of access to health care			
Extremely Easy	11/51 (21.5%)	23/38 (60.5%)	
Somewhat easy	25/51 (49%)	8/38 (21%)	<0.01
Neither Easy nor difficult	12/51 (23.5%)	2/38 (5.2%)	
Somewhat difficult	3/51 (5.8%)	3/38 (7.8%)	
Extremely difficult	0	2/38 (5.2%)	
Extremely Easy	11/51 (21.6%)	23/38 (60.5%)	OR=0.179
All other responses	40/51 (78.4%)	15/38 (39.4%)	(0.076–0.455) P=0.00018

Notes: † Other races" includes participants who identified as White/Caucasian, Black/African American, Hispanic/Latino, or Other.

access as "extremely easy", only 21.5% of Asian participants shared this perception. A larger proportion of Asian adolescents rated healthcare access as "somewhat easy" (49.0% vs 21.0%), and while none reported finding access "extremely difficult", 5.2% of their peers did.

Because seeking medical care involves multiple steps, even minor obstacles can discourage timely access. To better capture these challenges, responses were grouped into two categories: those who found access "extremely easy" and those who selected any other response. Regression analysis revealed that Asian participants were significantly less likely than their peers to describe healthcare access as "extremely easy" (OR = 0.179, 95% CI: 0.076–0.455, P = 0.00018).

Gender Differences in Asthma Knowledge and Healthcare-Seeking Behavior

The analysis of gender differences showed no significant variation in asthma diagnosis rates, with 26.8% of male adolescents and 21.3% of female adolescents having received a diagnosis (P=0.64, Table 3). No significant differences were observed between males and females in previous asthma education (9.8% vs 6.7%, P=0.68), self-rated asthma knowledge (39% vs 52.1%, P=0.28), recognition of asthma as a respiratory disease (97.5% vs 97.7%, P=0.73),

Table 3 Asthma Knowledge, History, and Healthcare Access Between Male and Female Adolescents

Categories	Male N= 42	Female N= 47	P
Median Age	13 (10–18)	15 (8–18)	0.399
Annual Household Income			
Less than 60k	8/26 (30.8%)	9/27 (33.3%)	
60–100 K	8/26 (30.8%)	2/27 (7.4%)	0.09
More than 100K	10/26 (38.6)	16/27 (59.3%)	
School Type			
Public	33/41 (80.5%)	41/47 (87.2%)	0.68
Other	8/41 (19.5%)	6/47 (12.8%)	

(*Continued*)

Table 3 (Continued).

Categories	Male N= 42	Female N= 47	P
Previous Asthma Diagnosis	11/41 (26.8%)	10/47 (21.3%)	0.64
Family and friends with asthma	22/41 (53.7%)	28/46 (60.9%)	0.52
Formal Asthma Education			
Yes	4/41 (9.8%)	3/45 (6.7%)	
No	30/41 (73.2%)	37/45 (82.2%)	0.68
Not sure	7/41 (17%)	5/45 (11.11%)	
Rate your knowledge about asthma			
Knowledgeable (Answer very knowledgeable and somewhat knowledgeable)	16/41 (39%)	24/46 (52.1%)	0.28
Asthma-Knowledge Assessment			
Identify asthma is chronic respiratory condition	39/40 (97.5%)	42/43 (97.7%)	0.73
Know asthma is triggered by allergen	23/38 (60.5%)	15/42 (35.7%)	0.82
Good knowledge of Symptoms			
Can identify 3 or more symptoms	28/40 (70%)	33/43 (76.7%)	0.62
Symptoms identified			
Cough	32/40 (80%)	35/43 (81.39%)	0.87
Shortness of breath	40/40 (100%)	42/43 (97.6%)	0.61
Chest tightness	33/40 (82.5%)	36/43 (83.7%)	0.89
Sneezing	9/40 (22.5%)	4/43 (9.3%)	0.22
Good Knowledge of asthma triggers			
Identify 3 or more allergens	18/38 (47.4%)	23/42 (54.8%)	0.65
Triggers identified			
Pollens and other tree allergens	23/38 (60.5%)	26/42 (61.9%)	0.45
Air Pollution	24/38 (63.15%)	31/42 (73.8%)	0.20
Exercise	16/38 (42.1%)	21/42 (0.5%)	0.50
Cockroach, mice, household leakage and dirt	9/38 (0.23%)	6/42 (0.14%)	0.49
Pets	14/38 (0.36%)	20/42 (47.6%)	0.43
If you have symptoms like shortness of breath, cough, chest tightness or wheezing and sneezing, what is the first thing you should do?			
Consult Your Doctor	4/40 (10%)	4/42 (9.5%)	
Ignore it	0	1/42 (2.3%)	
Inform Parent	36/40 (90%)	35/42 (83.3%)	0.62
Wait and see	0	2/42 (4.8%)	
How likely are you to seek medical help if you experience asthma symptoms?			
Extremely Likely	21/40 (52.5%)	13/43 (30.2%)	
Somewhat Likely	11/40 (27.5%)	21/43 (48.8%)	
Neither likely nor unlikely	2/40 (5%)	6/43 (13.95%)	0.08
Somewhat unlikely	4/40 (10%)	2/43 (4.7%)	
Extremely unlikely	2/40 (5%)	1/43 (2.3%)	
Extremely Likely	21/40 (52.5%)	13/43 (30.2%)	OR=2.55
All other responses	19/40 (47.5%)	30/43 (69.8%)	(1.037–6.268) P=0.032
In your opinion, what barriers might prevent students from seeking medical help for breathing problems or asthma symptoms?			
Lack of insurance	23/40 (57.5%)	27/42 (64.2%)	0.65
Fear Embarrassment	24/40 (60%)	26/42 (61.9%)	1
Difficulty accessing health care	19/40 (47.5%)	21/42 (50%)	0.83
Lack of awareness	34/40 (85%)	38/42 (90%)	0.51
Ease of access to health care			
Extremely Easy	13/41 (31.7%)	21/47 (44.7%)	
Somewhat easy	16/41 (39%)	16/47 (34%)	
Neither Easy nor difficult	8/41 (19.5%)	6/47 (12.7%)	0.78
Somewhat difficult	3/41 (7.3%)	3/47 (6.4%)	
Extremely difficult	1/41 (2.4%)	1/47 (2.1%)	

