Food Allergy in the United States: Recent Trends and Costs

An Analysis of Private Claims Data

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Summary

Food allergy is a growing national health problem, affecting both children and adults. It is increasing in prevalence and its most dangerous consequence—the severe, potentially fatal reaction called anaphylaxis—is becoming more common. This analysis reports trends and patterns related to the extent and impact of food allergy and anaphylactic food reaction using data from FAIR Health, a national, independent, nonprofit organization that emphasizes transparency in healthcare costs and health insurance information. Among the findings from FAIR Health's analysis of its database of billions of privately billed healthcare claims:

- From 2009 to 2016, the percent of claim lines with food allergy diagnoses compared to all of a state's medical claim lines grew in many states.[1] For example, in 2016, the state with the highest percent was North Carolina, which had a relatively low percent in 2009.
- From 2007 to 2016, the increase in claim lines with food allergy diagnoses was greater in rural (110 percent) than urban (70 percent) areas—despite past evidence that food allergy is more common in urban areas.
- From 2007 to 2016, claim lines with diagnoses of anaphylactic food reactions rose 377 percent.
- Although food allergy is commonly thought of as a childhood condition, about a third (34 percent) of claim lines with diagnoses of food allergy from 2007 to 2016 were attributable to patients over 18 years old.
- In the period 2007-2016, claim lines with food allergy diagnoses were associated with boys more than girls during childhood (ages 0 to 18 years), but in adults the reverse was true: Food allergy claim lines were associated with women more than men.
- Anaphylaxis is typically regarded as a medical emergency, but in the period 2007-2016, most services (70 percent) provided to patients diagnosed with anaphylactic food reaction were rendered in an office setting, with only 2 percent specifically designated as occurring in an emergency room.
- Although laboratory services associated with diagnoses of anaphylactic food reaction increased 871 percent in utilization from 2007 to 2016, charges for those services increased 5,390 percent in the same period.
- The food allergy with the highest average costs and services per patient in 2016 was milk product allergy, which generally tends to be associated with the youngest patients (infants and toddlers) and with prescription formulas.

Background

In the United States and other parts of the developed world, food allergy has been growing in prevalence, though the precise rate of increase is unclear.[2] A systematic review of studies on food allergy in US children from 1988 to 2011 found an increase of self-reported food allergy of 1.2 percentage points per decade.[3] The Centers for Disease Control and Prevention (CDC) stated in 2008 that the prevalence of

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[1] Claim lines are the individual procedures or services listed on an insurance claim. In figures in this report not related to state-by-state analysis, "percent of claim lines" usually means the percentage that claim lines associated with a given diagnosis in a given year bear to the total claim lines with that diagnosis throughout a designated period.
[2] Joyce Irene Boye, "Food Allergies in Developing and Emerging Economies: Need for Comprehensive Data on Prevalence Rates," *Clin Transl Allergy* 2, no. 1 (2012): 25; doi:10.1186/2045-7022-2-25.
[3] Corinne A. Keet et al., "Temporal Trends and Racial/Ethnic Disparity in Self-Reported Pediatric Food Allergy in the US," *Ann Allergy Asthma Immunol* 112, no. 3 (2014): 222-29.e3; doi:10.1016/j.anai.2013.12.007.

reported food allergy grew 18 percent among children from 1997 to 2007.[4] Another CDC study found the increase in food allergy prevalence among children to be 50 percent from 1997-1999 to 2009-2011.[5]

Food allergy, a condition in which the immune system reacts to certain foods that are normally considered harmless, is not only bothersome and restricting; it also can result in severe morbidity and even mortality. Anaphylaxis, a severe, life-threatening allergic reaction that can be triggered by food or other allergens, accounts for 186 to 225 deaths per year in the United States.[6] A study of pediatric emergency room visits and hospital admissions in Illinois due to anaphylaxis induced by food found that such visits and admissions grew annually by 29.1 percent from 2008 to 2012.[7]

Food allergy is more common in children than adults, but it is not restricted to children. Estimates of the proportion of children with food allergy range from approximately four[8] to eight percent,[9] and estimates of the proportion of adults with food allergy range from one[10] to three percent.[11] Although some children outgrow some food allergies, there have been reports that children may be outgrowing them more slowly than in the past.[12]

A number of genetic and environmental risk factors for food allergy have been identified, but it remains uncertain why food allergy is increasing in prevalence.[13] Greater awareness and detection of food allergy,[14] decreases in exposure to microbes early in life, changes in how food is manufactured and alterations in the human microbiome may all play a role.[15]

To shed light on recent trends and patterns related to food allergy and anaphylactic food reaction in the American privately insured population, FAIR Health analyzed its database of over 24 billion privately billed healthcare procedures. The study included analysis of the prevalence of food allergy, as measured in geographic patterns (state-by-state and urban/rural), anaphylactic food reaction trends and demographic patterns (age and gender). It also included examination of the impact on the healthcare

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[4] Amy M. Branum and Susan L. Lukacs, *Food Allergy among U.S. Children: Trends in Prevalence and Hospitalizations*, NCHS Data Brief, no. 10; Hyattsville, MD: National Center for Health Statistics, 2008; https://www.cdc.gov/nchs/data/databriefs/db10.pdf.
[5] Kristen D. Jackson, LaJeana D. Howie and Lara J. Akinbami, "Trends in Allergic Conditions among Children: United States, 1997-2011," NCHS Data Brief, no. 121; Hyattsville, MD: National Center for Health Statistics, 2013; https://www.cdc.gov/nchs/data/databriefs/db121.pdf.
[6] American Academy of Allergy, Asthma & Immunology, "Death from Anaphylaxis Is a Reassuringly Unusual Outcome," December 13, 2013, https://www.aaaai.org/global/latest-research-summaries/Current-JACI-Research/death-anaphylaxis.
[7] Ashley A. Dyer et al., "Pediatric Emergency Department Visits and Hospitalizations Due to Food-Induced Anaphylaxis in Illinois," *Ann Allergy Asthma Immunol* 115, no. 1 (2015): 56-62; doi:10.1016/j.anai.2015.05.006.
[8] Branum and Lukacs, *Food Allergy among U.S. Children*.
[9] Ruchi S. Gupta et al., "The Prevalence, Severity, and Distribution of Childhood Food Allergy in the United States," *Pediatrics* 128, no. 1 (2011): e9-17; doi:10.1542/peds.2011-0204.
[10] Stacie M. Jones and A. Wesley Burks, "Food Allergy," *N Engl J Med* 377, no. 12 (2017): 1168-76; doi:10.1056/NEJMcp1611971.
[11] Leticia Tordesillas, M. Cecilia Berin and Hugh A. Sampson, "Immunology of Food Allergy," *Immunity* 47, no. 1 (2017): 32-50; doi:10.1016/j.immuni.2017.07.004.
[12] Jessica H. Savage et al., "The Natural History of Egg Allergy," *J Allergy Clin Immunol* 120, no. 6 (2007): 1413-17; doi:10.1016/j.jaci.2007.09.040.
[13] Jessica Savage and Christina B. Johns, "Food Allergy: Epidemiology and Natural History," *Immunol Allergy Clin North Am* 35, no. 1 (2015): 45-59; doi:10.1016/j.iac.2014.09.004.
[14] Jacob Kattan, "The Prevalence and Natural History of Food Allergy," *Curr Allergy Asthma Rep* 16, no. 7 (2016): 47; doi:10.1007/s11882-016-0627-4.
[15] Jones and Burks, "Food Allergy."

system, as seen in places of service, most common procedure code categories, and costs and number of services per patient.

Methodology

FAIR Health analyzed private insurance claims associated with allergy diagnoses, evaluated claim characteristics (such as age and gender of patient and location of service) and examined procedure codes reported on the claims. Trends and patterns in utilization and costs were then identified. The claims-level analysis is a strength of the study. Claims reflect healthcare usage and the information provided on claims reflects the assessments of providers, whose training and experience make them better judges of health conditions than laypeople. The rest of this section describes the methodology in more detail.

Using the International Classification of Diseases (ICD-9-CM and ICD-10-CM) diagnostic codes reported on claims in the FAIR Health dataset, FAIR Health examined claims that were indicative of a food allergy (e.g., ICD-9-CM V15.01, Hx-peanut allergy, and ICD-10-CM Z91.010, peanut allergy) and anaphylaxis associated with a particular food (e.g., ICD-9-CM 995.64, anaphylactic reaction to tree nuts/seeds, and ICD-10-CM T78.00XA, anaphylactic reaction to other specific foods).

Although anaphylactic reaction to tree nuts/seeds (ICD-9-CM 995.64, ICD-10-CM T78.05XA, T78.05XD, T78.05XS) and anaphylactic reaction to crustaceans (ICD-9-CM 995.62, ICD-10-CM T78.02XA, T78.02XD, T78.02XS) are specifically segregated out within the International Classification of Diseases, their corresponding "history of" (Hx-) or diagnoses of the allergies are not. Tree nut/seed allergies are grouped into the ICD-9-CM Hx-other food allergy (V15.05) and ICD-10-CM other food allergy (Z91.018); crustacean allergies are grouped into the ICD-9-CM Hx-seafood allergy (V15.04) and ICD-10-CM seafood allergy (Z91.013).

Data were evaluated by stratifying them by gender, age, type of food causing the allergy or reaction and the location in which the service was performed, using a combination of the US Census Bureau's classification categorizations, including the urban-rural data, and the FAIR Health geozip paradigm, which divides the United States into 493 separate geographic regions.

