Evaluating the associations of race, ethnicity, and food allergens in the development of childhood asthma: Re-analysis of publicly available retrospective cross-sectional cohort data [version 1; peer review: peer review discontinued]

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Abstract

Asthma is among the most prevalent chronic diseases affecting children worldwide. Sociodemographic factors, such as race and ethnicity, as well as food allergens and their association with asthma, have been extensively studied in an individual manner. Less is known about how food allergens can influence the effect of sociodemographic factors on childhood asthma prevalence. In this study, we re-analyzed a publicly available retrospective cross-sectional cohort dataset of childhood asthma. Multiple logistic regression of asthma by race and ethnicity, before and after adjustment by the most prevalent allergens, was implemented to the dataset. Hispanic individuals showed a higher odds risk (ORs; 1.30, CI 1.26 – 1.35) of asthma than Non-Hispanic individuals (0.24, CI 0.23 – 0.25), but after adjustment by most frequent food allergen reactivities (shellfish, peanut, and milk), the asthma odd risks were comparable (Hispanic, 3.62 [CI 3.49 – 3.76]; Non-Hispanic, 3.51 [3.47 – 3.52]). When considering race, Black individuals (1.90, CI 1.87 – 1.94) had higher ORs of asthma than White individuals (0.21, CI 0.20 – 0.22), Asian/Pacific Islander individuals (1.00, CI 0.95 – 1.05), and Other/Unknown races (1.14, CI 1.11 – 1.27). Although the ORs increased by three to four times for all races after adjusting for the most frequent food allergen reactivities, the same pattern of childhood asthma remained when considering races (in this order, Black, Other/Unknown, Asian/Pacific Islander, and White). In the dataset evaluated in this study, food allergens modified the association of race and ethnicity with the development of asthma.

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Therefore, public health interventions that gear towards the incidence of childhood asthma should contemplate the interplay and differences in nutrition among races and ethnicities.

**Keywords**
asthma, food allergens, race, ethnicity

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Introduction

Asthma is a chronic respiratory disease affecting nearly 330 million people worldwide\(^1\). Children, whose immune system is yet to mature, are among the most susceptible to asthma. Indoor, as well as outdoor stimuli (e.g., allergens, air pollutants matter, and microbial exposures), can contribute to childhood asthma\(^2\). Outdoor allergens include traffic-related pollutants, fungal and pollen airborne allergens\(^3,4\). In recent years, food allergies have increased and, as a consequence, they can contribute to the prevalence of childhood asthma\(^1\). Allergy-induced childhood asthma is a growing public health concern, not only from increasing trends but also from heterogenous repeated exposure to stimuli.

The interplay of sociodemographic factors contributes to the incidence of childhood asthma. Ethnic, neighborhood and other sociodemographic differences have been linked to various exposure to indoor and outdoor allergens and pollutants. These differences have been associated with childhood asthma health disparities\(^5\). Nevertheless, few studies have addressed the relationship between food allergens and sociodemographic factors in childhood asthma morbidity. In this study, we reanalyzed a publicly available dataset\(^6\) employed in a study published by Hill et al.\(^7\), in which they used provider-based data to find relationships between food allergens and respiratory allergy.

Methods

Dataset

A publicly available cross-sectional cohort provider-based data (Children's Hospital of Philadelphia care network) published by Hill et al.\(^7\) was re-analyzed. It includes data on 333,200 children between infancy and 18 years of age who received one or more years of care in the primary care network. This dataset contains gender, race, ethnicity, payer type (i.e., Medicaid, non-Medicaid), and birth year information. It also includes physician-diagnosed childhood asthma, allergic rhinitis, atopic dermatitis, and food allergies: shellfish, milk, soy, egg, wheat, peanut, tree nut, walnut, pecan, pistachio, almond, basil, hazelnut, and cashew.

Statistical analysis

Statistical analysis was performed using R (version 3.5.0, \(https://www.r-project.org/\)). Descriptive analysis of demographics was published by Hill et al.\(^7\). Hill et al.\(^7\) also addressed the prevalence of eczema, childhood asthma, and rhinitis, prevalence of food allergy, and risk of childhood asthma and rhinitis by food allergens. Therefore, these results are not discussed in detail in the current study. We reported the prevalence of food allergies as well as multiple logistic regression of childhood asthma as determined by race/ethnicity before and after adjusting by reactivity to the predominant allergens. \(p\)-value <0.05 was considered statistically significant.

