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US racial/ethnic disparities in childhood asthma emergent health care use: National Health Interview Survey, 2013–2015

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ABSTRACT

Objective: Racial/ethnic disparities in Emergency Department (ED) visits due to childhood asthma are well documented. We assessed disparities among multiple racial/ethnic groups and examined the effects of asthma management in emergent health care use among children in the United States.

Methods: Data come from the sample child component of the 2013–2015 National Health Interview Survey (NHIS) (ages 2–17). Among children with current asthma, ($N = 3336$) we assessed racial/ethnic disparities in ED visits due to asthma in the past 12 months. We used multivariate logistic regression to calculate model adjusted odds ratios (ORs) including adjustment of asthma management questions available in NHIS 2013: use of an asthma action plan, preventative medication use, and an asthma management course.

Results: Using 2013–2015 NHIS data, Puerto Rican children had the highest prevalence of current asthma (21.2%). Among children with asthma, significantly higher odds of ED visits were seen among all minority subgroups (except non-Hispanic other) compared to non-Hispanic white children with Hispanic other having the highest adjusted odds ratio ($OR = 2.4$), followed by Puerto Rican ($OR = 2.0$), Mexican American ($OR = 1.8$) and non-Hispanic black children ($OR = 1.7$). In sub analyses using 2013 data, adjustment of management measures resulted in a modest to no effect in the odds of having an ED visit due to asthma.

Conclusions: The high prevalence of asthma and the disparity in asthma related ED visits among minority children exemplify the need for further research in understanding the mechanisms underlying the continuing existence of these health imbalances.

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National Health Interview Survey (NHIS); asthma management; asthma action plan; health disparities; prevalence

Introduction

With over seven million children living with asthma in the United States, racial/ethnic minority children carry a disproportionate burden with respect to both prevalence and morbidity [1–4]. The underlying mechanisms for these disparities are multifactorial. Literature points to a combination of both social and environmental exposures as well as poor access to and/or lack of quality healthcare [5,6]. However, only one study managed to explain up to 80% of the black-white disparity in hospital readmission due to asthma using a combination of socioeconomic hardship, biologic, environmental, disease management factors, and access to care measures [7]. Further research exploring the mechanisms underlying racial disparities in asthma morbidity have remained largely unsuccessful [8]. Additionally, many studies examining disparities in asthma outcomes have focused solely on the black-white disparity or have been unable to differentiate among Hispanic subgroups [7,9–12]. Demographically, there is a

projected increase in the number of children from race/ethnic minority groups in the United States by 2060, when minorities will comprise over 60% of the child population [13]. The CDC routinely publishes reports on asthma surveillance among minority subgroups using NHIS data and there exists a continued need to elucidate the characteristics associated with adverse asthma outcomes such as hospital readmission or emergency department (ED) use [14]. A reduction in ED visits due to asthma is a core objective of the Healthy People 2020 initiative [15]. Given the growing diversity of children in the United States, we sought to examine reasons for the racial/ethnic disparities in asthma emergent health care use using measures of ED visits due to asthma using years 2013–2015 of the National Health Interview Survey (NHIS).

ED visits due to asthma serve as clinical markers for adverse asthma outcomes and can signify clinical “red flags” of uncontrolled asthma [2,10,16–18]. Studies have indicated that due to advances in medical

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care over the past two decades, ED visits due to asthma can be prevented with appropriate management and control [19–21]. National guidelines enacted in 1991 emphasized the importance of preventing adverse asthma outcomes via outpatient management practices that include both environmental monitoring of the household and the use of written asthma management plans [20]. While some studies demonstrate a reduced risk of ED visits and hospitalizations in children with preventive asthma practices, the role these practices play in explaining racial/ethnic disparities is less well understood [5,19]. In this study, we examined whether NHIS survey questions assessing social/demographic characteristics, comorbid health conditions, access to health care, and using 2013 NHIS data, measures of asthma preventive management explained the effects of the racial/ethnic disparities in emergent health care use due to childhood asthma.

Methods

Data

Data come from the publicly available 2013–2015 waves of the NHIS. Administered by the National Center for Health Statistics (NCHS), the NHIS annually collects cross-sectional data using face-to-face household and telephone interviews to periodically assess the health status and trends of the United States (US) population in all 50 states and the District of Columbia (D.C.). Interviews occur throughout a given study year following a multistage probability study design, thus resulting in data that are nationally representative of households and noninstitutionalized civilian US populations. Black, Hispanic, and Asian populations are oversampled [22]. The content of NHIS is updated periodically and consists of a Core survey with four subsets including the Household Composition, the Family Core, the Sample Child Core, and the Sample Adult Core. In each household sampled, one child was randomly selected, and information was collected by interviewing an adult in the household knowledgeable about the sampled child. The response rate for the sample child survey was 66.3%. Data from children aged 2–17 years were included for analyses using the Sample Child Core content merged with sociodemographic variables from the Household Composition and the Family Core ($N = 34\,141$).

Of 34 141 children, a total of 34 087 were included for initial measures of prevalence based on complete asthma status. Our analytic sample to measure bivariate characteristics included a subset of children with

current asthma ($N = 3340$). Of these, four records were excluded due to missing data on ED use resulting in a final sample with $N = 3336$ for Tables 1 and 2. This subset met the criteria established in previous literature for having current asthma [8–10]. Current asthma was defined by an affirmative response to both the following questions: “Has a doctor or other health professional ever told you that your child has asthma?” and “Does your child still have asthma?” (Figure 1). Complete case analyses were utilized for logistic regression models for a final analytic sample of 3304 (Table 3).