Analysis was conducted on CPT® codes[16] (maintained by the American Medical Association [AMA]) and HCPCS Level II codes (maintained by the Centers for Medicare & Medicaid Services [CMS]), such as office or outpatient services established patient (E&M; e.g., CPT 99214, office outpatient visit, 25 minutes), immunology services (e.g., CPT 86003, allergen specific IgE quantitative or semi quantitative, each allergen) and allergy testing (e.g., CPT 95004, percutaneous tests with allergenic extracts).

The data were aggregated by a variety of key fields, including state, procedure code category (e.g., allergy testing, immunology services, office or outpatient services established patient), gender, age and year of service, to identify trends and patterns in utilization and cost by both charges and imputed allowed amounts.[17] The data were evaluated with single and multiple variables to look for distinct trends and associations.

In the graphical representations below, the term "claim lines" refers to the individual procedures or services listed on insurance claims. (The terms "procedures" and "services" are used interchangeably in this report.) A single claim for one patient may have multiple claim lines. "Percent of claim lines" is the percent of all claim lines associated with a given grouping of diagnosis codes (e.g., codes associated with food allergy diagnoses) in a given time period (e.g., 2007-2016). All charges and allowed amounts are

[16] CPT © 2016 American Medical Association (AMA). All rights reserved.
[17] Imputed allowed amounts are estimates of the amounts typically negotiated between payors and providers.

based on data in the FAIR Health repository of claim records contributed by payors and administrators who insure or process claims for private insurance plans covering more than 150 million individuals.

Geographic Patterns

State-by-State Trends, 2009-2016

In 2016, the percent of claim lines with food allergy diagnoses compared to all medical claim lines that were submitted for a state in the FAIR Health dataset was higher in many states than it was in 2009. In the heat maps below, where dark green represents the lowest percent of claim lines with food allergy diagnoses and red the highest, there was a shift in many states from mostly dark and moderate green in 2009 (figure 1) to pale green, yellow and orange in 2016 (figure 2). For example, in 2009, North Carolina was a moderate green (relatively low percent of claim lines with food allergy diagnoses); in 2016, it was a bright red—in fact, it had the nation's highest percent of claim lines with food allergy diagnoses.

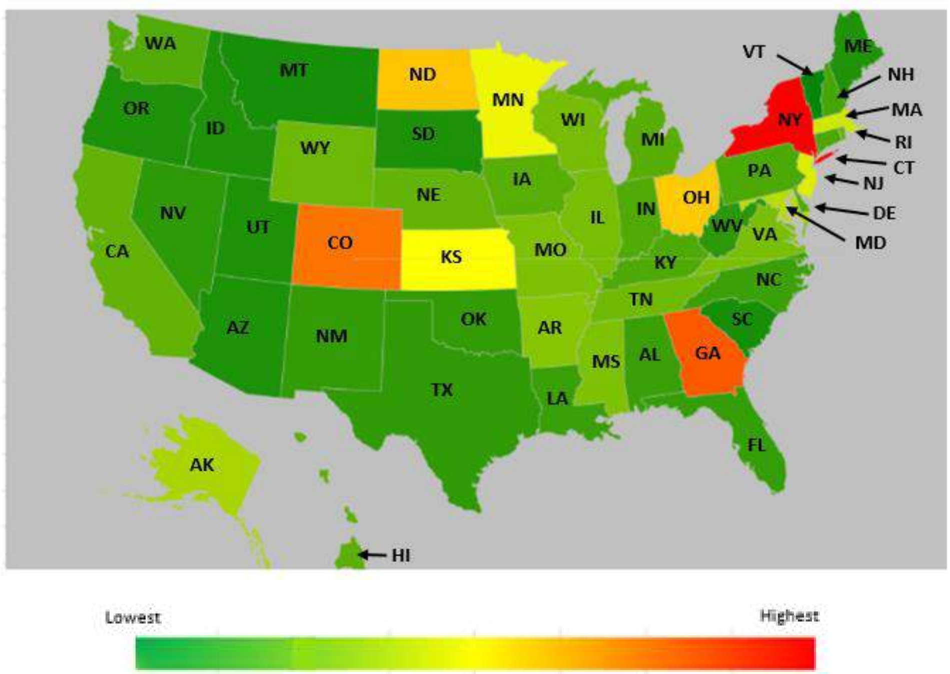

Figure 1. Percent of claim lines with food allergy diagnoses compared to all medical claim lines by state, 2009.

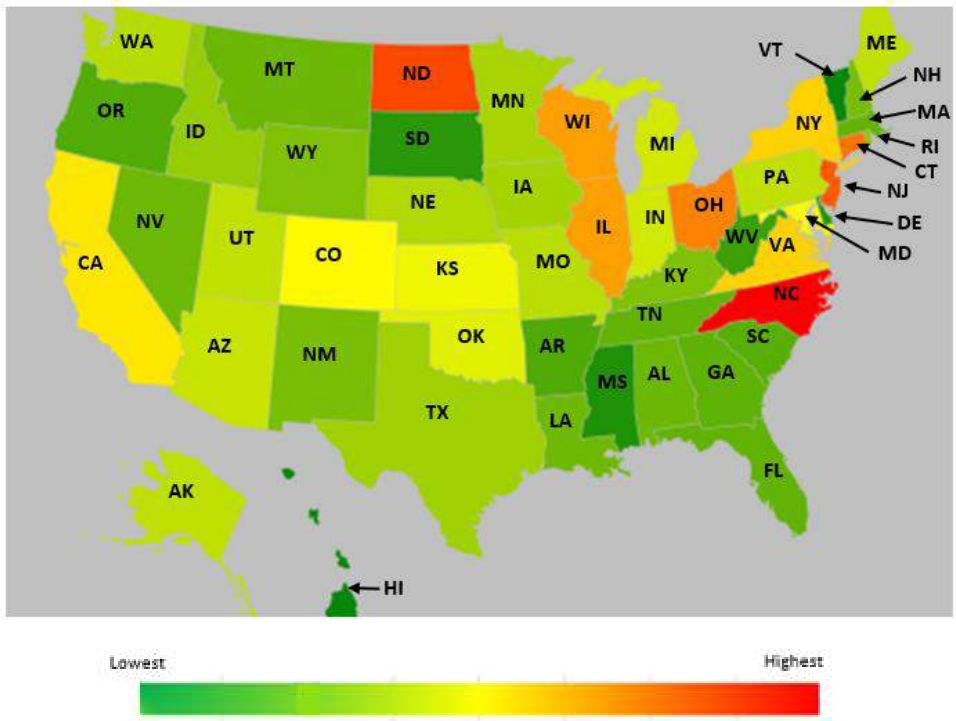

Figure 2. Percent of claim lines with food allergy diagnoses compared to all medical claim lines by state, 2016.

States with the highest percentage of food allergy diagnoses did not consistently remain at that level over time. The top five states for percent of claim lines with food allergy diagnoses in 2009 were (in order from highest to lowest) New York, Georgia, Colorado, North Dakota and Ohio. The top five states in 2016 were (in order from highest) North Carolina, North Dakota, New Jersey, Washington, DC, and Connecticut. North Dakota remained in the top five in both years, but all the other states changed. It is not known whether there are any environmental or genetic risk factors that would account for North Dakota's persistent association with food allergy.

One area of consistency among the top five states for percent of claim lines with food allergy diagnoses in 2009 and 2016 was in the most common food allergies found in both years: egg, milk product, peanut and "other" (a category that includes all nuts other than peanut). Those four allergens accounted for the top three food allergy diagnoses in all the top five states in both years, except for one outlier: seafood in North Carolina in 2016 (tables 1 and 2).

Table 1. Most common food allergy diagnoses by state, 2009 (diagnoses for each state ranked in order from most common).

Rank	Colorado	Georgia	New York	North Dakota	Ohio
1	egg	other	milk product	other	milk product
2	other	egg	other	egg	Other
3	peanut	peanut	peanut	peanut	Peanut

Table 2. Most common food allergy diagnoses by state, 2016 (diagnoses for each state ranked in order from most common).