knowledge of asthma symptoms (70% vs 76.7%, P=0.62), or awareness of asthma triggers (47.4% vs 54.8%, P=0.65) (Table 3). However, males were more likely to seek medical help for asthma symptoms, with 43.7% reporting they were "extremely likely" to do so, compared to 36.1% of females (P=0.08). Regression analysis, grouping "extremely likely" as one category and all other responses as another, yielded an odds ratio of 2.55 (95% CI: 1.037–6.268, P=0.032), suggesting that males had significantly higher odds of seeking medical help for asthma symptoms compared to the female adolescents.

Discussion

This study examined the demographics, asthma education, and knowledge of adolescents, highlighting gaps and disparities in asthma education, knowledge, and healthcare access by race and gender. The findings underscore significant gaps in asthma education and symptom recognition, as well as notable racial disparities in healthcare access and diagnosis rates.

Our findings confirm existing literature showing lower prevalence of asthma among Asian adolescents compared to peers from other racial groups (Table 1). This is consistent with multiple studies documenting lower asthma prevalence in Asian pediatric populations.[1,8,16,25] However, underdiagnosed asthma remains a significant problem among adolescents overall, with a prevalence rate of 20.2%.[13] Notably, while the absolute number of undiagnosed adolescents is higher in non-Asian racial groups, Bruzzese et al (2019), found that the percentage of undiagnosed cases is disproportionately higher among Asian adolescents.[13] This underdiagnosis likely contributes to the poorer disease management and adverse health outcomes observed in Asian and Pacific Islander population, as evidenced by their need for more invasive treatments and higher mortality rates.[10]

Studies investigating factors associated with underdiagnosed asthma are limited, particularly for Asian adolescents. However, research in Latino and African American adolescents has identified a lack of asthma knowledge and failure to recognize the severity of their symptoms as a key contributors to underdiagnosis of asthma.[18] Our study shows that only 8% participants had received prior asthma education (Table 1). This aligns with CDC reports on National school-based health education that show health curricula focused on variety of topics like sexual health, mental and emotional health, and nutrition but no mention of Asthma or related allergic conditions.[26] This lack of structured education may have contributed to the observed gaps in symptom recognition and asthma trigger identification (Table 1).