Measures

Emergent asthma health care use: ED visits due to asthma

Emergent asthma health care use, the binary dependent variable, was based on an affirmative response to the question: “During the past 12 months, did your child have to visit and emergency room because of his/her asthma?”

Race and ethnicity

Race/ethnicity, the independent variable, was self-reported and combined to create a six-category measure: Puerto-Rican Hispanic, Mexican American Hispanic, Hispanic other, non-Hispanic white, non-Hispanic black, and non-Hispanic other. Hispanic other included Hispanic subgroups that required merging into one category due to small sample size [Cuban (10.4%), Dominican (10.2%), Central or South American (53.9%), multiple Hispanic (16.8%), and other Spanish (8.7%)]. Non-Hispanic other also included multiple races that required merging into one category due to small sample size [Asian (80.4%), other race (19.6%)].

Demographic characteristics

Demographic variables included sex (male or female) and age. Age was categorized into three subgroups for analyses [2–18]. Children <2 years of age were excluded due to the difficulty in making a clinical diagnosis in this age group [23]. Previous literature has well documented there to be multiple socioeconomic indicators related to both occurrences of asthma and asthma morbidity [7,9,24]. In our conceptual framework, race/ethnicity is a proxy measure for social disadvantage, and explicit mechanisms by which these proxies shape adverse asthma outcomes are not well understood [25]. We assessed for several socioeconomic measures that may influence the association

Table 1. Descriptive statistics for US children with current asthma by race/ethnicity: National Health Interview Survey 2013–2015.