Rank	Connecticut	New Jersey	North Carolina	North Dakota	Washington, DC
1	other	other	other	other	other
2	peanut	peanut	peanut	peanut	peanut
3	milk product	milk product	seafood	milk product	egg

The percent of claim lines with anaphylactic food reaction diagnoses compared to all medical claim lines for a state also increased in some parts of the country between 2009 (figure 3) and 2016 (figure 4). The top five states with an anaphylactic food reaction in 2009 were (in order from highest) Massachusetts, New York, Rhode Island, Maryland and Colorado. Two of those states—New York and Colorado—were also in the top five for food allergy diagnoses, suggesting the relatedness of the two diagnoses: A state with many cases of food allergy could also be expected to have many cases of anaphylactic food reaction. But the other three states—Massachusetts, Rhode Island and Maryland—were not in the top five for food allergy diagnoses in 2009, implying that the relationship may be more complex. One explanation for this finding may be cases in which a patient is previously undiagnosed with food allergy at the time he or she has an anaphylactic food reaction. A 2005 study showed that in 24 percent of cases in which epinephrine (an emergency medication for anaphylaxis) was administered in Massachusetts schools during a two-year period, the individual receiving the drug had not been known to have a life-threatening allergy.[18]

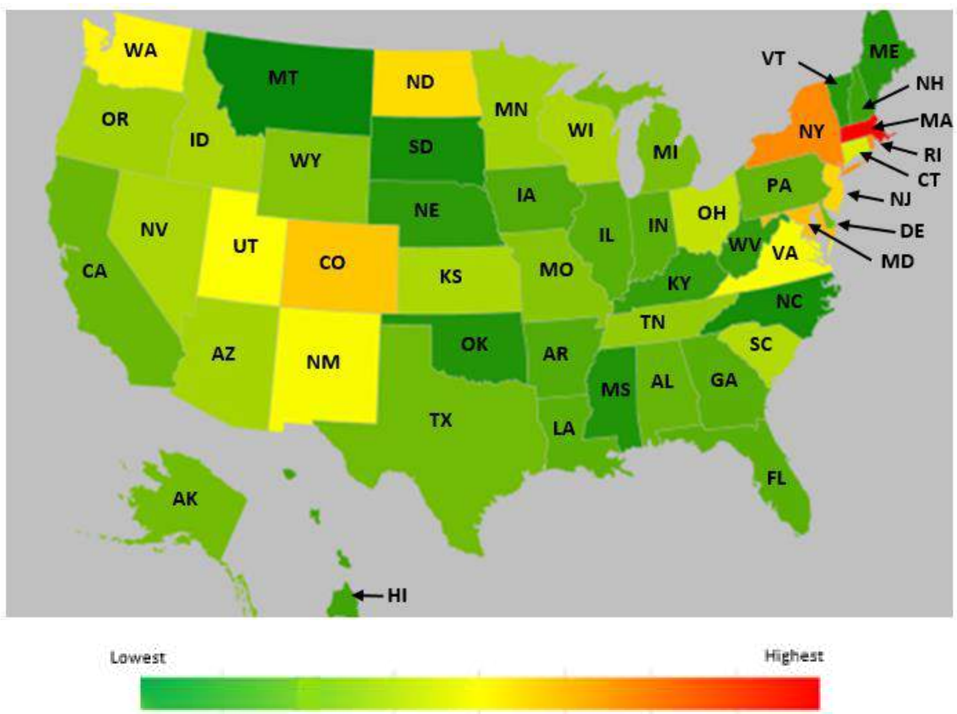

Figure 3. Percent of claim lines with anaphylactic food reaction diagnoses compared to all medical claim lines by state, 2009.

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[18] C. Lynne McIntyre et al., "Administration of Epinephrine for Life-Threatening Allergic Reactions in School Settings," *Pediatrics* 116, no. 5 (2005): 1134-40.

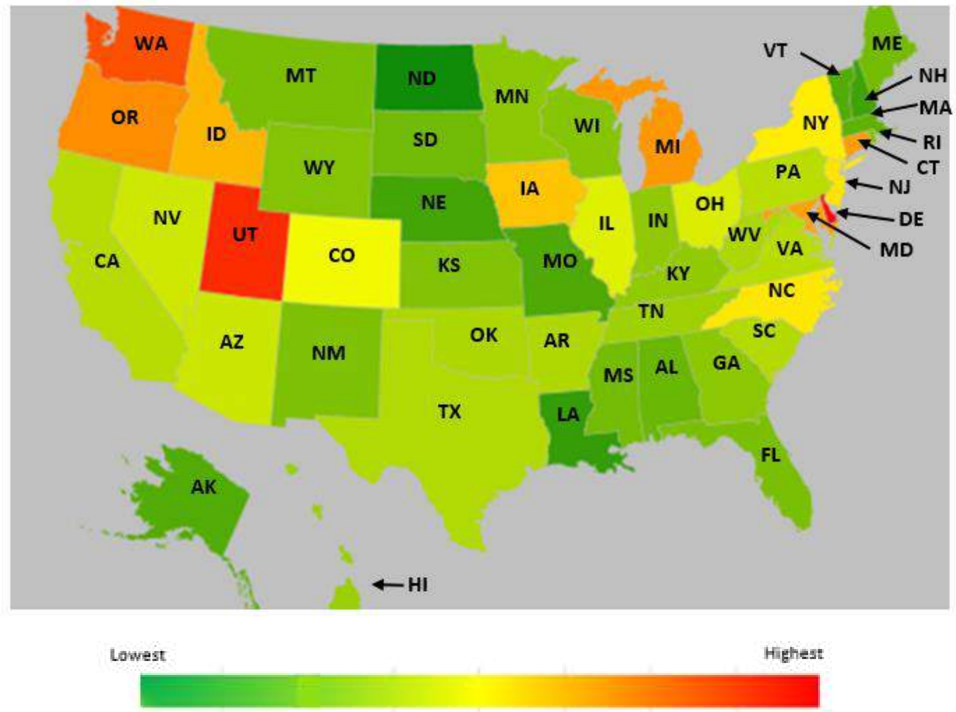

Figure 4. Percent of claim lines with anaphylactic food reaction diagnoses compared to all medical claim lines by state, 2016.

In 2016, the top five states for anaphylactic food reaction diagnoses were entirely different from the top five in 2009. The 2016 list was (in order from highest) Delaware, Utah, Oregon, Michigan and Connecticut. No states appeared on both the 2009 and 2016 top five anaphylactic food reaction lists. Connecticut was the only state in the top five for anaphylactic food reaction diagnoses in 2016 that was also in the top five for food allergy diagnoses that year.

As in the case of food allergy diagnoses, there was some consistency among the most common allergens identified in anaphylactic food reaction diagnoses in the top five states in 2009 and 2016 (tables 3 and 4). Both years showed a preponderance of peanut, tree nut/seed and "other," particularly in 2016, when those were the only diagnoses in the top three for each state. (Tree nut/seed was included in "other" in the diagnosis codes for food allergy, but broken out as a separate diagnosis in the codes for anaphylactic food reaction.) In 2009, there was a little more diversity, with Colorado and Maryland both including egg, and Colorado including fruit and vegetable. None of the states' top three lists included milk product or seafood, which were allergens identified for food allergy in the top five food allergy states in 2009/2016.

Table 3. Most common anaphylactic food reaction diagnoses by state, 2009 (diagnoses for each state ranked in order from most common).

Rank	Colorado	Maryland	Massachusetts	New York	Rhode Island
1	fruit/vegetable	other	other	other	other
2	other	egg	tree nut/seed	peanut	tree nut/seed
3	egg	peanut	peanut	tree nut/seed	peanut

Table 4. Most common anaphylactic food reaction diagnoses by state, 2016 (diagnoses for each state ranked in order from most common).

Rank	Connecticut	Delaware	Michigan	Oregon	Utah
1	other	peanut	peanut	peanut	peanut
2	peanut	tree nut/seed	other	tree nut/seed	tree nut/seed
3	tree nut/seed	other	tree nut/seed	other	other

Urban and Rural Patterns

A 2012 study found that the prevalence of childhood food allergy in the United States was greater in urban (9.8 percent) than rural (6.2 percent) areas.[19] Findings from FAIR Health's analysis reflect that distribution, showing that 60 percent of the distribution of claim lines with food allergy diagnoses in 2016 occurred in urban areas and 40 percent in rural areas (figure 5).

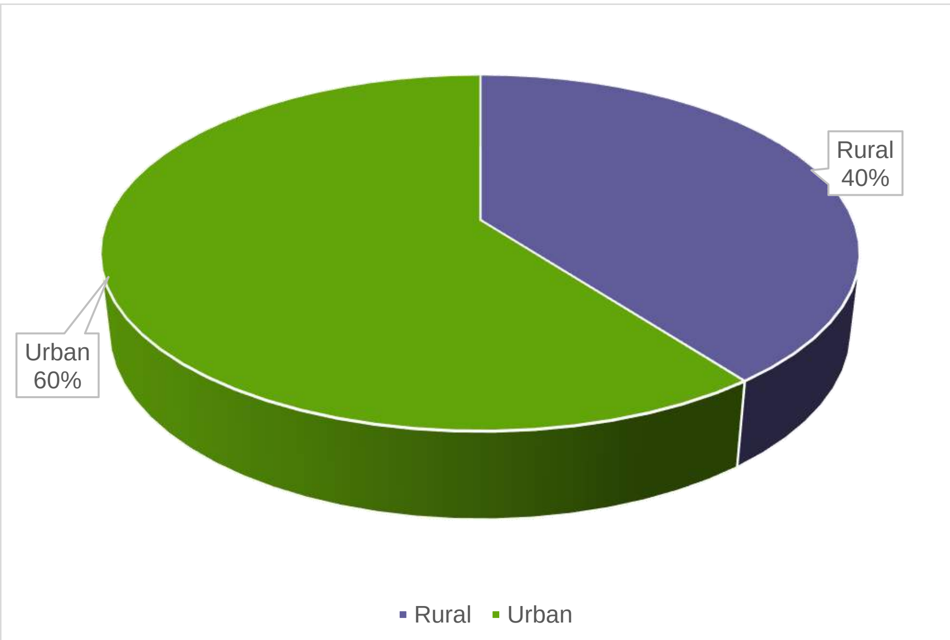

Figure 5. Urban/rural distribution of claim lines with food allergy diagnoses, 2016.

A similar distribution was found for claim lines with diagnoses of anaphylactic food reaction in 2016: 57 percent urban, 43 percent rural (figure 6).

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[19] Ruchi S. Gupta, "Geographic Variability of Childhood Food Allergy in the United States," *Clin Pediatr (Phila)* 51, no. 9 (2012): 856-61; doi:10.1177/0009922812448526.

