

Epidemiology of Childhood Food Allergy

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Abstract

Food allergy is a public health problem that affects nearly 6 million children in the United States. The extent to which children, families, and communities live with food allergies varies as much as the range of clinical symptoms associated with the disease itself. Food allergy is defined as the reproducible adverse event that elicits a pathologic immunoglobulin E (IgE)-mediated or non-IgE-mediated reaction. Once an allergic child ingests a specific food allergen, the reaction can result in clinical symptoms ranging from mild hives to life-threatening anaphylaxis.

Not surprisingly, food allergies have been shown to limit social interactions and impair children's quality of life due to the ubiquity of food where children live, learn, and play. To ensure the safety of our children, the development of sound policy, clinical practice, and health programs must be informed by current research characterizing childhood food allergy at the population level. To set the stage for understanding the current evidence base, this article reviews: 1) epidemiology of childhood food allergy; 2) severity of symptoms; 3) geographic distribution of childhood food allergy; 4) tolerance; 5) economic impact of childhood food allergy; and 6) future directions in childhood food allergy epidemiological research.

CME EDUCATIONAL OBJECTIVES

1. Understand the prevalence and severity of childhood food allergy in the United States.
2. Describe the geographic distribution of childhood food allergy.
3. Appreciate the economic impact of childhood food allergy on families and the US health care system.

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The current prevalence of childhood food allergy in the United States has been estimated to affect 8% of the population, with 30.4% of food-allergic children reporting having multiple food allergies.¹ Previous research has indicated that in the past decade, the prevalence of childhood food allergy has increased by 18%.² The increasing prevalence rate continues to be substantiated by several data sources reporting rises in food allergy-related ambulatory care visits,² food-induced anaphylactic reactions among youth,³ and food allergy-related hospitalizations.²

The 8 most common food allergies are peanut, milk, shellfish, tree nut, egg, fin fish, wheat, and soy (see Figure 1).¹ Demographic factors are well known to be associated with the development of food allergy. For example, the progression of allergy development from infant to child to adolescent is thought to be associated with the introduction of specific foods within a typical Western diet (see Table 1). For example, within a US context, milk allergy is more prevalent in younger age categories, whereas shellfish allergy does not emerge as a prevalent food allergy until later in childhood.

Current data suggest that disparities in prevalence and management of childhood food allergy by race/ethnicity may exist. It has been noted that non-Hispanic black children are more likely to report having a food allergy.^{1,4} Furthermore, upon assessing immunoglobulin E (IgE) levels, non-Hispanic blacks were more likely to have detectable levels of IgE antibodies to peanut, milk, and shellfish when compared with whites.² Additional research also suggests that black and Asian children are more likely to report having a food allergy; yet, these children were less likely to report having received a formal diagnosis of food allergy.¹ This finding is consistent with research indicating that nonwhite children are almost twice as likely to not be referred to specialists of any kind,⁵ including allergists.

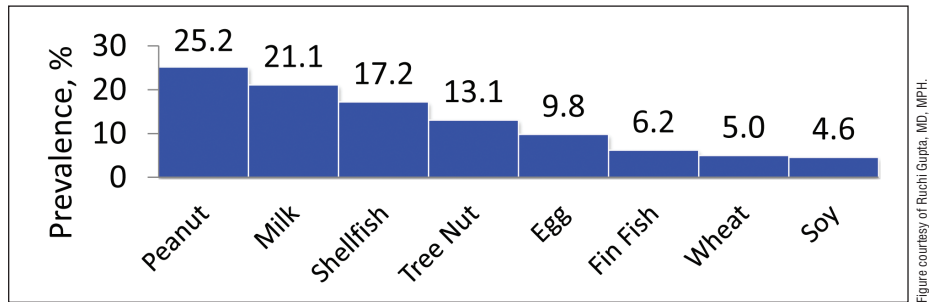


Figure 1. Prevalence by common food allergens among children with food allergies.

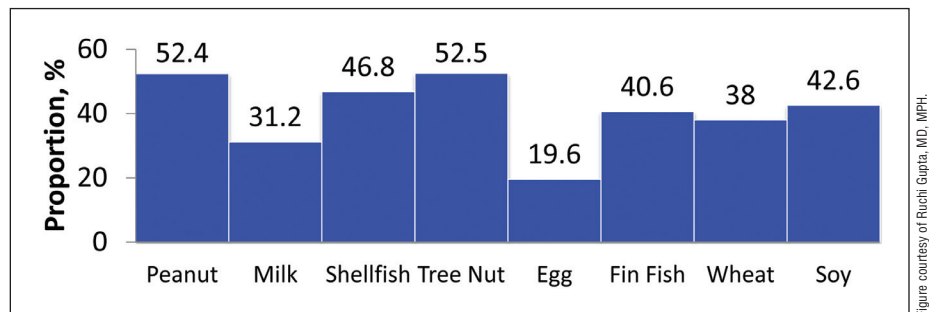


Figure 2. Children who have experienced a severe reaction by allergen.