Variable	Weighted proportions (CI ^a)							P value ^b
	Overall (N = 3336)	Puerto Rican (N = 160)	Mexican American (N = 516)	Hispanic- other (N = 241)	Non-Hispanic white (N = 1376)	Non-Hispanic black (N = 843)	Non-Hispanic other (N = 200)	
Adverse event								
Emergency Department (ED) visit past 12 months (%) (n = 3336)	18.33 (15.52–20.13)	26.30 (17.41–35.18)	19.74 (15.66–23.82)	28.21 (20.72–35.71)	12.93 (10.32–15.37)	24.34 (20.83–27.85)	20.34 (10.32–30.36)	<0.0001
Social & demographic characteristics								
Sex (%) (n = 3336)								
Male	58.70 (56.39–61.01)	47.11 (36.77–57.45)	59.16 (54.33–63.99)	61.47 (53.84–69.10)	57.62 (54.22–61.03)	60.68 (56.29–65.08)	65.92 (57.26–74.58)	0.07
Female	41.30 (38.99–43.61)	52.89 (42.55–63.23)	40.84 (36.01–45.67)	38.53 (30.90–46.16)	42.38 (38.97–45.78)	39.32 (34.92–43.71)	34.08 (25.42–42.74)	<0.01
Age (%) (n = 3336)								
2–4	12.14 (10.68–13.59)	17.33 (8.96–25.71)	10.63 (7.36–13.89)	12.36 (7.10–17.62)	9.64 (7.59–11.70)	17.14 (13.77–20.51)	11.38 (4.72–18.04)	
5–11	47.32 (44.83–49.81)	43.75 (32.36–55.14)	49.76 (44.62–54.90)	48.67 (39.71–57.63)	47.02 (43.29–50.75)	47.70 (43.36–52.05)	43.64 (32.58–54.70)	
12–18	40.54 (38.23–42.85)	38.91 (27.91–49.92)	39.61 (34.34–44.89)	38.97 (30.93–47.02)	43.34 (40.01–46.66)	35.16 (30.80–39.52)	44.98 (34.40–55.56)	
Poverty status (%) (n = 3336)								
<100%	28.38 (26.05–30.71)	45.47 (34.99–55.95)	39.60 (34.03–45.17)	30.44 (23.03–37.86)	19.16 (15.90–22.49)	39.00 (34.92–43.08)	18.56 (11.95–25.17)	<0.0001
100%–<200%	22.98 (21.08–24.90)	19.41 (11.04–27.79)	30.37 (25.43–35.32)	32.69 (24.56–40.83)	18.15 (15.36–20.94)	27.33 (23.66–31.00)	22.19 (12.35–32.03)	
200%–<400%	26.63 (24.57–28.69)	26.05 (15.35–36.75)	20.34 (15.71–24.96)	21.05 (14.82–27.28)	30.34 (26.54–34.14)	23.67 (20.29–27.05)	28.20 (19.07–37.33)	
>400%	22.01 (20.13–23.88)	9.07 (4.01–14.12)	9.67 (6.45–12.92)	15.81 (9.83–21.79)	32.32 (29.02–35.62)	10.00 (1.21–12.29)	31.05 (21.87–40.24)	<0.0001
Region (%) (n = 3336)								
Northeast	18.26 (16.09–20.42)	56.00 (45.18–66.82)	2.33 (0.51–4.15)	27.12 (19.06–35.17)	18.36 (15.05–21.68)	17.47 (14.35–20.60)	20.36 (11.75–28.98)	
Midwest	20.56 (18.55–22.58)	9.42 (0.87–17.97)	9.04 (5.91–12.16)	6.40 (2.32–10.48)	27.45 (24.05–30.86)	20.16 (16.50–23.82)	11.51 (2.23–20.79)	
South	40.40 (37.59–43.20)	28.21 (18.50–37.92)	34.89 (28.87–40.90)	44.63 (35.89–53.38)	37.97 (33.56–42.39)	53.20 (48.77–57.63)	23.53 (15.59–31.46)	
West	20.78 (18.79–22.78)	6.37 (1.50–11.25)	53.75 (47.43–60.07)	21.85 (14.21–29.50)	16.21 (13.36–19.06)	9.17 (6.94–11.40)	44.60 (34.64–54.56)	<0.0001
Highest education in household (%) (n = 3334)								
<12th grade	9.69 (8.29–11.10)	18.96 (10.47–27.46)	22.97 (18.88–27.06)	13.61 (8.67–18.56)	5.08 (3.28–6.88)	9.80 (7.25–13.35)	5.78 (1.74–9.81)	
High School Graduate/GED recipient	20.73 (18.73–22.73)	29.07 (19.84–38.30)	24.80 (19.72–29.87)	21.56 (15.66–27.46)	17.04 (14.17–19.90)	25.67 (21.86–29.48)	13.45 (6.80–20.10)	
Some college or AA degree	36.18 (33.77–38.60)	36.57 (27.49–45.64)	34.56 (29.31–39.80)	32.50 (24.51–40.49)	35.61 (31.50–39.73)	40.92 (36.32–45.51)	26.79 (18.06–35.51)	
Bachelor's or above	33.39 (31.13–35.66)	15.39 (6.30–24.49)	17.68 (13.43–21.92)	32.33 (24.38–40.28)	42.27 (38.54–46.01)	23.62 (19.63–27.60)	53.99 (43.38–64.60)	<0.0001
Family Structure (%) (n = 3336)								
One parent household	22.71 (20.63–24.79)	32.27 (22.05–42.50)	17.87 (14.04–21.70)	28.10 (19.86–36.33)	15.91 (13.23–18.60)	38.15 (33.45–42.85)	13.08 (7.56–18.59)	
Two parent household	77.29 (75.21–79.37)	67.73 (57.50–77.95)	82.13 (78.30–85.96)	71.90 (63.67–80.14)	84.09 (81.40–86.77)	61.85 (57.15–66.55)	86.92 (81.41–92.44)	<0.0001
Housing status (%) (n = 3332)								
Owned or being bought	53.73 (43.79–63.67)	32.55 (21.97–43.13)	40.89 (35.75–46.02)	42.34 (33.45–51.22)	70.16 (66.77–73.54)	31.78 (27.78–35.77)	65.46 (56.65–74.29)	
Rented/Other	46.27 (51.25–56.21)	67.45 (56.88–78.03)	59.11 (53.98–64.25)	57.66 (48.78–66.55)	29.84 (26.46–33.23)	68.22 (64.23–72.22)	34.54 (25.72–44.28)	
Number of children in household (n = 3336)								
1	24.38 (22.88–25.89)	23.04 (16.44–29.63)	16.54 (13.67–19.41)	28.99 (21.70–36.30)	25.45 (23.03–27.87)	27.20 (24.30–30.11)	17.78 (12.26–23.30)	<0.0001
≥1	75.62 (74.11–77.12)	76.96 (70.37–83.56)	83.46 (80.59–86.33)	71.00 (63.70–78.30)	74.55 (72.13–76.97)	72.80 (69.89–75.70)	82.22 (76.70–87.74)	
Health conditions								
Low birthweight (%) (n = 3018)								
Yes	12.02 (10.38–13.67)	17.26 (8.89–25.64)	12.02 (7.65–16.39)	9.46 (4.57–14.34)	8.63 (6.45–10.81)	17.92 (14.71–21.13)	16.13 (8.52–23.74)	<0.0001
No	87.98 (86.33–89.62)	82.74 (74.36–91.11)	87.98 (83.61–92.35)	90.54 (85.66–95.43)	91.37 (89.19–93.55)	82.08 (78.87–85.29)	83.87 (76.26–91.48)	0.07
Physical condition (%) (n = 3334)								
None	95.96 (94.90–97.01)	98.69 (97.07–100.00)	97.48 (95.85–99.12)	99.53 (98.69–100.00)	95.59 (94.21–96.98)	95.33 (93.30–97.37)	92.07 (82.59–100.00)	
≥1	4.04 (2.99–5.10)	1.31 (0.00–2.93)	2.52 (0.88–4.15)	0.47 (0.00–1.31)	4.41 (3.02–5.79)	4.67 (2.63–6.70)	7.93 (2.63–17.41)	

(Continued)

Table 1. Continued.

