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Uncontrolled asthma and household environmental exposures in Puerto Rico

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Abstract

Objective: To describe asthma control and household environmental exposures among adults and children with asthma in Puerto Rico.

Methods: A cross-sectional analysis was conducted using data from the 2014–2016 Behavioral Risk Factor Surveillance System Asthma Call-back Survey on 931 adults and 177 children with current asthma in Puerto Rico. These data were analyzed to assess the prevalence of uncontrolled asthma in Puerto Rico and potential associations with household environmental exposure to cockroaches, smoke, and mold. Asthma control was classified using daytime and nighttime symptoms, activity limitation, and short-acting beta agonist use. Prevalence and prevalence ratios were calculated, adjusting for sample weighting.

Results: An estimated 53% of adults with asthma and 29% of children with asthma in Puerto Rico have uncontrolled asthma. Among adults with asthma, in the past 30 days, 29% had seen or smelled mold and 50% had seen cockroaches; in the past week, 12% reported having someone smoke in their home. Adults with uncontrolled asthma were 1.4 times more likely to have observed mold in their homes than were those with controlled asthma when adjusting for age, sex, education, and income (prevalence ratio [95% confidence interval]: 1.4 [1.1, 1.8]). Children with uncontrolled asthma were also more likely to have mold observed in their home than were children with controlled asthma (adjusted PR[95% CI]: 3.0 [1.3, 7.1]).

Conclusions: Uncontrolled asthma is common among adults and children with asthma in Puerto Rico. These results suggest potential differences in household mold exposure by asthma control status.

Keywords

triggers; mold; cockroaches; smoking; asthma control; allergens

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Introduction

In the United States, 19.2 million adults and 5.5 million children have asthma [1]. Uncontrolled asthma can lead to missed school and workdays, hospitalizations, and even death. Some racial and ethnic groups, including individuals in Puerto Rico, have a disproportionately high prevalence of asthma. In Puerto Rico, 11% of the population has current asthma, compared with 8% in the 50 U.S. states [2, 3]. Although asthma-related mortality is decreasing in Puerto Rico, the asthma rate in Puerto Rico during 1999–2007 was 1.77–4.01 times greater than in the rest of the United States [4]. The lifetime odds of receiving an asthma diagnosis for children in Puerto Rico are 2.3 times higher than for non-Hispanic white children in the United States [5]. Asthma control includes reducing symptom-related impairment and functional limitations, preventing exposure to asthma triggers, and reducing risk for future asthma attacks [6]. Asthma control has been associated with better health indicators, reduced cost of treatment, and fewer workdays lost [7].

The tropical island of Puerto Rico differs from other parts of the United States in climate and environmental exposures. These environmental differences might influence asthma rates in Puerto Rico. Studies show that dust storms in the Caribbean might be associated with increased hospital stays for asthma [8]. Environmental exposure to mold and airborne particulate matter has been associated with increases in outpatient, hospital, and emergency department claims for asthma in Puerto Rico [9]. Additionally, the infectious season for respiratory syncytial virus, an asthma trigger [10], is longer in Puerto Rico than in other parts of the United States, which could be associated with an increase in asthma symptoms during that time [11].

Eliminating exposure to environmental triggers of asthma, such as pests, mold, and smoke, can help prevent asthma exacerbations in adults and children [6]. We know that asthma incidence is higher in Puerto Rico than in other parts of the United States, but little is known about asthma control and asthma triggers in Puerto Rico. The objective of this study was to describe asthma control and household environmental exposures among adults and children with asthma in Puerto Rico. We hypothesized that there are differences in household environmental exposures by asthma control status among adults and children with asthma in Puerto Rico.

Methods

Asthma Call-back Survey

A cross-sectional analysis was conducted using data from the Behavioral Risk Factor Surveillance System (BRFSS) which is a telephone survey that gathers information on health-related behaviors and chronic diseases in all U.S. states, the District of Columbia, and three U.S. territories, including Puerto Rico [12]. Data were collected using the Asthma Call-back Survey which is a survey developed by the Asthma and Community Health Branch at the Centers for Disease Control and Prevention. The Asthma Call-back Survey is given to BRFSS respondents who report ever being diagnosed with asthma and collects data on a wide range of information including asthma history and symptoms, health care

utilization, asthma management, and environmental exposures [13]. The BRFSS uses sample weighting to adjust for unequal probability of being selected and differential non-response [12].

