BRIEF REPORT

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 allergens 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.

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 worldwide¹. 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 asthma²⁻⁴. Indoor allergens frequently linked to childhood asthma include pests (dust mites, cockroaches, and mice), microbial contaminants (bacteria and fungi), and anthropogenic indoor air pollution^{3,5-8}. Outdoor allergens include traffic-related pollutants, fungal and pollen airborne allergens^{9,10}. In recent years, food allergies have increased and, as a consequence, they can contribute to the prevalence of childhood asthma¹¹. Allergy-induced childhood asthma is a growing public health concern, not only from increasing trends but also from heterogeneous 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 disparities¹²⁻¹⁵. Nevertheless, few studies have addressed the relationship between food allergens and sociodemographic factors in childhood asthma morbidity. In this study, we re-analyzed a publicly available dataset¹⁶ employed in a study published by Hill *et al.*¹⁷, 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.*¹⁷ 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.*¹⁷. Hill *et al.*¹⁷ 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.*^{16,17}, 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.*¹⁷ 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 data¹⁶ was employed to expand the findings by Hill *et al.*¹⁷ 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^{15,18-20}. 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^{21,22}. 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.

Figure 1. Prevalence of food allergen reactivity among races and ethnicities. After converting the food allergen variables into binary outcomes, the proportion of reactivity was calculated for each allergens 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)	OR (CI 95%) 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.*¹⁷, 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.*¹⁷ 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 dataset¹⁶.

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.44529>¹⁶.

The R script used in this analysis can be found in [Supplementary File 1](#).

Competing interests

No competing interests were disclosed.

Grant information

The author(s) declared that no grants were involved in supporting this work.

Supplementary material

Supplementary File 1: Food allergens re-analysis R script.

[Click here to access the data.](#)

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