Variable	Weighted proportions (CI ^a)					P value ^b
	Overall (N = 3336)	Puerto Rican (N = 160)	Mexican American (N = 516)	Hispanic-other (N = 241)	Non-Hispanic white (N = 1376)	
Mental/Developmental condition (%) (n = 3336)						
None	79.32 (77.49–81.16)	75.47 (66.39–84.56)	87.31 (84.22–90.40)	75.75 (68.02–83.47)	76.19 (73.37–79.02)	<0.001
≥1	20.68 (18.84–22.51)	24.53 (15.44–33.61)	12.69 (9.60–15.78)	24.25 (16.53–31.98)	23.81 (20.99–26.63)	
Access to health care Type of preventative care (%) (n = 3330)						
Clinic or health center	21.74 (19.64–23.84)	29.54 (20.75–38.33)	37.77 (31.05–44.61)	32.97 (25.08–40.87)	14.87 (12.45–17.29)	<0.0001
Doctor's office or HMO	75.34 (73.12–77.57)	66.31 (57.15–75.48)	59.24 (52.47–65.87)	62.03 (53.87–70.20)	83.10 (80.39–85.78)	
Hospital outpatient or ED/other	2.91 (2.04–3.78)	4.15 (0.56–7.76)	3.00 (1.22–4.78)	5.00 (1.18–8.81)	2.04 (0.91–3.17)	
Health insurance (%) (n = 3313)						
Private	47.60 (45.06–50.14)	22.23 (12.42–32.03)	30.97 (25.80–36.14)	38.23 (30.56–45.90)	62.18 (58.52–65.84)	<0.0001
Public	48.20 (45.7–50.68)	73.98 (63.94–84.01)	61.39 (56.17–66.62)	58.17 (50.45–65.89)	34.23 (30.61–37.84)	
None	4.20 (3.35–5.06)	3.80 (0.65–6.95)	7.63 (4.88–10.39)	3.60 (0.75–6.44)	3.59 (2.30–4.89)	

^aCI: Confidence Interval.^bRao-Scott Chi Square Test.

Other = does not have usual place, does not get care anywhere, some other place.

Significance of bold values: $P < 0.05$.

between race/ethnicity and ED/hospitalization due to asthma including: household income, census region of the United States (Northeast, Midwest, South, West), highest education in the household (categorized as less than high school, high school graduate, some college, and college degree), housing status (own/rent), family structure (single parent or two parent household) and number of children in the household (one child or more than one child) [9]. The ratio of family income to the federal poverty level (FPL) was used to create a categorical measure of poverty contrasting <100%, 100%–<200%, 200%–<400%, and ≥400%.

Physical and mental comorbidities

Additional physical and mental health indicators have been shown to be patterned by race/ethnicity and also to be related to asthma severity [26–28]. We controlled for the following health related comorbidities: chronic physical conditions, mental/developmental conditions, and low birth weight. Physical chronic conditions were categorized as binary according to the presence of one or more of the following: Down's syndrome, cerebral palsy, muscular dystrophy, cystic fibrosis, sickle cell anemia, diabetes, arthritis, congenital heart disease, or other heart condition. Mental/developmental conditions were also categorized as binary with presence of one or more of the following: intellectual disability, developmental delay, attention deficit hyperactivity disorder (ADHD/ADD), or autism spectrum disorder. Children were categorized as low birth weight if they met the international World Health Organization's standardized criterion of weighing less than 2500 g at birth [29].

Healthcare access

Healthcare access has been suggested in previous studies to account for racial/ethnic disparities in ED/hospitalization visits due to childhood asthma [7,11,30]. Measures of access to healthcare in our study were twofold and included both measures of health insurance (public, private, or none) and type of preventive care (doctor's office or health maintenance organization (HMO), clinical or health center, and hospital (ED or hospital outpatient).

Asthma management questions included in NHIS 2013 survey

We were particularly interested in the questions on asthma management available in NHIS 2013. Three measures were created from these questions including: (i) a binary measure of whether or not a doctor or other health professional had ever given the child an

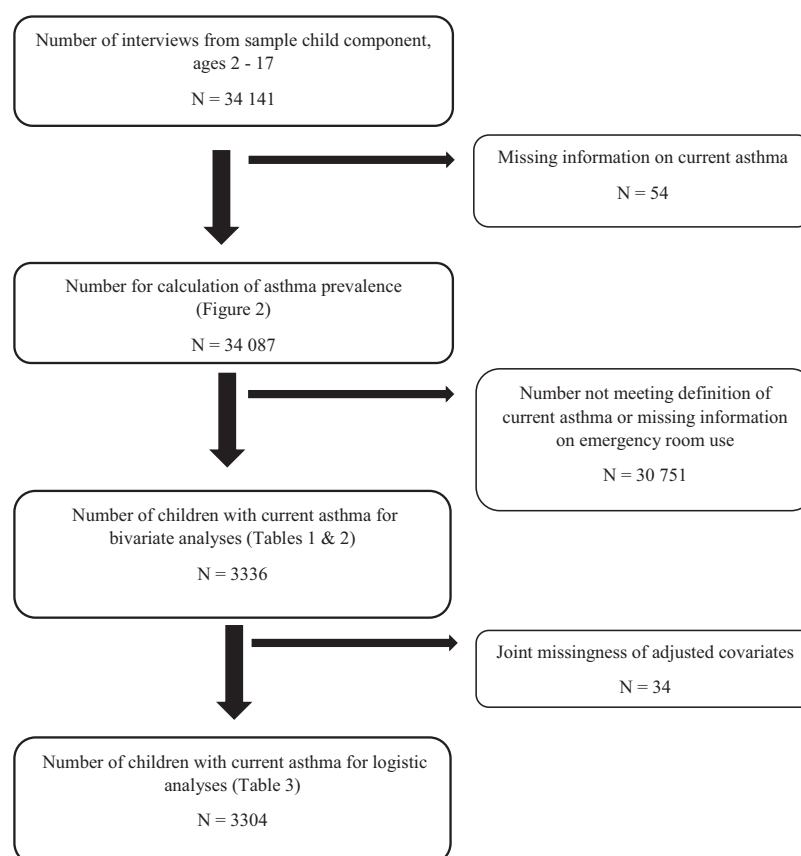


Figure 1. Data Inclusion Criteria NHIS 2013–2015.

asthma action plan (indicating when to change the amount or type of medicine, when to call the doctor for advice, and when to go to the emergency room) (ii) a categorical measure of frequency of use of preventive asthma medication (either pill or inhaler), categorized as every day/every other day, less often, or never; and (iii) a binary measure of whether or not a course or class was taken on how to manage asthma.