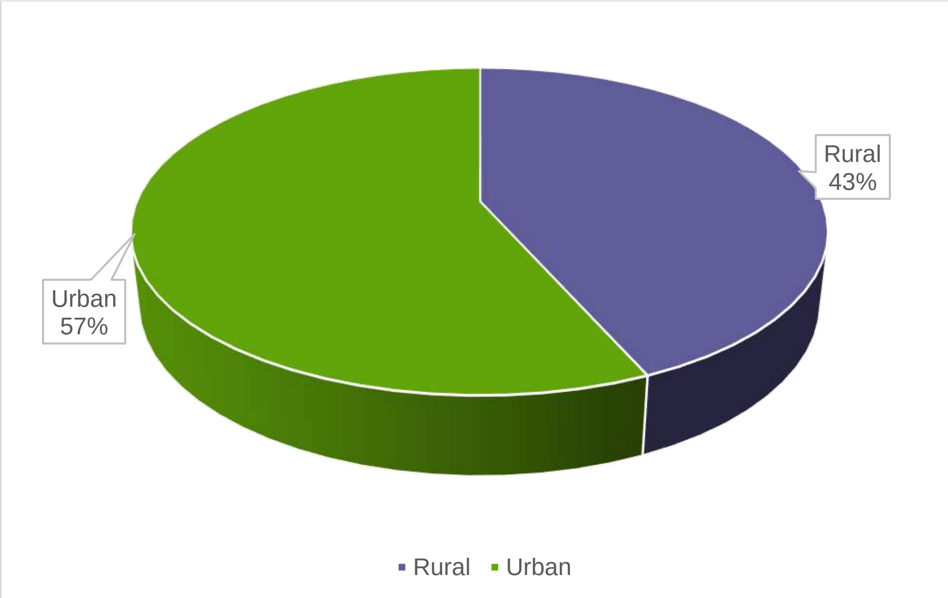

Figure 6. Urban/rural distribution of claim lines with anaphylactic food reaction diagnoses, 2016.

Despite the evidence of greater prevalence of food allergy in urban than rural areas, there were increases in food allergy diagnostic claims in rural as well as urban areas. From 2007 to 2016, claim lines with food allergy diagnoses increased in both rural and urban areas (although the percent of total claim lines associated with food allergy diagnoses in each area decreased in 2016), and the increase was greater in rural (110 percent) than urban (70 percent) settings (figure 7). The greater growth in rural than urban areas calls into question the "hygiene hypothesis," which postulates a protective effect against allergy from farm living due to greater childhood exposure to microbes.[20]

[20] Sally F. Bloomfield et al., "Too Clean, or Not Too Clean: The Hygiene Hypothesis and Home Hygiene," *Clin Exp Allergy* 36, no. 4 (2006): 402-25.

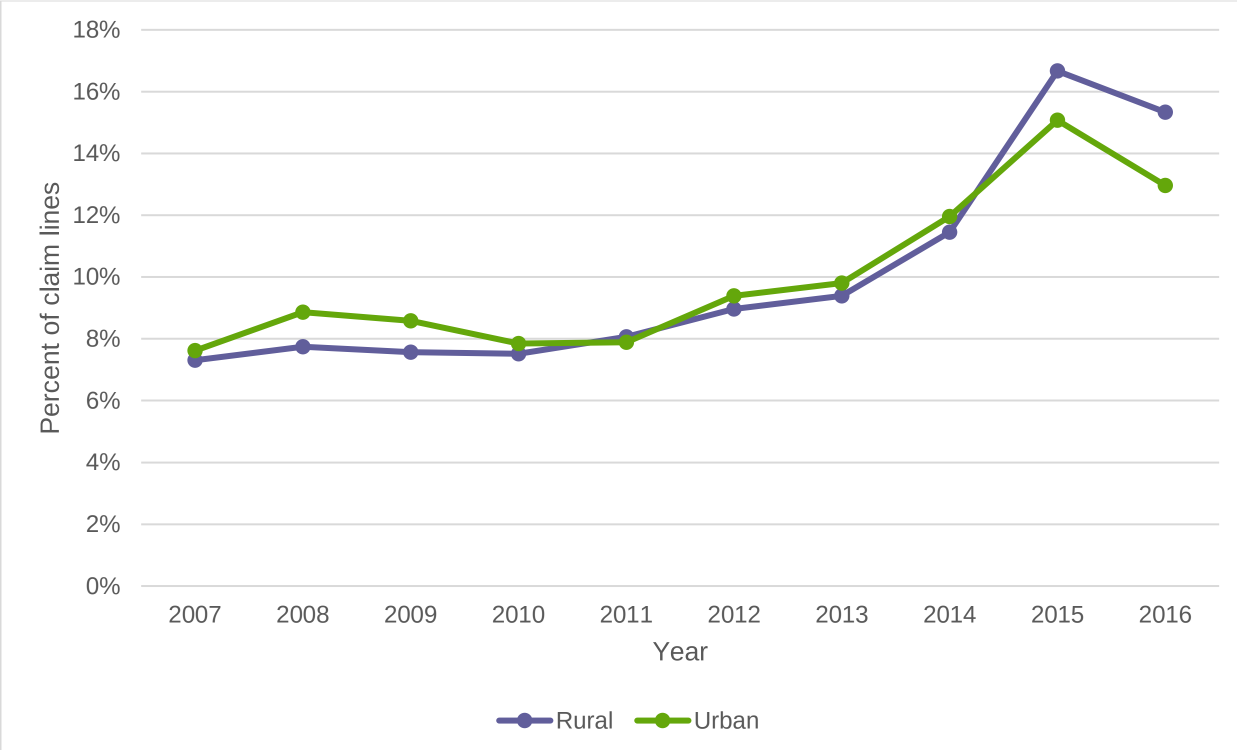

Figure 7. Claim lines with food allergy diagnoses in rural and urban settings, 2007-2016.

Anaphylactic Food Reactions

While the increase in claim lines with food allergy diagnoses from 2007 to 2016 was remarkable (110 percent in rural settings, 70 percent in urban settings), the increase in claim lines with diagnoses of anaphylactic food reactions during the same period was even more striking: 377 percent (figure 8). The disparity may seem puzzling, since an anaphylactic food reaction occurs as a result of a food allergy, so that it might seem the increase should be the same for both. As noted earlier, however, anaphylactic food reaction diagnoses can and do occur in the absence of prior food allergy diagnoses. Therefore, it is not surprising that claim lines for the two diagnoses present different trends.

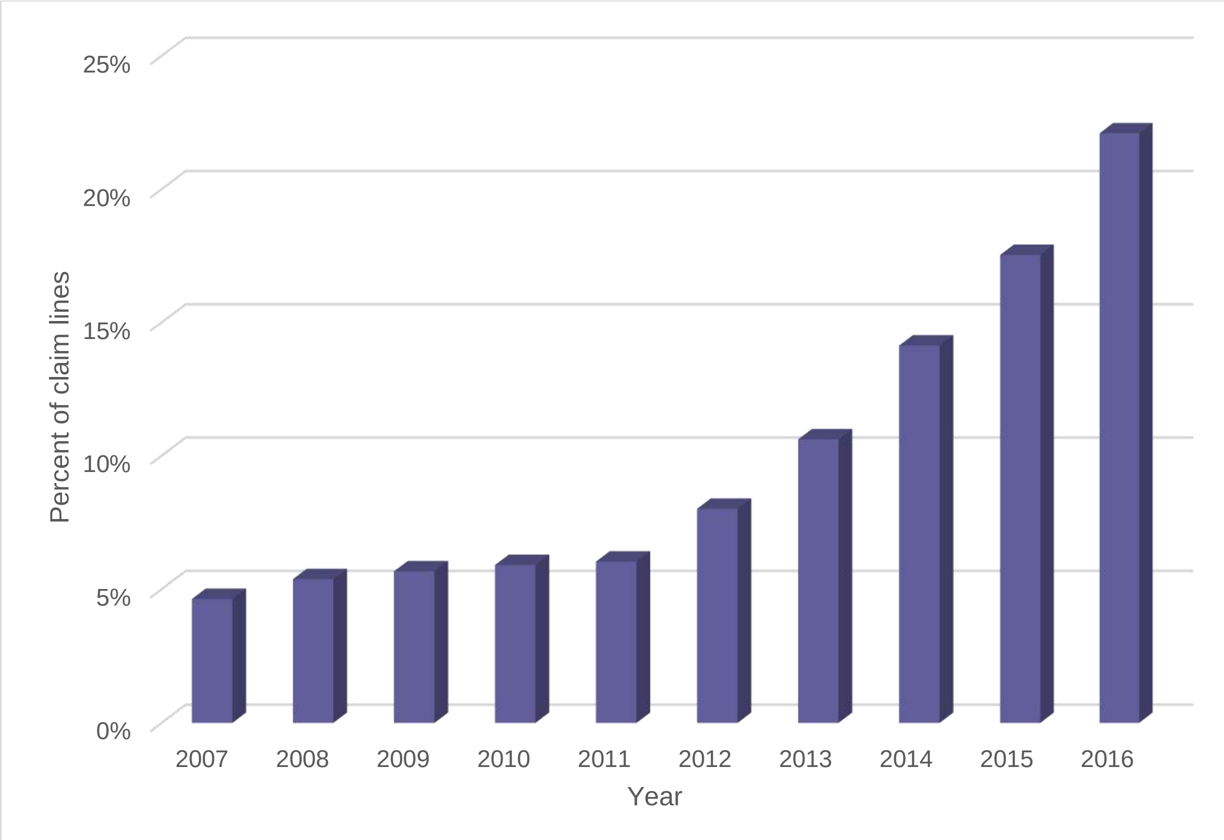

Figure 8. Claim lines with diagnoses of anaphylactic food reactions, 2007-2016.