Approximately 2 weeks after completing BRFSS, respondents identified as having asthma are called back and invited to participate in the Asthma Call-back Survey. In states that include children for BRFSS, randomly selected children who have asthma are also eligible for the Asthma Call-back Survey [14]. Puerto Rico randomly selects adults and children with asthma for this survey. Parents or guardians of children with asthma complete the survey for their children. Because of the small numbers of children and adults participating in the Asthma Call-back Survey in Puerto Rico, 3 years of data (2014, 2015, and 2016) were combined to produce stable estimates. In Puerto Rico, between 2014 and 2016, the BRFSS survey had a response rate between 53% and 59% and the Asthma Call-back Survey had a response rate between 50% and 57% [12, 14].

Study Variables

In this study, we analyzed data on asthma control, environmental exposures in the home, and sociodemographic factors. As described in other analyses of the Asthma Call-back Survey [15], asthma control was classified using frequency of daytime symptoms in the past 30 days, frequency of nighttime awakenings in the past 30 days, number of limited activity days in the past 30 days, and use of short-acting β−2 agonists for symptom control in the past 3 months. Adults were classified as having uncontrolled asthma if they reported experiencing daytime symptoms >2 days per week, nighttime awakenings >2 times per month, moderate to a lot of limited activity days per month and use of short-acting β−2 agonists >2 days per week. For children, definitions of controlled and uncontrolled asthma vary by age group (Table 1).

The definitions we used differ from those previously used when analyzing Asthma Call-back Survey data [16]. In previous versions of the survey, activity limitation was assessed in the past 12 months, rather than the past 30 days, and so was excluded from previous control definitions.

Environmental exposure data were collected by asking the following survey questions: “In the past 30 days, has anyone seen a cockroach inside your home?” “In the past 30 days, has anyone seen or smelled mold or a musty odor inside your home? Do not include mold on food” and “In the past week, has anyone smoked inside your home?” [14]. Sociodemographic variables included age, sex, household income (<$15,000, $15,000 to <$25,000, or ≥$25,000), and education level of adults. Due to low counts of household incomes in higher income categories, income was grouped into only three categories with the highest being ≥$25,000.

Analysis

For this analysis, we first examined the prevalence of uncontrolled asthma in Puerto Rico in children and adults. Next, we assessed prevalence of environmental exposure to pests, smoke, and mold in the home and their potential associations with uncontrolled asthma. Analyses were restricted to persons with current asthma who answered “yes” to the

questions “Have you ever been told by a doctor, nurse, or other health professional that you (or your child) had asthma?” and “Do you (or your child) still have asthma?”, consistent with other analyses of the Asthma Call-back Survey [16]. Unweighted numbers and weighted percentages of demographic categories were calculated among survey respondents with current asthma and also restricted to persons with uncontrolled asthma. Weighted percentages and unadjusted and adjusted prevalence ratios were calculated to assess differences in the presence of environmental exposures in the home by asthma control status. Predicted marginal probabilities from logistic regression models were used to calculate prevalence ratios, controlling for age, sex, education (for adults), and household income [17]. A separate model was run for each environmental exposure. SAS 9.4 (SAS Institute, Cary, North Carolina) and SAS-callable SUDAAN (RTI International, Research Triangle Park, North Carolina) were used for this analysis.

Results

Characteristics of people with current asthma

Combining data from the 2014–2016 Puerto Rico Asthma Call-back Surveys yielded a sample of 931 adults with current asthma. Through survey weighting, this sample is representative of 478,076 adults with asthma in Puerto Rico. Among adults in Puerto Rico with current asthma, 67% were female (Table 2). Almost half of persons with asthma (48%) had their highest level of education as finishing high school or having less education that that. Persons with the lowest household income (<$15,000 annually) represented 51% of current asthma cases. Only 19% of adults with current asthma had an annual household income of ≥$25,000. Overall, 53% of adults with asthma in Puerto Rico had uncontrolled asthma. Examining differences in asthma control by age, persons aged 65–74 years were the most likely to have uncontrolled asthma (69%); persons aged 18–24 years were the least likely to have uncontrolled asthma (32%). Comparing uncontrolled asthma across educational attainment levels and household income, uncontrolled asthma was most common among adults who had less education than a high school diploma (60%) and among those with a household income <$15,000 (56%).

Data were available for 177 children with current asthma, who through sample weighting were representative of 201,838 children with asthma in Puerto Rico. Approximately half of children with asthma were aged ≤9 years (Table 2). Among children with asthma, 52% were male, 53% had an annual household income <$15,000, and 29% had uncontrolled asthma. Children aged ≤9 years were more likely to have uncontrolled asthma (38%) than were children aged 10–17 years (20%). Comparing across household income levels, 34% of children with an annual household income <$15,000 had uncontrolled asthma compared with 28% among those with a household income ≥$25,000.