Disease-specific education improves early asthma diagnosis and reduces healthcare costs associated with delayed diagnosis. However, currently educational programs are primarily directed toward patients already diagnosed of asthma, leaving the undiagnosed population devoid of disease-specific knowledge.[27] Beyond formal education, disease information can be obtained from healthcare providers for asthma diagnosed patients and from social networks, friends and families for others.[28] In our survey, although only 8% reported of having prior asthma education, 53.4% participants considered themselves as somewhat or very knowledgeable about the disease. Furthermore, 60% of participants could correctly identify three or more major asthma symptoms (59.5%) or triggers (50.6%). These findings closely align with the 53.4% who self-identified as knowledgeable and with the 56.8% who reported having a family member or friend with an asthma diagnosis—suggesting that informal exposure to the disease may play a significant role in shaping asthma knowledge among adolescents (Table 1). This also indicates that children who are knowledgeable about asthma—whether through personal experience or formal education—may serve as valuable sources of information for their peers, potentially aiding in earlier recognition and diagnosis. These findings underscore the importance of improving asthma communication by healthcare providers and integrating asthma education into school curricula to enhance community-level awareness and promote early identification of the disease.

Nevertheless, we identified significant gaps regarding participants' ability to identify secondary symptoms commonly associated with allergic asthma. For example, sneezing, a common symptom often associated with allergic asthma and asthma co-existing with allergic rhinitis,[29,30] was identified as an asthma symptom by only 15.4% of participants (Table 1). Similarly, recognition of indoor asthma triggers such as cockroaches, mice, household leakage, and dirt was limited to just 18.5% of the participants. This finding is particularly concerning given New York State Department of Health's report linking higher emergency room visits for asthma to these specific indoor triggers.[8] These findings emphasize the need for comprehensive asthma education programs in schools and communities to improve symptom

recognition, disease diagnosis and disease management strategies, consistent with previous research recommendations.[18] Importantly, these programs should not be limited to students with a formal asthma diagnosis. As is already done with school-based mental health and sexual health education, providing age-appropriate asthma education to all students—regardless of current diagnosis—can foster early symptom recognition, improve health-seeking behavior, and even empower youth to support peers or family members who may be undiagnosed or unaware of asthma triggers. Given asthma's high prevalence, significant health burden, and potential for undiagnosed cases, especially in certain racial groups, universal education represents a preventive public health strategy rather than a remedial one.

In addition, these findings have important implications for clinical practice and public health interventions. Healthcare providers should consider implementing routine screening for asthma symptoms during well-visits for all adolescents, with particular attention to Asian adolescents and females who may be less likely to report symptoms or seek care. Educational interventions should be developed for integration into school health curricula, focusing not only on primary symptoms but also on secondary symptoms and indoor triggers that are frequently overlooked. Community-based programs tailored to specific cultural contexts could help address the knowledge gaps among Asian adolescents and improve healthcare navigation skills. Additionally, healthcare systems should evaluate and address barriers to care access perceived by Asian families, potentially through cultural competency training for providers, simplified appointment processes, and expanded telehealth options to reduce access barriers.

To examine racial and gender disparities in asthma education, we further analyzed the data by comparing Asian adolescents—who have the highest rates of underdiagnosis—to their peers from other racial groups, as well as female participants—who experience higher rates of undiagnosed asthma—to males (Table 2 and Table 3). Although the differences were not statistically significant, there was a trend suggesting racial disparities in asthma knowledge. A higher percentage of participants from other racial groups rated themselves as knowledgeable about asthma (64.9% vs 45.1% among Asians, p=0.08) and demonstrated a better understanding of asthma symptoms (83.3% vs 66.7% among Asians, p=0.13). Although this trend aligns with the findings of Bruzzese et al (2011), who identified limited knowledge of symptoms and their severity as a key factor contributing to asthma underdiagnosis among African American and Latino children,[18] the observed differences in our study were not as pronounced as in previous studies. This difference could be because we compared between races (Asians to other racial groups), whereas Bruzzese et al compared diagnosed and undiagnosed individuals within the same racial groups (ie, African American and Latino populations). These results suggest that factors associated with racial disparities in asthma knowledge may vary across different populations. Further research with larger sample sizes is needed to better understand these disparities in each specific race.

Bruzzese et al (2011) also found that treatment costs and insurance coverage played a minor role in asthma underdiagnosis,[18] as some patients did not seek care. To further explore this, we assessed adolescents' healthcare-seeking behaviors when experiencing asthma symptoms. The majority (86.7%) reported that they would inform their parents, highlighting the central role of caregivers in adolescent health management. However, despite high insurance coverage (97.8%), only 40.5% indicated they were extremely likely to seek medical care (Table 1), suggesting additional barriers to accessing healthcare beyond insurance status. Notably, only 38.2% adolescents reported that accessing healthcare was "extremely easy" (Table 1).