Results

To determine the prevalent food allergens among races and ethnicities in the dataset from Hill et al.\(^6,7\), proportions of reactivity were plotted (Figure 1). The highest food allergen reactivities were among Non-Hispanic (15%) and White (8%) individuals, and the lowest among Asian/Pacific Islander (7%) and Hispanic (0.5%) individuals. The most common reactivities were to peanut, shellfish, egg, milk, fish, and soy; except for Black individuals (highest to shellfish) the most reactive food allergen was peanut. Shellfish was the second most prevalent food allergen, except for Black (peanut) and White (milk) individuals, and Other Races (milk). These results suggest that race and ethnicity contribute to different food allergen reactivities.

Hill et al.\(^7\) have reported an association between the development of childhood asthma and food allergies. To follow the race and ethnic prevalence of food allergies and to expand Hill et al.'s, previous findings, we evaluated associations of race (Black, White, Asian/Pacific Islander, Others) and ethnicity (Hispanic vs. Non-Hispanic) with the development of childhood asthma (Table 1). Although Hispanic individuals had five times higher odds ratio (OR = 1.31) than non-Hispanic individuals (OR = 0.23), after adjusting for race, ethnicity, and top three most prevalent food allergens (peanut, shellfish, and milk), the OR was comparable (Hispanic: OR = 3.62; Non-Hispanic: OR = 3.51). Among races, Black individuals had the highest odds ratio (OR = 1.90) and White individuals the lowest (OR = 0.21) When considering race after adjusting for the top three prevalent allergens, Black individuals (OR = 5.14) had the highest OR compared to White individuals (OR = 3.47), Asian/Pacific Islander individuals (OR = 4.24), and Others/Unknown (OR = 4.45). In summary, Hispanic and Black individuals and other races had the highest ORs compared to White and Asian/Pacific Islander individuals, but the risk increased for all ethnicities and races after considering the three most prevalent food allergens.

Discussion/Conclusion

In this study, re-analysis of published and publicly available data\(^6\) was employed to expand the findings by Hill et al.\(^7\) on the association of food allergens and sociodemographic factors with the development of childhood asthma. For this purpose, logistic regressions were employed to evaluate the association of race and ethnicity in the development of asthma.

Differences in development of childhood asthma, as adjusted by food allergens, were detected not only by ethnicity but also by race. Health disparities, as determined by race and ethnicity, are well established, and our results align with previous findings\(^8,9\). In these studies, Black and Hispanic individuals have been reported to have a higher prevalence of childhood asthma. Similarly, food allergens and their association with asthma have been extensively documented\(^10\). In the current study, Hispanic and Black individuals were also the groups with the highest asthma prevalence. Furthermore, food allergens modified the effect of sociodemographic factors in asthma development.
After converting the food allergen variables into binary outcomes, the proportion of reactivity was calculated for each allergen and categories by both race and ethnicity (Hispanic and Non-Hispanic). The food allergens with the top three reactivities were included into the multiple logistic regression models.

Table 1. Odds risk of childhood asthma by race/ethnicity before and after adjustments by predominant allergens.

| Ethnicity/Race          | OR (95% CI) Before adjustment | OR (95% CI) After adjustment* |
|-------------------------|-------------------------------|-------------------------------|
| Hispanic                | 1.30 (1.26 – 1.35)            | 3.62 (3.49 – 3.76)            |
| Non-Hispanic            | 0.24 (0.23 – 0.25)            | 3.51 (3.47 – 3.52)            |
| Black                   | 1.90 (1.87 – 1.94)            | 5.13 (5.14 – 5.20)            |
| White                   | 0.21 (0.20 – 0.22)            | 3.47 (3.46 – 3.51)            |
| Asian/Pacific Islander  | 1.00 (0.95 – 1.05)            | 4.24 (4.23 – 4.32)            |
| Other Races/Unknown     | 1.14 (1.11 – 1.27)            | 4.45 (4.42 – 4.58)            |

*Adjustment for top three food allergen reactivities (peanut, shellfish, milk)

As reported by Hill et al., the dataset was a retrospective examination of health records at only one health institution, and diseases relied on diagnosis codes: the latter is often reported as a possible contributor to bias in how data is collected. Hill et al. addressed this limitation by carrying out a comparison of diagnosis codes with accepted diseases parameters. All other limitations and approaches to address previously published by Hill et al. apply to the current study as we used their publicly available dataset.

In conclusion, food allergens modified the effect of sociodemographic factors in the development of childhood asthma.

Development and implementation of asthma interventions should consider the possible confounding interaction of nutritional allergens with race and ethnicity factors.

Data availability

The dataset used in this study is available from http://doi.org/10.5281/zenodo.4452916.

The R script used in this analysis can be found in Supplementary File 1.
Competing interests
No competing interests were disclosed.