Environmental exposures in the home among people with asthma

Among adults with asthma in Puerto Rico, in the past 30 days, 29% had seen or smelled mold in their home, 50% had seen cockroaches in their home, and, in the past week, 12% reported having someone smoke in their home (Table 3). Examining differences by education level, the highest prevalence of observing mold or having smoking in the home

were among persons with a high school diploma or less education than that (31% and 16%, respectively). Smoking in the home was reported by 15% of adults with a household income <$15,000 annually, compared with 4% of adults with a household income ≥$25,000 annually. No similar trends by education and income were observed for cockroaches in the home.

All household environmental exposures examined were reported at lower percentages in homes of children with asthma than in homes of adults with asthma. Mold was reported in 11% of homes of children with current asthma, cockroaches in 40%, and smoking in the home in 3% (Table 3). Mold was reported the least in homes of children in the lowest income families (8%), compared with those of higher income families (14% to 15%). We observed no substantial variation across income levels of prevalence of cockroaches in the homes of children with asthma. The sample size was too small to address differences in smoking prevalence in the homes of children with asthma across demographic categories.

Asthma control and environmental exposures in the home

Comparing differences in environmental exposures by asthma control, adults with uncontrolled asthma were more likely to have seen or smelled mold in their homes in the past 30 days than were adults with controlled asthma (34% vs. 23%) (Table 4). These differences persisted when adjusting for age, sex, education, and household income (prevalence ratio [PR]: 1.4; 95% confidence interval [CI]: 1.1–1.8). However, adults with uncontrolled asthma were less likely to report smoking in their home than were adults with controlled asthma (10% vs. 15%). We observed no differences by categories of asthma control in frequency of cockroaches in the home.

Similar to the results observed in adults, when controlling for age, sex, and household income, children with uncontrolled asthma were 3 times more likely to have mold reported in their homes than were children with controlled asthma (PR: 3.0; 95% CI: 1.3–7.1) (Table 4). There was no evidence of significant differences in the prevalence of cockroaches or smoking in the homes of children with controlled asthma and those with uncontrolled asthma.

Discussion

We used BRFSS Asthma Call-back Survey results from 2014–2016 to describe asthma control and environmental exposures among children and adults with asthma in Puerto Rico. We found that 53% of adults with asthma and 29% of children with asthma in Puerto Rico had uncontrolled asthma. When examining differences in asthma control by demographic group in Puerto Rico, the largest proportion of adults and children who have uncontrolled asthma (56% and 34%, respectively) fall into the lowest income group (<$15,000 annually). The results indicate that, in Puerto Rico, a lower proportion of persons in households with lower income and education levels have their asthma under control than do those in households with higher income and education levels. When comparing to the rest of the United States, in analyses of the Asthma Call-back Survey across all states and territories that conduct the survey, 50% of adults and 38% of children with current asthma had

uncontrolled asthma [16]. Similarly, across the rest of the United States, having uncontrolled asthma is associated with being in the lowest income group [16].

This analysis found that the environmental exposures of mold and cockroaches were common in the homes of adults with asthma in Puerto Rico. The results also suggest that adults with lower education levels and lower household incomes who have asthma might live with higher levels of some household environmental triggers, which is consistent with results from a study in Boston that identified differences in indoor allergen levels by socioeconomic status [18]. The same trend was not observed in children; prevalence of exposure to environmental allergens was not highest among children with the lowest household incomes. When controlling for covariates, our study only identified mold exposure, and not cockroaches or smoking in the home, as being more common among adults and children with uncontrolled asthma.. The findings are consistent with a study that identified increased levels of mold to be associated with increases in emergency department, inpatient, and hospitalization claims for asthma [9]. Another study found that people with asthma in Puerto Rico are more likely to adopt indoor environmental control measures, such as use of dust mite-impermeable pillow cover or mattress encasements, but less likely to use an exhaust fan, which can reduce indoor environmental triggers such as mold and smoke [19].

This study did not observe a higher prevalence of cockroaches or smoking in the home, both known asthma triggers [20], among adults with uncontrolled asthma compared with adults with controlled asthma. There are several potential explanations for this finding. For example, it is possible that persons with uncontrolled asthma may be more likely to take steps to reduce cockroach and smoke exposure in their homes in order to prevent further asthma exacerbations. Future studies with information on temporality will help elucidate these relationships.