The US Food & Drug Administration (FDA) identifies eight foods as the most common allergenic foods, accounting for 90 percent of food allergic reactions: crustacean shellfish, eggs, fish, milk, peanuts, soybeans, tree nuts and wheat.[21] When FAIR Health analyzed the claim lines with diagnoses of anaphylactic food reaction during the period 2007-2016 by type of food, all of these, except for soybeans and wheat, appeared among the allergenic foods responsible for the reactions (figure 9). The reason for the absence of soybean- and wheat-induced anaphylaxis is that they do not have distinct diagnostic codes, but are categorized as "other specific foods." Indeed, "other specific foods" was the most common group of food allergens (33 percent of claim lines), which includes not only foods that less commonly cause allergies but cases in which the actual food allergen is not known.

[21] "Food Allergies: What You Need to Know," US Food & Drug Administration, March 2017, https://www.fda.gov/downloads/Food/ResourcesForYou/Consumers/UCM220117.pdf.

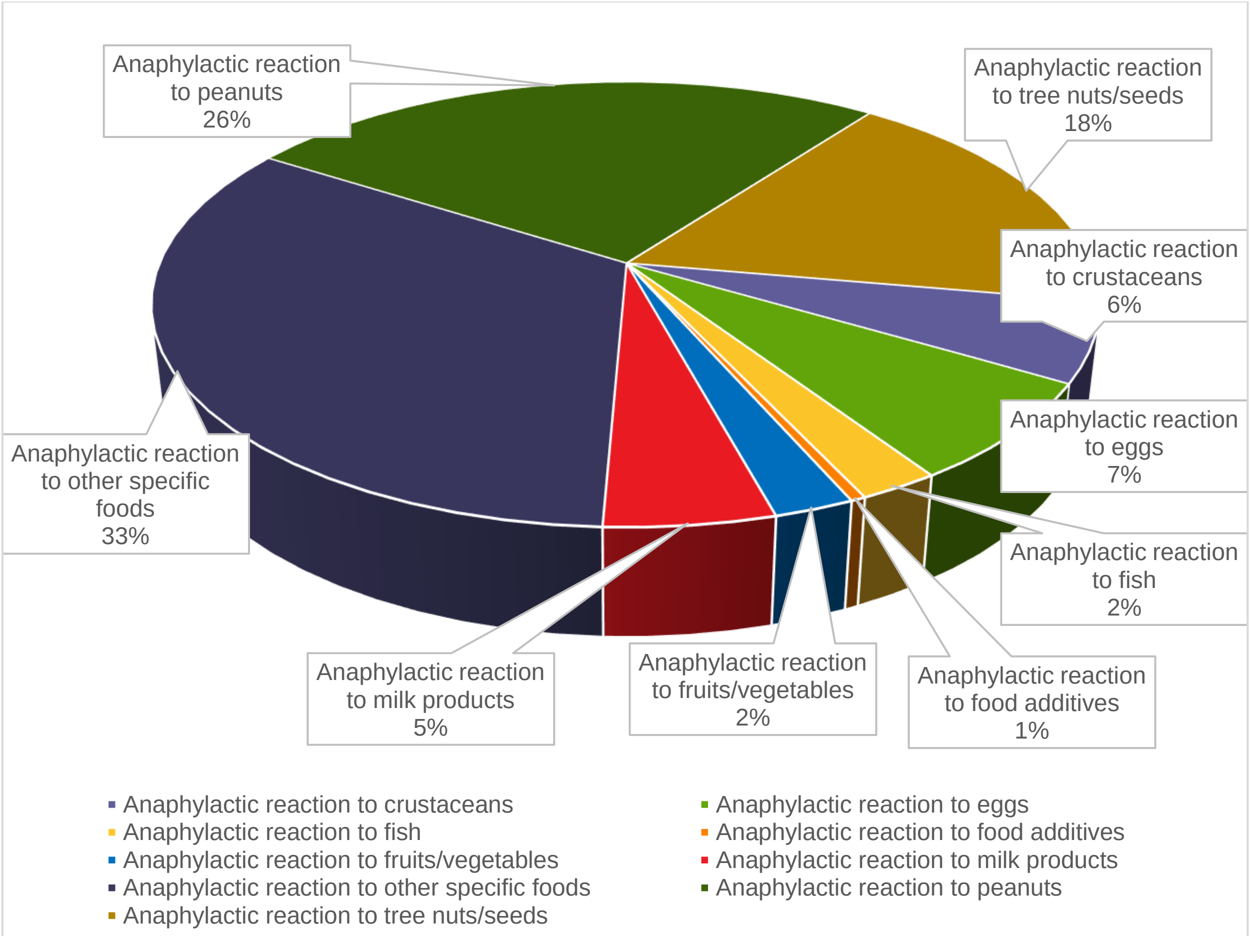

Figure 9. Claim lines with anaphylactic food reaction diagnoses by type of food, 2007-2016.

Among specifically identified foods causing anaphylaxis, the most common was peanut (26 percent), followed closely by tree nut/seed (18 percent). This finding is consistent with the finding described above (table 4), in which "other," peanut and tree nut/seed were the top three anaphylactic food reaction diagnoses for all of the five states that had the greatest prevalence of anaphylactic food reaction diagnoses in 2016.

Egg allergy, crustacean allergy and milk product allergy were also common, making up, respectively, 7 percent, 6 percent and 5 percent of the anaphylactic food reaction claim lines. Fish and fruit/vegetable each accounted for 2 percent of the anaphylactic food reaction claim lines, and food additive for 1 percent. (Food additives may include a variety of ingredients, such as colors, emulsifiers, stabilizers, sweeteners and preservatives.[22])

In 2016, the incidence of billing with the "other specific foods" diagnosis code decreased, which was probably due to better training in the ICD-10-CM set of diagnostic codes and the great quantity of educational information about food allergies that had been disseminated over the years (figure 10). Claim lines associated with anaphylaxis due to "other specific foods" did not increase as much as anaphylactic food reactions attributed to a specific food or food category. "Other specific foods" had only a 71 percent

[22] Mozhgan Moghtaderi, "Sensitization to Food Additives in Patients with Allergy: A Study Based on Skin Test and Open Oral Challenge," *Iran J Allergy Asthma Immunol* 15, no. 3 (2016): 198-203.

increase from 2007 to 2016. By comparison, claim lines with diagnoses of peanut anaphylactic reactions increased 445 percent and those with diagnoses of tree nut/seed anaphylactic reactions increased 603 percent.

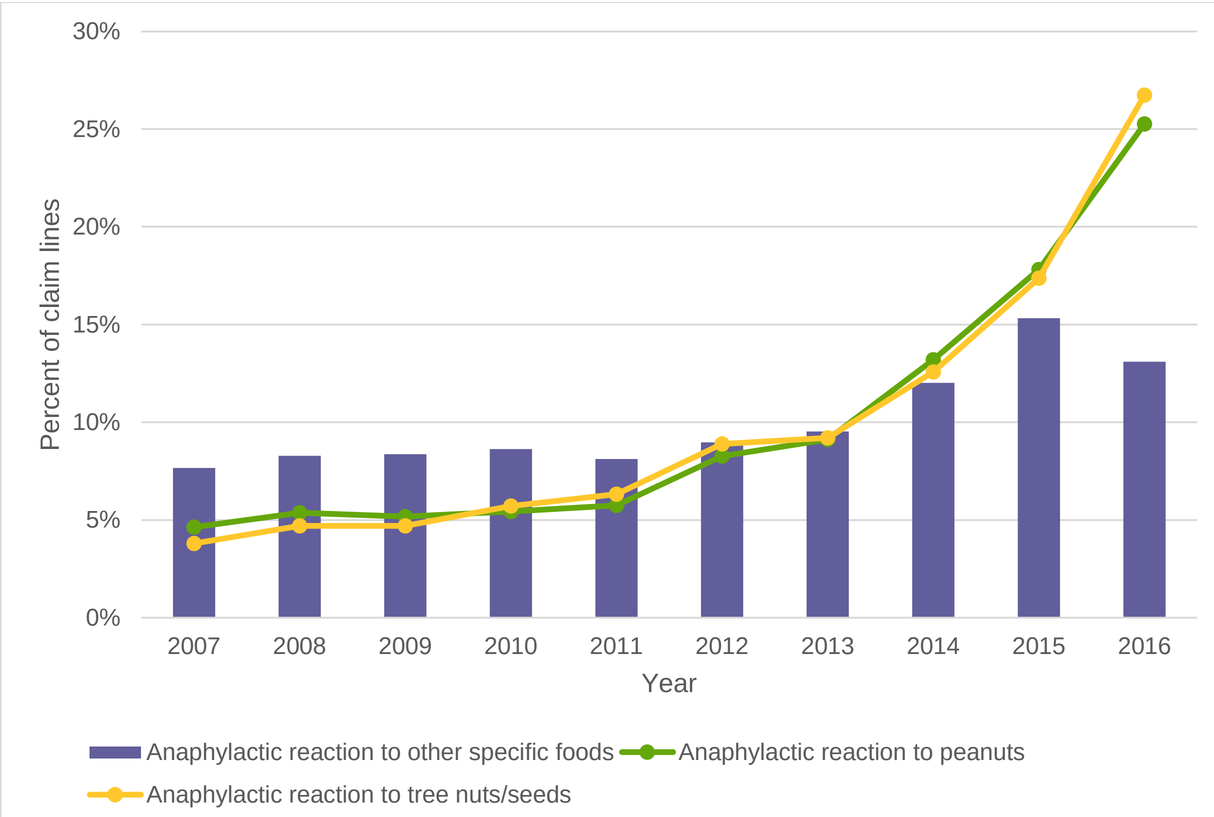

Figure 10. Claim lines with anaphylactic food reaction diagnoses attributed to peanuts, tree nuts/seeds and "other specific foods," 2007-2016.