Furthermore, a statistically significant racial difference was observed in participants' perceptions of healthcare access. Specifically, Asian participants were significantly less likely to report that accessing healthcare was "extremely easy" compared to participants from other racial groups, suggesting that disparities in healthcare access may contribute to undiagnosed asthma among Asian adolescents (OR = 0.179, 95% CI: 0.076–0.455, P = 0.00018, Table 2). Given the critical role that parents play in adolescents' healthcare, it would be valuable to explore whether this racial difference is also observed in parents' perceptions of healthcare access. Seeking medical care requires navigating multiple steps, from deciding to book an appointment to visiting a doctor, and even minor barriers or discomforts in the process can deter patients from seeking timely treatment. These barriers can range from practical challenges such as lack of insurance, medical costs, income status, and transportation,[31] to individual factors such as symptom perception, emotional state, and family or social conditioning.[32,33] Additionally, difficulties in navigating the healthcare system itself may further discourage care-seeking behavior.[33–35] Future research is warranted to better understand the racial and cultural factors that contribute to perceived difficulties in accessing healthcare and the underdiagnosis of asthma.

A notable gender difference was also observed in healthcare-seeking behavior, with males significantly more likely than females to seek medical help for asthma symptoms (OR = 2.55, 95% CI: 1.037–6.268, P = 0.032, Table 3). This finding suggests that, although asthma awareness levels were similar between genders, female adolescents may be less likely to seek timely medical intervention. In fact, Bruzzese et. al, found that females were more likely to have undiagnosed asthma compared to males,[18] suggesting that differences in healthcare-seeking behavior could be underlying factor for the underdiagnosis of asthma among female adolescents. Possible contributing factors include variations in symptom perception, self-management confidence, and social influences on healthcare utilization. Further research is necessary to explore the reasons behind this gender disparity and to develop strategies that encourage female adolescents to seek prompt medical consultation for respiratory symptoms.

Our investigation of asthma knowledge and healthcare-seeking behaviors among Asian adolescents addresses a significant gap in the literature, as this population remains understudied despite concerning disparities in asthma outcomes. Our findings reveal complex interactions between cultural factors, education, perception about healthcare access, and healthcare seeking behavior that may contribute to underdiagnosis. Despite these insights, our analysis faced several limitations. The relatively small sample size may have limited our ability to detect statistically significant differences between groups, particularly for the comparisons between Asian adolescents and other racial groups. The cross-sectional design prevents us from establishing causal relationships between the factors studied and asthma underdiagnosis. Additionally, all measures were self-reported, which may be subject to recall bias or social desirability bias, particularly regarding healthcare access and knowledge assessment. Future research should employ larger samples, longitudinal designs, and objective measures of asthma knowledge and healthcare utilization to better understand the complex factors contributing to asthma underdiagnosis in diverse adolescent populations. Factors such as healthcare access, provider bias, and culturally specific influences—while not examined in this study—may also play a critical role and warrant further investigation to inform the development of inclusive and effective interventions for all adolescents.

Conclusion

This study reveals significant gaps in asthma education and knowledge among adolescents, particularly in recognizing asthma symptoms and triggers. While awareness of asthma as a chronic respiratory condition is high, formal asthma education is lacking, with only 8% of participants reporting prior education. Racial disparities in asthma diagnosis and healthcare access are evident, with Asian adolescents reporting lower diagnosis rates and more difficulty accessing healthcare compared to their peers. Although healthcare insurance coverage is generally high, barriers such as lack of awareness, fear, cost, and difficulty navigating the healthcare system contribute to delays in seeking medical care. Gender differences in healthcare-seeking behavior were also observed, with males being more likely to seek medical help for asthma symptoms. These findings underscore the need for asthma education programs, improved access to healthcare, and further research into the factors contributing to racial and gender disparities in asthma care.

Our study serves as a foundation for future research investigating the underlying reasons for racial differences in healthcare access perceptions, particularly among Asian adolescents. Additional research should explore cultural, linguistic, and systemic factors that may contribute to these disparities and evaluate targeted interventions to address them. Furthermore, understanding the psychosocial factors influencing adolescents' healthcare-seeking behaviors when experiencing symptoms, especially among females, could inform the development of gender-sensitive approaches to improve timely diagnosis. Comprehensive asthma education programs in schools would benefit all adolescents, while culturally tailored interventions addressing the specific barriers faced by different demographic groups are essential to reduce disparities in asthma diagnosis and care.

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