Given the higher prevalence of asthma in Puerto Rico than in the rest of the United States, this analysis provides important insight into the demographic characteristics of people with asthma and household environmental factors associated with asthma control in Puerto Rico. A strength of this analysis is use of data from the BRFSS and the Asthma Call-back Survey, which have been tested and validated to capture information on a variety of health behaviors and exposures. Additionally, this study classifies people with asthma into asthma control categories based on The Expert Panel Report 3 (EPR-3): Guidelines for the Diagnosis and Management of Asthma, which takes into account many different aspects of asthma management [21]. The methods for weighting these survey results allows the smaller survey sample from across 3 years to be representative of the larger population of people with asthma in Puerto Rico.

This analysis did not examine the impact of race on asthma control because of differing concepts of race categories in Puerto Rico compared with those in mainland United States [22]. The Asthma Call-back Survey is subject to social desirability bias because all information is self-reported. Respondents might not feel comfortable admitting that they smoke in their home or have pests and mold, which would result in an underestimate in the prevalence of environmental exposures. This might be especially true when caregivers are

reporting results for their children, which could have contributed to the lower percentages of reported environmental exposures among children than among adults. Future studies that are able to use more objective environmental sampling measures will help accurately describe trends in household exposures. Furthermore, the BRFSS Asthma Call-back Survey is a cross-sectional study so it is not able to determine temporality between environmental exposures and asthma control. Finally, because of the low number of respondents among children with asthma, we could not examine smaller age groups of interest, such as children aged ≤5 years.

Conclusions

The results from this study help us better understand asthma control and environmental exposures among patients with asthma in Puerto Rico. The findings suggest that environmental exposures are common in the homes of adults with asthma in Puerto Rico. In addition, children and adults in Puerto Rico with uncontrolled asthma are more likely than those with controlled asthma to have observed mold in the home. Results on differences by education and income suggest that people among lower education levels and household income groups might need to be prioritized for outreach and communication about reducing environmental triggers such as mold in the home. Additional studies that sample environmental exposures in homes of patients with asthma in Puerto Rico will further our understanding of this important topic area.

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Table 1.

Classification of asthma control among children and adults with asthma adopted from the National Asthma Education and Prevention Program Expert Panel Report 3 guidelines[21]

Measure for current impairment	Controlled asthma	Uncontrolled asthma
Daytime symptoms (past 30 days)	≤2 days a week	>2 days a week
Nighttime awakenings (past 30 days)		
Age, in years		
0–4	≤1 time a month	>1 time a month
5–11	≤1 time a month	≥2 times a month
≥12	≤2 times a month	>2 times a month
Limited activity days (past 30 days)	Not at all – a little	A moderate amount – a lot
Short-acting β−2 agonists used for symptoms control (past 3 months)	≤2 days a week	>2 days a week

Table 2.

Characteristics of people with current asthma in Puerto Rico, 2014–2016

Characteristic	Unweighted number	Weighted column %	Uncontrolled asthma weighted row % (95% CI)
Adults			
Total	931	100.0	53.4 (48.9–58.0)
Age, in years			
18–24	100	23.0	32.0 (19.4–44.6)
25–34	73	15.1	53.9 (41.0–66.8)
35–54	138	18.5	61.8 (50.8–72.7)
55–64	207	18.4	60.3 (52.0–68.6)
65–74	200	12.7	69.4 (61.8–77.0)
≥75	213	12.4	53.9 (44.8–63.0)
Sex			
Male	211	32.8	51.6 (42.0–61.2)
Female	720	67.2	54.4 (49.5–59.2)
Education level			
High school or less	418	48.4	60.4 (53.6–67.1)
Some college	225	24.5	42.2 (33.7–50.7)
College or more	287	27.1	51.2 (43.4–59.0)
Household income			
<$15,000	408	50.6	55.8 (49.3–62.3)
$15,000 to <$25,000	227	30.5	49.3 (40.6–58.1)
≥$25,000	172	19.0	51.5 (41.5–61.5)
Children			
Total	177	100.0	29.0 (21.3–36.7)
Age, in years			
0–9	83	50.4	37.7 (25.6–49.7)
10–17	94	49.6	20.1 (10.0–30.3)
Sex			
Male	98	51.9	30.5 (19.3–41.7)
Female	79	48.1	27.3 (16.1–38.5)
Household income			
<$15,000	78	52.8	33.9 (21.7–46.1)
$15,000 to <$25,000	41	24.9	27.0 (12.4–41.6)

Characteristic	Unweighted number	Weighted column %	Uncontrolled asthma weighted row % (95% CI)
≥$25,000	43	22.4	27.9 (12.2–43.6)

CI = confidence interval

Table 3.