Demographic Patterns

Age

Although the majority of food allergy diagnoses occur in childhood, some of those allergies continue into adulthood, and food allergy can emerge for the first time in adults (adult-onset food allergy).[23] According to FAIR Health data, patients 18 years old and younger accounted for 66 percent of the claim lines with food allergy diagnoses in the period 2007-2016; those over 18 years old accounted for the remaining 34 percent (figure 11). Claim lines with food allergy diagnoses occurred in all age groups, even patients over 60 years old (4 percent).

[23] Shmuel Kivity, "Adult-Onset Food Allergy," *Isr Med Assoc J* 14, no. 1 (2012): 70-72.

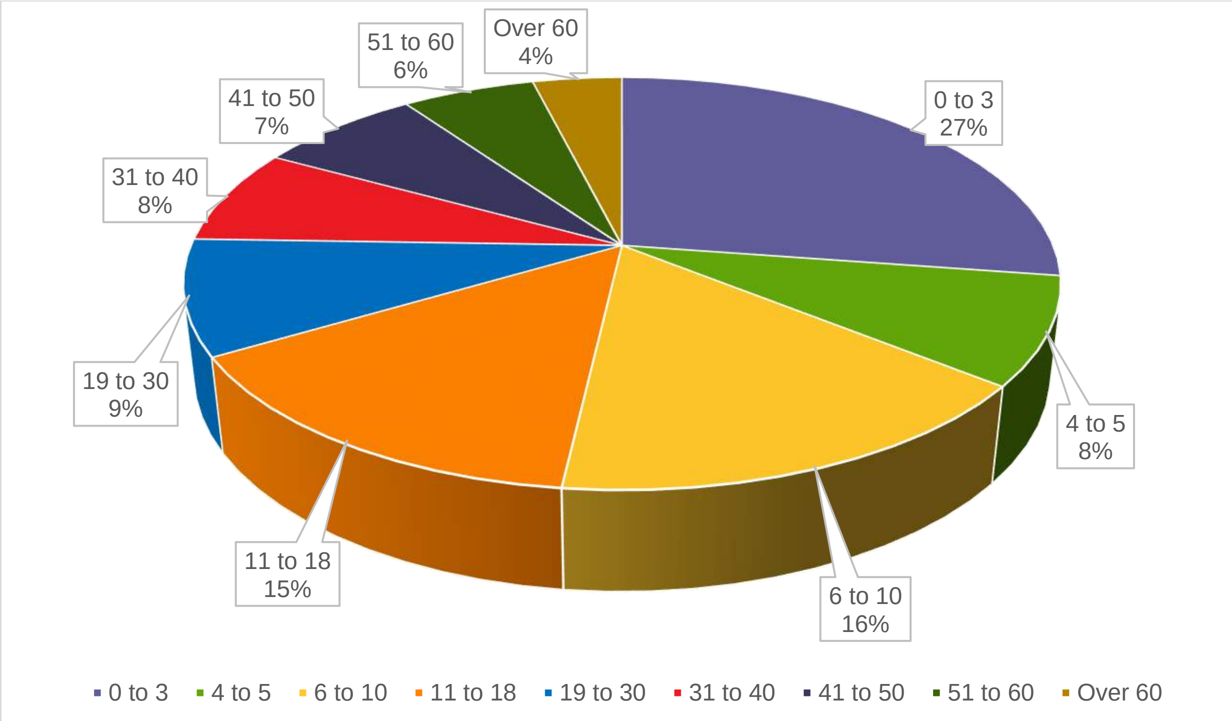

Figure 11. Claim lines with food allergy diagnoses by age group in years, 2007-2016.

Still, claims for children predominated. Almost a third (27 percent) of all claim lines with food allergy diagnoses were attributable to patients between the ages of 0 and 3. Preschool age children (4-to-5-year-olds) accounted for 8 percent of the total, with individuals ages 6 to 18 making up an additional third (31 percent).

The age distribution of claim lines with food allergy and anaphylactic reaction diagnoses in the period 2007-2016 varied by type of food. Peanut, for example, was responsible for claim lines with food allergy and anaphylaxis diagnoses primarily in people 18 years old and younger (figure 12). A high number of claims were seen in the age group 6 to 10 years, which accounted for 30 percent of all claim lines with anaphylactic reaction to peanut diagnoses and 28 percent of all claim lines with peanut allergy diagnoses.

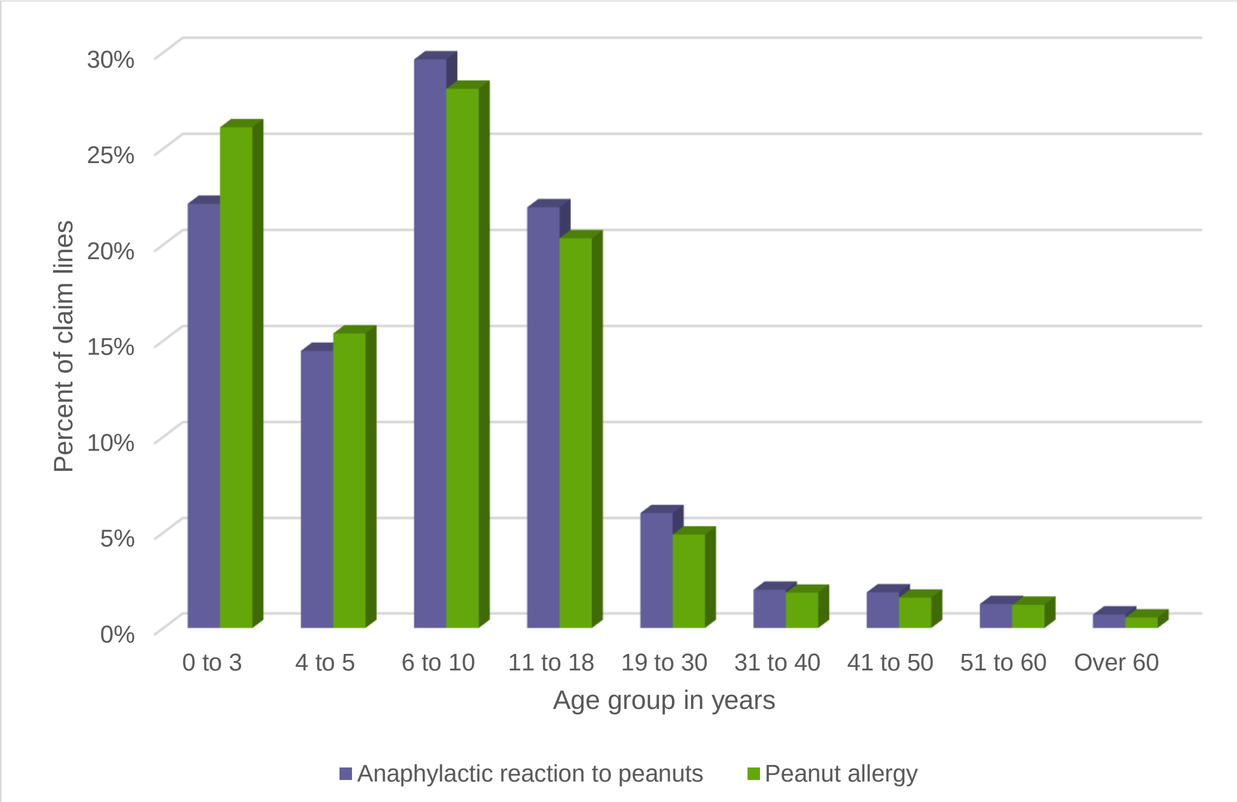

Figure 12. Claim lines with diagnoses of peanut allergy and anaphylactic reaction to peanuts by age group in years, 2007-2016.

It is notable that in the age groups from 6 to 30 years, claim lines with diagnoses of anaphylactic reaction to peanut were more common than claim lines with peanut allergy diagnoses, which was not the case in all other age groups. The years 6 to 30 are when children move into school settings with growing independence and young adults move away from their parents, and it may be that the diminution of parents' control over what their children eat leads to more cases of exposure to peanuts and anaphylactic reaction. More research will be needed to ascertain the precise cause of this difference.

Although the adult age groups had a much lower distribution of peanut-related diagnoses than the pediatric ones, it should not be concluded that the adults outgrew their peanut allergies. Although most children outgrow some food allergies, such as those to milk, egg, wheat and soy, in 80 to 90 percent of cases allergies to peanut, as also to tree nut, fish and shellfish, are lifelong allergies.[24] Peanut allergy most frequently emerges in childhood,[25] and it is likely that adults who have had a peanut allergy since childhood have learned to avoid exposure to peanuts and therefore avoid anaphylactic episodes and peanut allergy diagnoses.