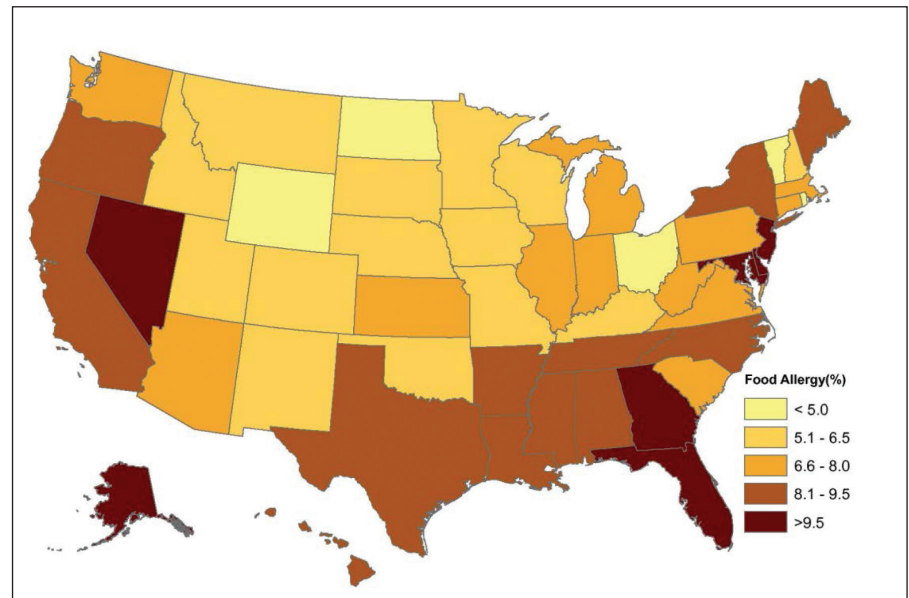


Figure 3. Geographic variability of childhood food allergy. (From Gupta et al;⁹ with permission).

Although targeted studies have shown differences in food allergies by race/ethnicity, many limitations exist within the disparities literature, including wide variations in study design, small sample sizes, and the utilization of different operational definitions pertaining to food allergy.⁴

SEVERITY OF REACTION

Reactions to food allergens vary from mild-to-moderate to severe symptomatology. Mild-to-moderate symptoms include angioedema of the lips, eyes, face, or additional body parts; oropharyngeal symptoms; eczema; flushing; hives; pruritus; and vomiting.⁶ Some signs of

severe symptomatology are low blood pressure or syncope, dyspnea, wheezing or any respiratory difficulty, multiple organ system involvement, or anaphylaxis. Anaphylaxis is a severe systemic reaction typically involving multiple organ systems, with the potential to be fatal.

Severity of reactions can differ both by allergen and by the child's age. After examining severity of reaction of the top 8 food allergens, it was found that the number of children having experienced a previous severe reaction ranged between 20% and 52% (see Figure 2) and was particularly heightened for children affected by tree nut (52.5%), peanut (52.4%), and shellfish (46.8%) allergies.¹

In addition to established variation in children experiencing a severe reaction by allergen, it is also clear that variations exist by age. Specifically, the adolescent population with food allergies to peanuts and tree nuts is at the greatest risk for experiencing a severe reaction.⁷ Previous research has shown that food-allergic youth aged 14 to 17 years were almost twice as likely to have a severe reaction history when compared with food-allergic children 2 years old and younger.¹ Adolescents with multiple food allergies were almost 3 times as likely to have experienced a severe reaction when compared with his or her single food allergy counterparts.¹ Moreover, in a study considering risk-taking behaviors and coping strategies of adolescents and young adults aged 13 to 21 years, it was found that despite having a known food allergy, many participants did not carry an epinephrine auto-injector at all times and were willing to try foods that "may contain" potentially harmful food allergens.⁸

GEOGRAPHIC DISTRIBUTION

Although previous research has clearly demonstrated an urban/rural divide related to atopic diseases (eg, asthma, eczema, allergic rhinitis), we are now

TABLE 1.

Prevalence Variation by Age among Children with Food Allergies

Age	Peanut, %	Shellfish, %	Tree Nut, %	Milk, %	Egg, %	Wheat, %
0-2 years (n = 5429)	22.2	7.5	5.4	31.5	15.8	4.0
3-5 years (n = 5910)	30.3	12.9	14.3	22.1	13.7	5.0
6-10 years (n = 9911)	22.5	17.1	14.3	19.6	11.1	5.0
11-13 years (n = 6716)	28.1	20.4	15.2	17.7	6.6	8.2
≥ 14 years (n = 10,514)	20.2	23.8	13.4	18.4	4.1	3.3

TABLE 2.