Environmental exposures in the homes of adults and children with current asthma stratified by demographic characteristics, Puerto Rico, 2014–2016

Characteristic	Mold seen or smelled in the past 30 days weighted % (95% CI)	Cockroaches seen in the past 30 days weighted % (95% CI)	Smoking in the past week weighted % (95% CI)
Adults			
Total	29.1 (25.2–32.9)	50.1 (45.5–54.6)	12.2 (9.1–15.3)
Age, in years			
18–24	17.4 (9.5–25.4)	44.9 (33.0–56.8)	15.4 (7.1–23.8)
25–34	24.4 (13.8–35.0)	51.7 (38.7–64.7)	15.1 (4.5–25.7)
35–54	29.5 (19.9–39.0)	51.6 (40.9–62.3)	8.8 (3.0–14.6)
55–64	42.6 (33.9–51.2)	54.8 (46.3–63.3)	13.6 (7.5–19.8)
65–74	39.6 (31.3–48.0)	48.3 (39.7–57.0)	10.2 (5.0–15.5)
≥75	25.0 (17.1–32.9)	50.0 (40.9–59.0)	7.5 (1.9–13.1)
Sex			
Male	24.0 (16.8–31.2)	55.7 (46.0–65.5)	16.9 (9.9–23.9)
Female	31.5 (27.1–36.0)	47.3 (42.5–52.1)	9.9 (6.8–13.0)
Education level			
High school or less	31.0 (24.8–37.1)	49.4 (42.4–56.5)	15.5 (10.4–20.7)
Some college	27.6 (20.4–34.8)	55.9 (47.3–64.6)	12.2 (5.8–18.6)
College or more	27.0 (20.6–33.4)	45.9 (38.1–53.7)	6.3 (2.9–9.7)
Household income			
<$15,000	31.3 (25.3–37.4)	46.9 (40.4–53.4)	14.9 (9.7–20.2)
$15,000 to <$25,000	27.3 (19.7–34.8)	59.0 (50.5–67.5)	14.7 (8.1–21.4)
≥$25,000	31.2 (22.5–39.9)	44.7 (34.7–54.8)	3.6 (0.8–6.3)
Children			
Total	10.9 (5.6–16.2)	40.0 (30.4–49.6)	3.1 (1.0–5.2)
Age in years			
0–9	8.8 (3.3–14.2)	44.3 (31.1–57.5)	n/a[a]
10–17	13.1 (4.0–22.1)	35.7 (22.5–48.8)	5.5 (1.4–9.6)
Sex			
Male	14.4 (5.7–23.1)	37.4 (25.9–48.8)	4.5 (1.1–8.0)
Female	7.1 (1.7–12.6)	42.9 (27.7–58.0)	n/a[a]
Household Income			

Characteristic	Mold seen or smelled in the past 30 days weighted % (95% CI)	Cockroaches seen in the past 30 days weighted % (95% CI)	Smoking in the past week weighted % (95% CI)
<$15,000	7.8 (0.0–15.8)	39.6 (25.5–53.7)	5.1 (1.1–9.1)
$15,000 to <$25,000	14.2 (2.6–25.8)	39.9 (21.3–58.5)	n/a[a]
≥$25,000	14.5 (4.5–24.4)	43.4 (23.3–63.6)	n/a[a]

CI = confidence interval

[a]Result suppressed due to the small sample size resulting in an unreliable estimate

Table 4.

Asthma control and environmental exposures at home in adults and children with current asthma, Puerto Rico, 2014–2016

Environmental exposure	Uncontrolled asthma (n = 530) weighted % (95% CI)	Controlled asthma (n = 401) weighted % (95% CI)	Unadjusted PR (95% CI)	Adjusted PR (95% CI)[a]
Adults				
Mold	34.4 (28.8–40.0)	22.9 (17.8–28.0)	1.5 (1.2–2.0)	1.4 (1.1–1.8)
Cockroaches	45.7 (39.6–51.8)	55.0 (48.4–61.6)	0.8 (0.6–1.1)	0.9 (0.7–1.0)
Smoking	9.5 (6.0–13.1)	15.2 (10.0–20.5)	0.6 (0.4–0.9)	0.6 (0.4–0.9)
Children				
Mold	18.7 (4.6–32.8)	7.7 (3.2–12.2)	2.4 (1.1–4.9)	3.0 (1.3–7.1)
Cockroaches	44.6 (28.8–60.5)	38.1 (26.5–49.8)	1.2 (0.7–2.0)	1.1 (0.7–2.0)
Smoking	n/a[c]	2.5 (0.2–4.7)	1.9 (0.5–7.4)	1.3 (0.5–3.6)

PR = prevalence ratio; CI = confidence interval

PR compared prevalence of environmental exposure by asthma control

[a]Adjusting for age, sex, education level, and household income

[b]Adjusting for age, sex, and household income

[c]Result suppressed due to the small sample size resulting in an unreliable estimate