The age distribution of claim lines with crustacean-related allergy and anaphylactic reaction diagnoses (figure 13) was very different from that of peanut-related diagnoses in the same period. ("Seafood allergy" is used in the figure because there is no specific diagnostic code for crustacean allergy; seafood includes crustaceans. There is, however, a specific diagnostic code for crustacean anaphylactic reaction.) Claim lines with anaphylactic reaction to crustacean and seafood allergy diagnoses began to climb in the age

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[24] Nedeljko Radlović, "Food Allergy in Children," *Srp Arh Celok Lek* 144, nos. 1-2 (2016): 99-103.
[25] Kivity, "Adult-Onset Food Allergy."

group 6 to 10 years, and reached their peak among people aged 19 to 30 years, who had 18 percent of all claim lines with crustacean anaphylactic reaction and seafood allergy diagnoses. Unlike what was seen with peanut-related diagnoses, levels of crustacean-related diagnoses continued to be high in older adult groups. This may be because crustacean allergy is more commonly an adult-onset allergy than peanut allergy. One study found that the most common trigger food for adult-onset food allergy was shellfish.[26]

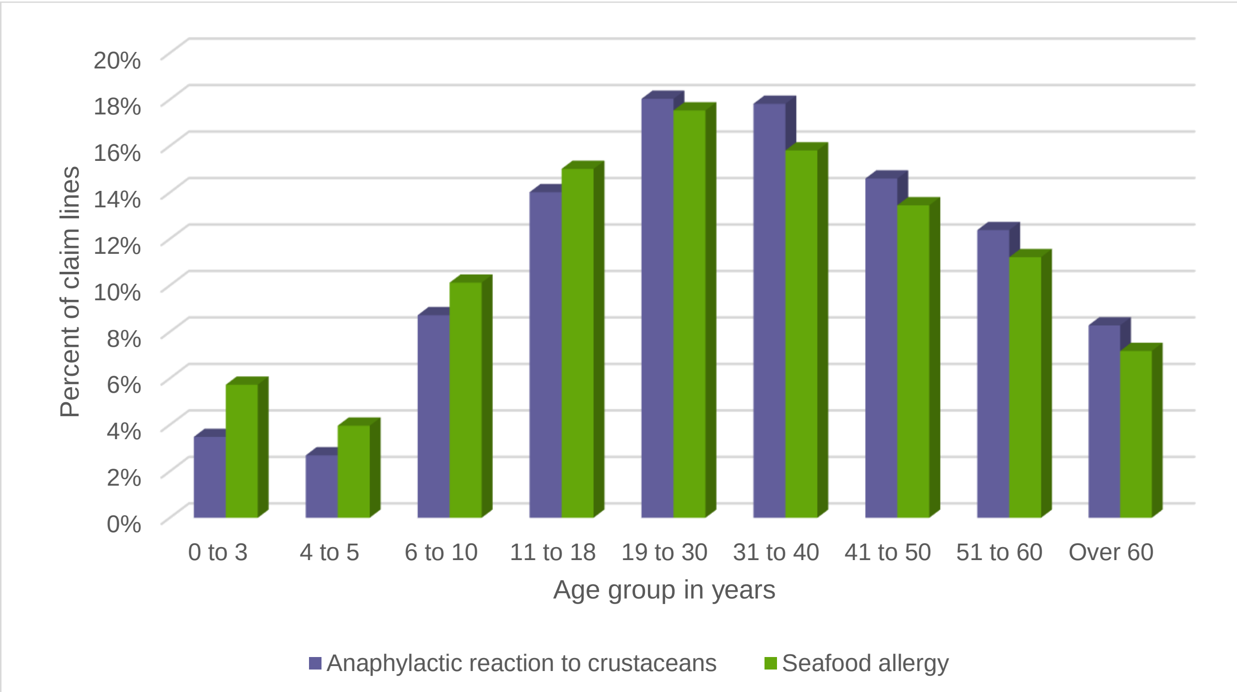

Figure 13. Claim lines with diagnoses of seafood allergy (including allergy to crustaceans) and anaphylactic reaction to crustaceans by age group in years, 2007-2016.

After the age of 18, the incidence of crustacean anaphylactic reaction diagnosis was greater than that of seafood allergy diagnosis, whereas among those 18 and younger the reverse was true. This could be related to the way the allergy manifests itself in adults, or to greater caution about the allergy in parents of young children who develop it.

Yet another type of age distribution was seen with allergy and anaphylactic reaction to food additives in the period 2007-2016 (figure 14). Claim lines with those diagnoses were spread much more evenly between children and adults than was the case with peanut- and crustacean-related diagnoses. The peak, however, was among the adults, in the age group 31 to 40 years, with 18 percent of all claim lines with anaphylactic reaction to food additive diagnoses and 13 percent of all food additive allergy diagnoses. In that age group, the percentage of anaphylactic reaction diagnosis claim lines was considerably higher than that of allergy diagnosis.

[26] Toral A. Kamdar, "Prevalence and Characteristics of Adult-Onset Food Allergy," *J Allergy Clin Immunol Pract* 3, no. 1 (2015): 114–15.e1; doi:10.1016/j.jaip.2014.07.007.

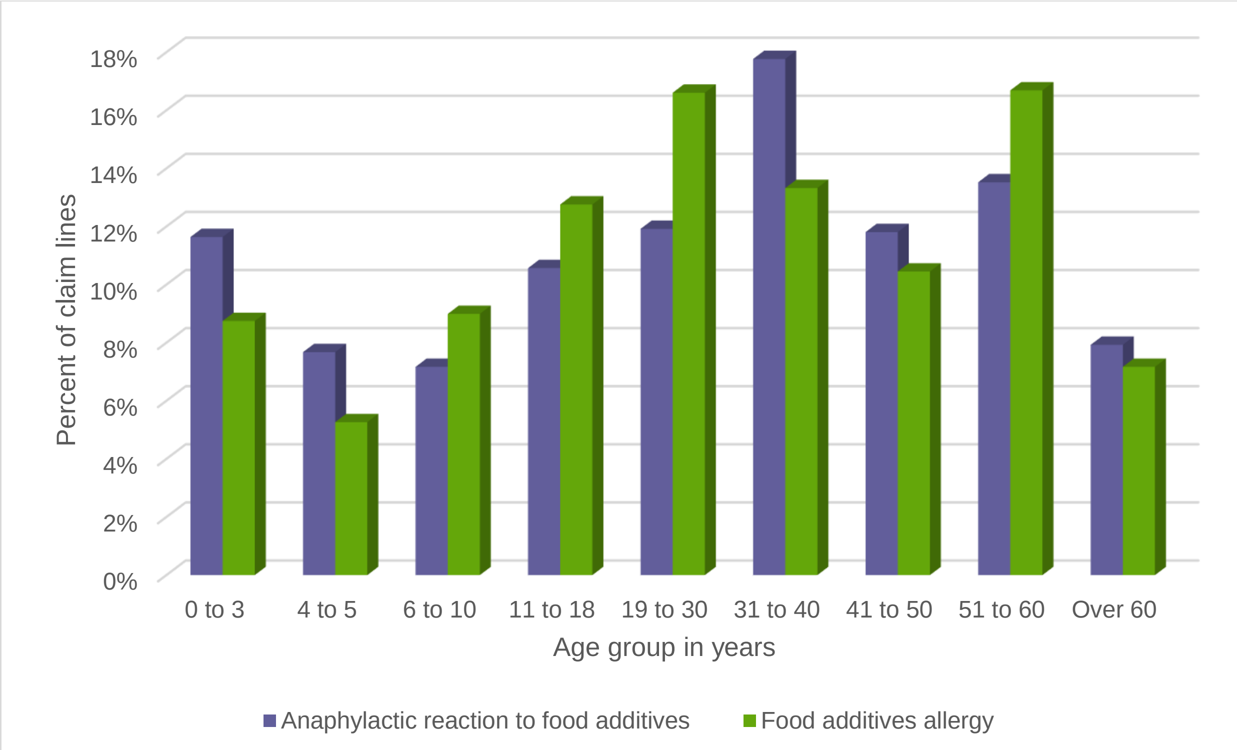

Figure 14. Claim lines with diagnoses of food additives allergy and anaphylactic reaction to food additives by age group in years, 2007-2016.

FAIR Health performed a longitudinal study of private insurance claims from a statistically significant cohort of individuals who had had a food allergy diagnosis from 2013 to 2016, to analyze by age group what percentage had an anaphylactic food reaction diagnosis later in that period (figure 15). The peak age group was children 4 to 5 years old, of whom 8 percent had an anaphylactic food reaction after being diagnosed with food allergy. Children 6 to 10 years old had the second highest percentage (7 percent) and 0- to 3-year-olds had the third highest (6 percent). Among adults, the percentages were much lower: Between 2 and 3 percent of adults from 19 years to over 60 years had an anaphylactic reaction to a food to which they were allergic. Possible reasons for these findings are that adults diagnosed with a food allergy may be better able to control their exposure to the food to which they are allergic, or perhaps that adults are less prone to anaphylactic food reaction if they do come in contact with an allergenic food.