Supplementary material
Supplementary File 1: Food allergens re-analysis R script.
Click here to access the data.

References

1. Baxi SN, Phipatanakul W: The role of allergen exposure and avoidance in asthma. Adolesc Med State Art Rev. 2010; 21(1): 57–71, vi–ix.
2. Reddy MB, Covar RA: Asthma phenotypes in childhood. Curr Opin Allergy Clin Immunol. 2016; 16(2): 127–134.
3. Casas L, Tischer C, Taulé M: Pediatric asthma and the indoor microbial environment. Curr Environ Health Rep. 2016; 3(3): 238–249.
4. Ahluwalia SK, Matsui EC: The indoor environment and its effects on childhood asthma. Curr Opin Allergy Clin Immunol. 2011; 11(2): 137–143.
5. Torjusen EN, Diette GB, Breyssse PN, et al.: Dose-response relationships between mouse allergen exposure and asthma morbidity among urban children and adolescents Indoor Air. 2013; 23(4): 268–274.
6. Perzanowski MS, Chew GL, Divjan A, et al.: Early-life cockroach allergen and polycyclic aromatic hydrocarbon exposures predict cockroach sensitization among inner-city children. J Allergy Clin Immunol. 2013; 131(3): 886–893.
7. Mendell MJ, Mirer AG, Cheung K, et al.: Respiratory and allergic health effects of dampness, mold, and dampness-related agents: a review of the epidemiologic evidence. Environ Health Perspect. 2011; 119(6): 749–756.
8. Breyssse PN, Diette GB, Matsui EC, et al.: Indoor air pollution and asthma in children. Proc Am Thorac Soc. 2010; 7(2): 102–106.
9. Schulz ES, Grzuza E, Bellander T, et al.: Traffic-related air pollution and lung function in children at 8 years of age: a birth cohort study. Am J Respir Crit Care Med. 2012; 186(12): 1296–1301.
10. Quintero E, Rivera-Mariani F, Bolaños-Rosero B: Analysis of environmental factors and their effects on fungal spores in the atmosphere of a tropical urban area (San Juan, Puerto Rico). Aerobiologia (Bologna). 2010; 26(2): 113–124.
11. Graham F, Eigenmann PA: Clinical implications of food allergen thresholds. Clin Exp Allergy. 2018; 48(6): 632–640.
12. Olmedo O, Goldstein IF, Acosta L, et al.: Neighborhood differences in exposure and sensitization to cockroach, mouse, dust mite, cat, and dog allergens in New York City. J Allergy Clin Immunol. 2011; 128(2): 284–292.e7.
13. Cohen RT, Czeizel JC, Hinckson VJ, et al.: Health-care use among Puerto Rican and African-American children with asthma. Chest. 2006; 130(2): 463–471.
14. Wegiercka G, Johnson CC, Zoratti E, et al.: Racial differences in allergic sensitization: recent findings and future directions. Curr Allergy Asthma Rep. 2013; 13(3): 255–261.
15. Leong AB, Ramsey CD, Czeizel JC: The challenge of asthma in minority populations. Clin Rev Allergy Immunol. 2012; 43(1–2): 156–183.
16. Hill D, Grundmeier R, Ram G, et al.: Allergy dataset. Zenodo. 2016. http://www.doi.org/10.5281/zenodo.44529
17. Hill DA, Grundmeier RW, Ram G, et al.: The epidemiologic characteristics of healthcare provider-diagnosed eczema, asthma, allergic rhinitis, and food allergy in children: a retrospective cohort study. BMC Pediatr. 2016; 16: 133.
18. Washington OM, Curtis LM, Waite K, et al.: Sociodemographic Factors Mediate Race and Ethnicity-associated Childhood Asthma Health Disparities: a Longitudinal Analysis. J Racial Ethn Health Disparities. 2017; 1–11.
19. Koebnick C, Fischer H, Daley MF, et al.: Interacting effects of obesity, race, ethnicity and sex on the incidence and control of adult-onset asthma. Allergy Asthma Clin Immunol. 2016; 12(1): 50.
20. Keet CA, McCormack MC, Pollack CE, et al.: Neighborhood poverty, urban residence, race/ethnicity, and asthma: Rethinking the inner-city asthma epidemic. J Allergy Clin Immunol. 2015; 135(3): 655–662.
21. Fox A, du Toit G, Fooq RK: Mini Review - Asthma and food allergy. Curr Pediatr Rev. 2018.
22. Vermeulen EM, Koplin JJ, Dharmage SC, et al.: Food allergy is an important risk factor for childhood asthma, irrespective of whether it resolves. J Allergy Clin Immunol Pract. 2016; 4(4): 1336–1341.e3.
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