Statistical analyses

We first examined the prevalence of current asthma by race/ethnicity in our initial sample of 34 087 children. Data on the 3336 children with current asthma were used for subsequent bivariate analyses (Table 1), and a complete case analyses on 3304 children was used for multivariable analyses (Table 3). We evaluated bivariate differences by race/ethnicity in social and demographic characteristics, health conditions and access to health care using 2013–2015 data, (Table 1) and asthma management measures using 2013 data (Table 2). Bivariate associations were tested using the Rao-Scott test statistic [31]. Multivariable logistic regression was performed in both crude and adjusted models for years 2013–2015, including 2013

only models to assess the effects of the asthma management covariates. Non-Hispanic white children served as the referent category in all models. The crude models (Model 1, Model 3) regressed race/ethnicity on the binary outcome of ED visit due to asthma in the past 12 months. We added, age & sex sociodemographic characteristics, physical and mental/developmental conditions, and access to care (Model 2, Model 4). In 2013, we included models to assess the effects of asthma management variables (Models 5–7). All analyses were performed using SAS 9.4 (SAS Institute, Cary, NC) and Stata 15 software (Stata Corp, College Station, TX). Statistical significance was assessed with a two-tailed alpha of 0.05. Both bivariate and multivariate logistic regression analyses accounted for the NHIS survey's complex, multistage sampling design using survey design variables (PSU and STRATA) and NHIS sampling weights necessary for variance estimation [32]. Weights were divided by three to adjust for multiple years of data collection.

Missing data

In the 2013–2015 waves of NHIS, there were 34 141 interviews for children aged 2–17. Children with missing values on missing asthma status ($N = 54$) were

Table 2. Descriptive statistics for US children with current asthma by race/ethnicity, National Health Interview Survey 2013: Asthma management.

Variable	Weighted Proportions (CI ^a)						P value ^b
	Overall (N = 1120)	Puerto Rican (N = 52)	Mexican American (N = 155)	Hispanic- other (N = 90)	Non-Hispanic white (N = 449)	Non-Hispanic black (N = 323)	Non-Hispanic other (N = 51)
<i>Asthma management</i>							
Doctor/other health professional ever give an asthma action plan? (n = 1107)							0.26
Yes	50.82 (47.22–54.65)	48.88 (28.63–69.12)	53.90 (45.91–61.90)	52.75 (40.14–65.35)	46.72 (41.18–52.27)	56.93 (50.56–63.30)	55.42 (37.04–73.81)
No	49.06 (45.35–52.78)	51.12 (30.88–71.37)	46.10 (38.10–54.09)	47.25 (34.54–59.86)	53.28 (47.73–58.82)	43.07 (36.70–49.44)	44.58 (26.19–62.96)
How often to take preventative medication past 12 months? (%) (n = 1118)							
Every day or every other day	30.05 (26.42–33.68)	26.99 (10.04–43.95)	30.16 (20.69–39.62)	28.25 (16.06–40.44)	33.48 (27.52–39.45)	25.89 (20.61–31.18)	19.33 (7.31–31.34)
Less often	24.98 (21.95–28.03)	24.92 (11.48–38.37)	27.91 (21.24–34.57)	32.14 (19.07–45.20)	20.78 (16.37–25.18)	29.87 (23.84–35.90)	27.22 (13.16–41.28)
Never	44.96 (41.46–48.47)	48.08 (27.95–68.21)	41.94 (32.82–51.05)	39.61 (28.00–51.23)	45.74 (40.08–51.40)	44.24 (37.62–50.86)	53.45 (37.75–69.14)
Ever took a course on how to man- age asthma? (n = 1117)							0.05
Yes	11.19 (9.02–13.35)	19.08 (6.41–31.76)	11.70 (6.48–16.91)	22.15 (14.06–30.25)	9.65 (6.50–12.80)	10.54 (6.59–14.48)	8.37 (0.00–18.58)
No	88.81 (86.65–90.98)	80.92 (68.24–93.59)	88.30 (83.09–93.52)	77.85 (69.75–85.94)	90.35 (87.18–93.50)	89.46 (85.52–93.41)	91.63 (81.42–100.00)

^aCI: Confidence Interval.^bRao-Scott Chi Square Test.

excluded from the prevalence estimates, yielding an initial analytic sample of 34 087 children. In the analyses focusing on the subset of children with current asthma for bivariate analyses (Tables 1 and 2), we restricted to children who met the definition of having current asthma ($N = 30\,747$ observations discarded) and children without missing ED use ($N = 4$ discarded) for a final analytic sample of 3336. Missing values for household income (14.9% missing) were multiply imputed using methods made available by NHIS [33]. Missing values for race/ethnicity (9.7% missing) were singly imputed by NCHS. For logistic analyses, a complete case analyses were utilized for remaining measures on social & demographic factors, health conditions, access to health care and asthma management ($N = 3304$ for 2013–2015 data, $N = 1087$ for 2013 data) to allow for comparisons between crude and adjusted models. Missing rates ranged from <1.0% for measures of highest education in the household and presence of a physical condition to 10% for low birth weight. Given high rate of missing for low birthweight, sensitivity analyses (data not shown) compared coefficients by including and excluding low birth weight in the logistic regression model adjusting for social and demographic factors, health conditions, access to health care and asthma management. Models did not reveal a change in more than 10% among covariates suggesting lack of confounding effect from low birthweight, therefore records missing low birthweight were retained to prevent bias emerging in the regression estimates and low birthweight was not included as a covariate in the fully adjusted models.