Geographic Variability of Childhood Food Allergy by Population Density

Urban Centers, 9.8%	Metro Cities, 9.2%	Urban Outskirts, 7.8%	Suburban Areas, 7.6%	Small Towns, 7.2%	Rural Areas, 6.2%
Peanut: 2.8%	Peanut: 2.4%	Peanut: 1.8%	Peanut: 2.0%	Peanut: 1.6%	Milk: 1.5%
Shellfish: 2.4%	Milk: 1.8%	Shellfish: 1.5%	Milk: 1.5%	Milk: 1.4%	Peanut: 1.4%
Finfish: 1.8%	Shellfish: 1.4%	Milk: 1.4%	Shellfish: 1.2%	Wheat: 1.1%	Shellfish: 0.8%
Milk: 1.8%	Tree Nut: 1.3%	Tree Nut: 1.0%	Tree Nut: 1.2%	Shellfish: 1.0%	Tree Nut: 0.6%
Egg: 1.3%	Egg: 1.0%	Finfish: 0.7%	Wheat: 0.8%	Tree Nut: 0.9%	Egg: 0.5%

just beginning to describe the geographic distribution of childhood food allergy. In a 2012 study, data were analyzed for more than 38,000 children in the US to describe the relationship between childhood food allergy and geography. The distribution of childhood food allergy rates was geocoded and mapped (see Figure 3).⁹

After controlling for potential confounding factors such as race/ethnicity and latitude, this research found that increased food allergy prevalence rates were associated with increased population density.⁹ A clear stepwise progression of prevalence rates in relationship

to population density can be found when comparing rural (6.2%), suburban (7.6%), and urban (9.8%) areas (see Table 2). Of note, prevalence rates of specific food allergies were found to be varied by region, with soy and milk allergies holding constant across all regions (see Table 2).⁹

One popular theory regarding the potential role of vitamin D and the geographic distribution of food allergy hypothesizes that we should see a strong north-south gradient with higher prevalence rates of food allergy at northern latitudes, and lower prevalence rates as we progress south. Although the pre-

vious geographic study did not find a north-south decrease in prevalence, myriad studies are beginning to explore this hypothesis.

For example, research examining the regional rates of epinephrine auto-injector prescriptions as a proxy for anaphylaxis found state-by-state variation in prescription rates. In this study, Epipen prescriptions substantiated the vitamin D hypothesis and followed a strong north-south gradient, with the highest concentration of epinephrine auto-injector prescriptions found in New England.¹⁰

Comparing these 2 studies is not possible because they were considering different questions, (childhood food allergy prevalence versus prevalence of anaphylaxis) and assessing different levels of data. That said, such differences in self-reported food allergy versus prescription prevalence of Epipen prescriptions illustrate the need to better understand the epidemiology of childhood food allergy by geography, prescription habits of clinicians by region, and the mechanism of the disease itself.

TOLERANCE DEVELOPMENT

Often, the first question a caregiver of a newly diagnosed food-allergic child asks their physician is, “What are the chances my child will outgrow his or her food allergy?” For a clinician, this is a difficult question to answer due to the dearth of research exploring factors associated with the development of tolerance. The few recent studies that have been conducted suggest that children with food allergies previously assumed to have a high likelihood of being outgrown are actually persisting into adolescence and beyond.¹¹ Although it is difficult to disentangle the multiple factors thought to be associated with developing tolerance, current research exploring these factors suggests that more than 26% of food-allergic children will achieve tolerance (mean age of tolerance development = 5.4 years).¹²

The limited information we do have regarding factors associated with the development of tolerance is found when studying the natural history of allergies^{11,13-20} in addition to studying risk factors and persistence of specific allergies.^{20,21} Overall, the likelihood of developing tolerance has namely been associated with the severity of reactions,

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type of food allergen, and with demographic factors.

For example, children reporting a mild-to-moderate reaction history, not being allergic to multiple foods, and being white as compared to black ($P < .05$) were more likely to develop tolerance.¹² By type of allergen, children with milk, egg, and soy allergies were more likely to outgrow their food allergies; by age, tolerance tends to occur more frequently for children reporting a younger age for first reaction.¹²

ECONOMIC IMPACT OF CHILDHOOD FOOD ALLERGIES

Childhood food allergy impacts both the health care system and US families through a variety of expenditures from emergency department visits and hospitalizations, to buying special foods and staying home to care for a child with food allergy. One previous study examined the cost of food-allergic events for a mixed child and adult population to be \$500 million.²² However, the authors themselves noted that this value may underestimate the true cost of food allergy due to missing food allergy cases by relying solely on the International Classification of Diseases-9 (ICD-9) codes. In addition, as the study focused on allergic

events, it did not capture important costs borne by families.

In a recent cross-sectional study that surveyed a representative sample of caregivers of a child with food allergy ($n = 1,643$), the combined cost of childhood food allergy totaled total \$24.8 billion annually (\$4,400 per child) with a significant proportion of the costs borne by families (\$20.5 billion).²³ In clinical practice, a clinician may want to include how childhood food allergy may impact family level expenses when counseling families and children.

CONCLUSIONS

Understanding the epidemiology of childhood food allergy is critical and should continue to guide the development and implementation of management strategies for clinicians and families alike. To better understand risks associated with developing food allergy and address potential disparities, longitudinal studies including geographically representative participants need to be conducted throughout the life of a child.

Furthermore, to better allocate resources and develop sound policies, we must begin to tease out the economic predictors associated with childhood food allergies to help decrease the burden of food allergy on both the health care system and families. Until families can safely access a cure, we must continue to improve our management strategies to ensure children with food allergies have the same opportunities to live full, productive, happy lives. ■

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