Results

Racial/ethnic disparities in childhood asthma prevalence

Figure 2 presents the prevalence of current asthma in US children by race/ethnicity ($n = 34\,141$). Overall, there was a 9.7% prevalence of asthma among children ($N = 3340$) using the 2013–2015 waves of NHIS. Separating by race/ethnic groups, Puerto Rican children had the highest prevalence of current asthma (21.2%, CI: 19.6, 24.8), followed by non-Hispanic black (14.5%, CI: 13.5, 15.6), Hispanic other (8.5%, CI: 7.1, 9.9), non-Hispanic white (8.2%, 7.6, 8.7), and Mexican American children (7.5%, CI: 6.7, 8.2). Non-Hispanic other children had the lowest prevalence of asthma (7.1%, CI: 5.7, 8.4).

Table 3. Weighted logistic regression models for asthma ED visits among US children with asthma National Health Interview Survey 2013–2015.

	Odds ratios (OR) and 95% confidence intervals (CI) of asthma ER visits by race/ethnicity				
	Puerto Rican OR (95% CI)	Mexican American OR (95% CI)	Hispanic other OR (95% CI)	non-Hispanic black OR (95% CI)	non-Hispanic other OR (95% CI)
Type of Model: NHIS 2013–2015 (<i>N</i> = 3304)					
Model 1: Crude Model ^a	2.42 (1.47, 4.01)	1.67 (1.20, 2.34)	2.65 (1.73, 4.06)	2.17 (1.62, 2.90)	1.73 (0.91, 3.62)
Model 2: Full Model: Age, Sex, Social & Demographic, Health Conditions, Access to Care ^b	1.98 (1.15, 2.66)	1.79 (1.21, 2.66)	2.44 (1.53, 3.90)	1.72 (1.24, 2.38)	1.90 (0.95, 3.81)
Type of Model: NHIS 2013 (<i>N</i> = 1087)					
Model 3: Crude Model ^c	2.37 (0.95, 5.88)	1.86 (1.09, 3.18)	1.42 (0.66, 3.07)	1.97 (1.22, 3.18)	1.91 (0.76, 4.80)
Model 4: (same as Model 2 covariates) ^d	2.31 (0.94, 5.69)	2.07 (1.09, 3.94)	1.52 (0.70, 3.35)	1.85 (1.09, 3.14)	2.24 (0.88, 5.71)
Model 5: Model 4 +Asthma Action Plan ^e	2.36 (0.94, 5.93)	1.96 (1.04, 3.69)	1.44 (0.67, 3.10)	1.79 (1.04, 3.07)	2.15 (0.83, 5.55)
Model 6: Model 4 +Preventative Medication ^f	2.41 (0.95, 6.13)	2.00 (1.07, 3.77)	1.49 (0.68, 3.29)	1.88 (1.08, 3.28)	2.50 (0.97, 6.45)
Model 7: Model 4 +Management Course ^g	2.21 (0.89, 5.50)	2.05 (1.08, 3.89)	1.41 (0.63, 3.19)	1.86 (1.09, 3.17)	2.29 (0.89, 5.90)

^aNo covariates included.^bAddition of adjustment for age and sex, income, region, number of children in the household, highest education in household, housing status, family structure, physical & mental conditions, health insurance, and preventative care type.^cNo covariates included.^dSame variables as Model 2.^eModel 2 + ever given asthma plan.^fModel 2 + frequency of preventative medication.^gModel 2 + ever took course on how to manage asthma.Significance of bold values: *P* < 0.05.

Racial/ethnic disparities in asthma emergent health care use

In our final analytic sample of children with current asthma using 2013–2015 NHIS Data (*N* = 3336), results from bivariate analyses (Table 1) reveal varying proportions by race/ethnicity of emergent health care use measured by ED visits due to asthma in the past year. Hispanic other children had the highest proportion of ED visits (28.2%, CI: 20.7–35.7) followed by Puerto Rican (26.3%, CI: 17.4–35.2), non-Hispanic black (24.3%, CI: 20.8–27.9), non-Hispanic other (20.3%, CI: 10.3–30.4), Mexican American (19.7% CI: 15.7–23.8), and the lowest being among non-Hispanic white children (12.9%, CI: 10.3–15.4%) (*p* < 0.0001). Results from bivariate analyses also indicated several socioeconomic differences (*p* < 0.0001) that exist among racial/ethnic groups in terms of region of residence, poverty status, highest education in the household, housing status, and number of children in the household. Both low birthweight (*p* < 0.0001) and presence of a mental/developmental condition also varied significantly among racial/ethnic groups (*p* < 0.001). In

terms of access to healthcare, varying proportions by racial/ethnicity was observed for both the type of preventive care (*p* < 0.0001) and type of health insurance (*p* < 0.0001). For example, 62.2% of non-Hispanic white children had private health insurance, compared with only 22.2% of Puerto Rican and 33.5% of non-Hispanic black children. Among bivariate analyses for asthma management variables using NHIS 2013 data (Table 2), only ever taking a course reached statistical significance (*p* = 0.05) with Puerto Rican children having the highest proportion at 19.1% and non-Hispanic white and non-Hispanic other having the lowest at 9.7% and 8.4%, respectively. There were not marked differences seen for frequency of preventative medication use nor for ever given asthma action plan (*p* > 0.05). However, descriptively we can assess that non-Hispanic black children had the highest proportion of ever given an action plan at 56.9% compared to non-Hispanic white who had the lowest proportion at 46.7%. While our bivariate analyses demonstrated several marked associations between our race/ethnic multi-category variable and covariates, the frequency tables were limited to the Rao-Scott chi square test, which cannot elucidate pairwise significance.

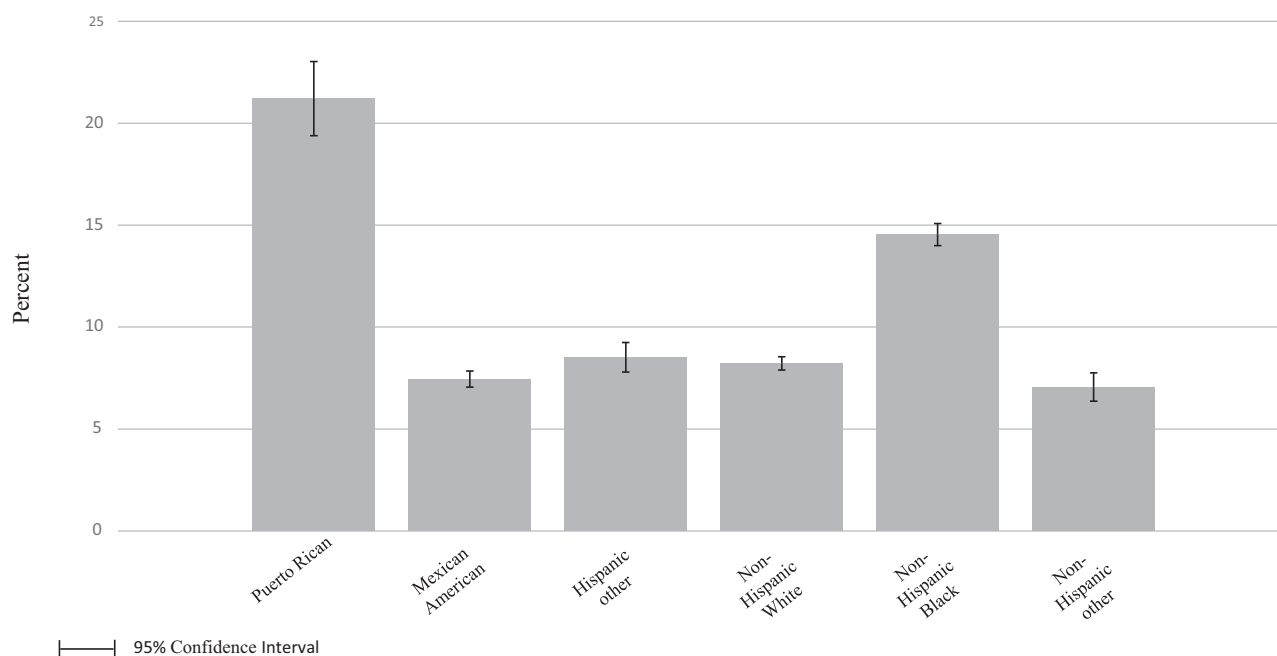


Figure 2. Weighted Prevalence of Childhood Asthma by Race/Ethnicity ($n = 34\ 087$). US National Health Interview Survey 2013–2015.

Multivariable logistic regression of emergent health care use

Table 3 presents the odds ratios (OR) and 95% confidence intervals (CI) from a series of logistic regression models to examine the odds of asthma morbidity by race/ethnicity, after adjusting for covariates with NHIS 2013–2015 data and sub analyses with asthma management variables using NHIS 2013 data. Using 2013–2015 data, the odds of having an ED visit among minority subgroups compared to non-Hispanic white children were similar in both the crude (Model 1) and adjusted models (Model 2) and were significant across all groups with the exception of non-Hispanic other children. After adjustment, Puerto Rican and Hispanic other were 2–2.4 times as likely to have an ED visit compared to non-Hispanic white children. Non-Hispanic black and Puerto Rican children were also 1.7–1.8 times as likely to have had an ED visit compared to non-Hispanic white children, after adjusting for all covariates in the model.

Using 2013 data, the odds were also similar among both crude (Model 3) and adjusted models (Model 4), with only Mexican American and non-Hispanic black reaching significance and having almost two times the odds of having an ED visit compared to non-Hispanic white children. We then ran a series of models to assess the effects of asthma management to compare to the odds ratios in the adjusted model without asthma management (Model 4). These subsequent logistic regressions revealed similar effects on

the odds ratios. Adjustment for an asthma action plan (Model 5) only modestly attenuated the odds of an ED visit (compared to adjusted Model 4) for Mexican American children (OR = 2.0, CI: 1.0–3.7) and non-Hispanic black children (OR = 1.8, CI: 1.0–3.1). Adjustment for preventative medication resulted in a slight increase in the odds of an ED visit for non-Hispanic black children (OR = 1.9, CI: 1.1, 3.3) compared to non-Hispanic white children and a slight attenuation for Mexican American children (OR = 2.0, CI 1.1, 3.8). And finally, adjustment of ever taking a management course resulted in only slight attenuation of the odds among Mexican American children and slight increase in odds among non-Hispanic black children.

Across all crude and adjusted models with NHIS 2013 data, there were no statistically significant differences in the odds ratios of ED visits among Puerto Rican, Hispanic other and non-Hispanic other children (all confidence intervals included 1.0) compared to non-Hispanic white children.

Discussion

To our knowledge, this study is one of the first to use asthma management questions in the National Health Interview Study to attempt to understand its effects on the notable racial/ethnic differences in emergent health care use due to asthma in US children. Using 2013–2015 NHIS data, the highest prevalence of

asthma was seen among Puerto Rican children (21.2%), which is consistent with estimates from the literature [34–36]. Using 2013–2015 logistic regression models, all minority subgroups with the exception of non-Hispanic other had significantly greater risk of emergent health care use, captured through ED visits, with Hispanic other having the highest odds of an ED visit due to asthma in the past 12 months compared to non-Hispanic white children.

Research exploring the mechanisms underlying racial/ethnic disparities in asthma morbidity has largely been limited to examining black-white disparities, and has focused primarily on sociodemographic and health factors [6]. We took advantage of the opportunity to examine three NHIS 2013 measures of asthma management to see if they could better explain these disparities in asthma morbidity. However, we found that their effects of the odds of having an ED visit was only modest and the odds ratios were consistent across racial/ethnic groups. Similarly, bivariate analyses did not reveal striking differences between race/ethnicity and measures of asthma management, with only ever taking an asthma course reaching significance. While pairwise comparisons were not performed, a closer look at asthma management in bivariate analyses (Table 2), showed that this difference may exist primarily between Hispanic other and non-Hispanic white which had non-overlapping confidence intervals. Among Hispanic other, 22.2% had ever taken an asthma management course compared to 9.7% of non-Hispanic white. This is in line with previous research by McDaniel & Waldfogel who demonstrated with NHIS 2003/2008 data that both non-Hispanic black children and Puerto Rican/other Hispanic children were more likely to have taken an asthma management course compared to non-Hispanic white children. In our bivariate analyses, we did observe varying proportions between non-Hispanic black and non-Hispanic white children, however the confidence intervals overlapped, suggesting that the lack of difference seen may be attributed to our small sample size using 2013 data. However, contrary to McDaniel & Waldfogel, we did not aggregate Puerto Rican children with Hispanic other, suggesting the difference observed by McDaniel & Waldfogel in having ever received an asthma action plan may be driven by the Hispanic other child population.

Our study is not without limitations. Due to the limited availability of environmental measures in the NHIS, we were unable to control for environmental exposures such as tobacco smoke and traffic related

air pollution known to exacerbate asthma symptoms [7]. Additionally, the measures of asthma management may be subject to reverse causality if they occurred as a result of an ED visit. Those who have more severe asthma may be more likely to have an ED visit, and thus been more likely to be recommended by their health provider to seek out asthma management classes or be given an asthma action plan. Due to the inability to evaluate clinical measures in NHIS data, we were unable to assess measures of disease severity such as responsiveness to preventative medications, compliance with treatment, or functional limitations due to asthma [37]. Also, the differing results from the 2013–2015 crude model (Model 1) and 2013 only model (Model 3), particularly among Puerto Rican and Hispanic other children in no longer researching statistical significance is suggestive of altering percentages of these subgroups year to year, limiting the accuracy of estimates using the smaller size in 2013 only data.

Our study also had notable strengths. First, we used nationally representative data allowing our results to be generalizable to the United States population of children living with current asthma. Second, we captured race/ethnicity with six categories to more accurately represent the diverse racial and ethnic makeup of the United States population, in contrast to studies that only examine the black-white disparities or are unable to disaggregate among Hispanic subgroups in childhood asthma disparity [7,9–12]. The use of NHIS data allows for disaggregation of Hispanic children into subgroups, differentiating between Puerto Rican, Mexican American, and Hispanic other children [18,38,39]. Many other studies aggregate Puerto Rican and Mexican American children into one “Latino” or “Hispanic” category [21]. Our results reveal differences between Puerto Rican and Mexican American children in terms of both asthma prevalence and emergent health care use, suggesting that aggregation of these two subgroups masks important differences in asthma morbidity disparities among Hispanic children.

Conclusion

Our study demonstrated notable differences in the 2013–2015 waves of NHIS data in emergent health care use due to asthma across minority subgroups, which persisted after adjustment of sociodemographic factors, health conditions, and access to health care. The inclusion of the independent assessment of asthma management variables in the logistic regression models in the 2013 wave resulted in a

combination of attenuated odds and increase in odds among minority groups compared to non-Hispanic white children, however these observed changes were only modest. Asthma disparities in childhood asthma are well known and have been documented in the clinical research literature since the 1980s. Increasingly, there have been many success stories from state and local health departments who receive funding from CDCs National Asthma Control Program (NACP) to increase asthma awareness, encourage asthma management, and reduce environmental triggers in the home, which has resulted in reduction in asthma related emergency room visits and hospitalizations [40,41]. Despite these statewide gains, our study emphasizes the continued national level asthma disparities that exist using recent years of NHIS data. Today, 26 states do not receive funding from the NACP, highlighting the need for expansion and sustainment of evidenced based programs to target populations most in need. As we are nearing the Healthy People 2020's objective to reduce asthma disparities, continued research is needed in parallel to the expansion of evidenced based programs to further elucidate the mechanisms underlying disparities across an increasingly diverse United States.

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Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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