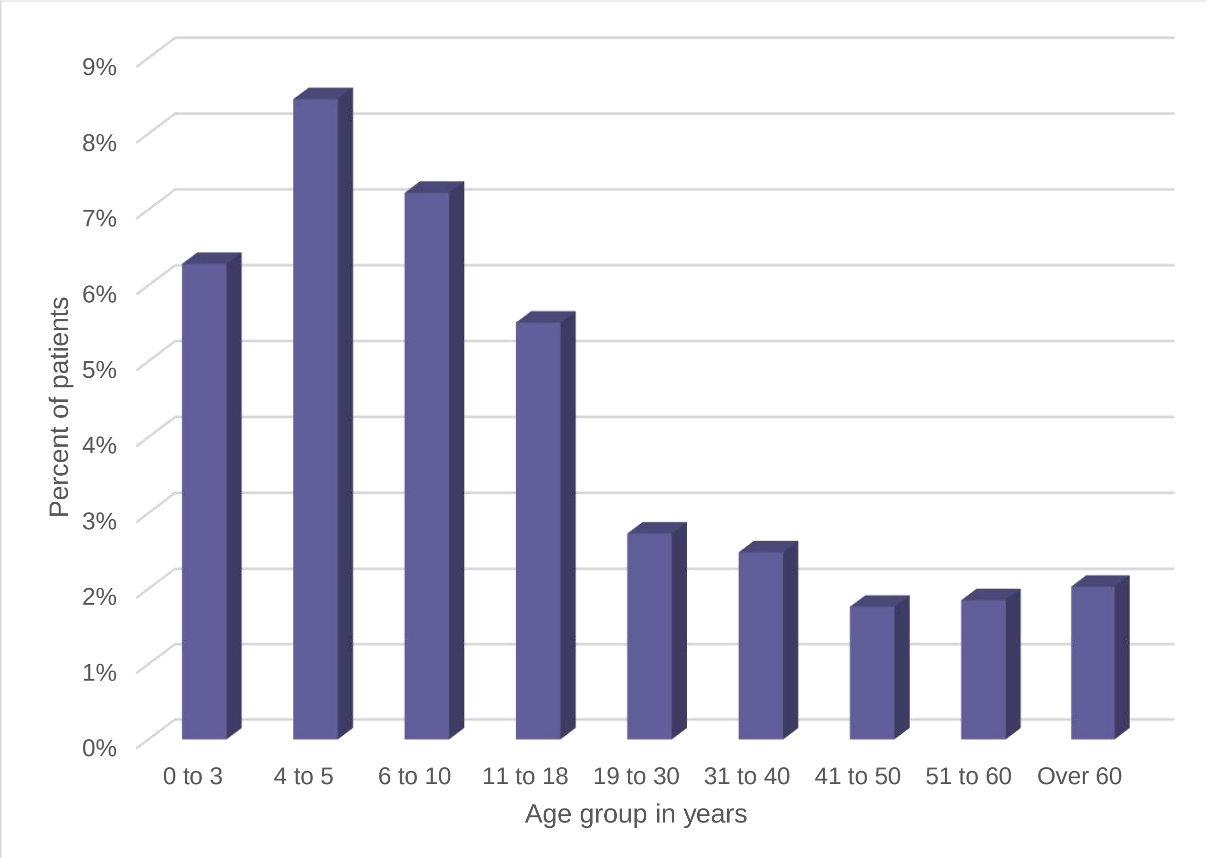

Figure 15. Percent of patients with a food allergy diagnosis who subsequently had an anaphylactic food reaction diagnosis, by age group in years, 2013-2016.

Gender

It has been reported that male gender is a risk factor for food allergy.[27] But FAIR Health evidence suggests that the risk may depend on the specific allergy and the age of the patient. Analyzing the gender distribution of claim lines with diagnoses of allergies to various foods from 2007 to 2016, FAIR Health found that more claim lines of male patients were associated with peanut, egg and milk product allergy diagnoses, but that more claim lines for women were related to seafood and food additive allergy diagnoses (table 5). There may be many reasons for this difference, but one point to note is that peanut, egg and milk product allergies typically develop in childhood, whereas seafood and food additive allergies are more associated with adult onset. Women in general have been found to be more likely than men to visit physicians[28] and make use of healthcare services,[29] so they may seek treatment for symptoms of

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[27] Andrew H. Liu et al., "National Prevalence and Risk Factors for Food Allergy and Relationship to Asthma: Results from the National Health and Nutrition Examination Survey 2005-2006," *J Allergy Clin Immunol* 126, no. 4 (2010): 798–806.e13; doi:10.1016/j.jaci.2010.07.026.
[28] Jill J. Ashman, Esther Hing and Anjali Talwalkar, "Variation in Physician Office Visit Rates by Patient Characteristics and State, 2012," NCHS Data Brief, no. 212; Hyattsville, MD: National Center for Health Statistics, 2015; https://www.cdc.gov/nchs/data/databriefs/db212.pdf.
[29] Klea D. Bertakis et al., "Gender Differences in the Utilization of Health Care Services," *J Fam Pract* 49, no. 2 (2000):147-52.

seafood and food additive allergies more than men with the same symptoms. Or, women may be more susceptible to these allergies—or both.

Table 5. Gender distribution of claim lines for specific food allergies, 2007-2016.

Allergy	Female	Male
Peanut	42%	58%
Egg	42%	58%
Milk product	45%	55%
Seafood	59%	41%
Food additive	66%	34%

An analysis of claim lines with food allergy diagnoses by age group and gender in the period 2007-2016 shows that such claim lines are associated with boys more than girls from birth through age 18, and that afterward the reverse is true: the preponderance of claim lines are associated with women rather than men (figure 16). As noted, this pattern could be due to greater healthcare-seeking behavior in women than men, or it could be that women have more adult-onset food allergies than men, or both. Further research into this pattern would be warranted. A 2009 systematic review of food allergy studies presented a similar finding: among children with food allergies, 64 percent were males; among adults with food allergies, 65 percent were females.[30]

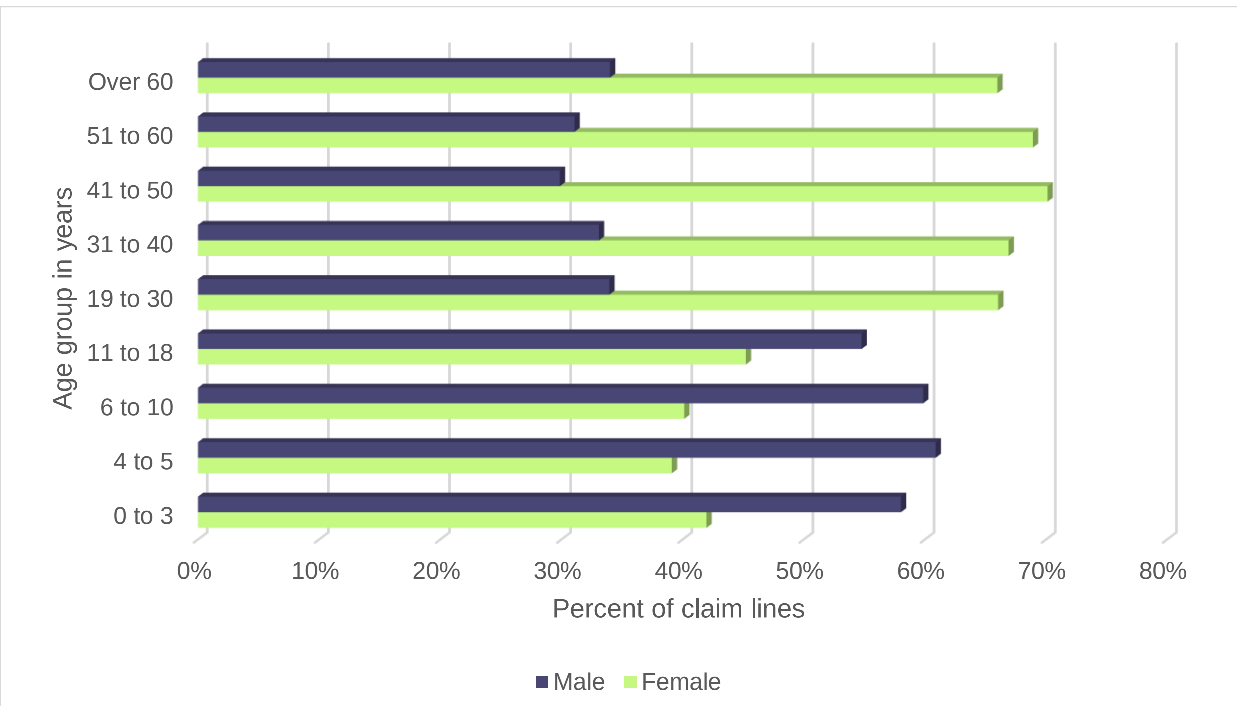

Figure 16. Claim lines with food allergy diagnoses by age group and gender, 2007-2016.

30 Caleb Kelly and Venu Gangur, "Sex Disparity in Food Allergy: Evidence from the PubMed Database," *J Allergy (Cairo)*, 2009:159845 (2009); doi:10.1155/2009/159845.

The age group and gender pattern found with food allergy in general is also found on the level of one of the most common specific allergies: peanut allergy. In the period 2007-2016, claim lines with diagnoses of peanut allergy (figure 17) and anaphylactic reaction to peanut (figure 18) were associated with boys more than girls up through the age of 18, and with women more than men after that age.

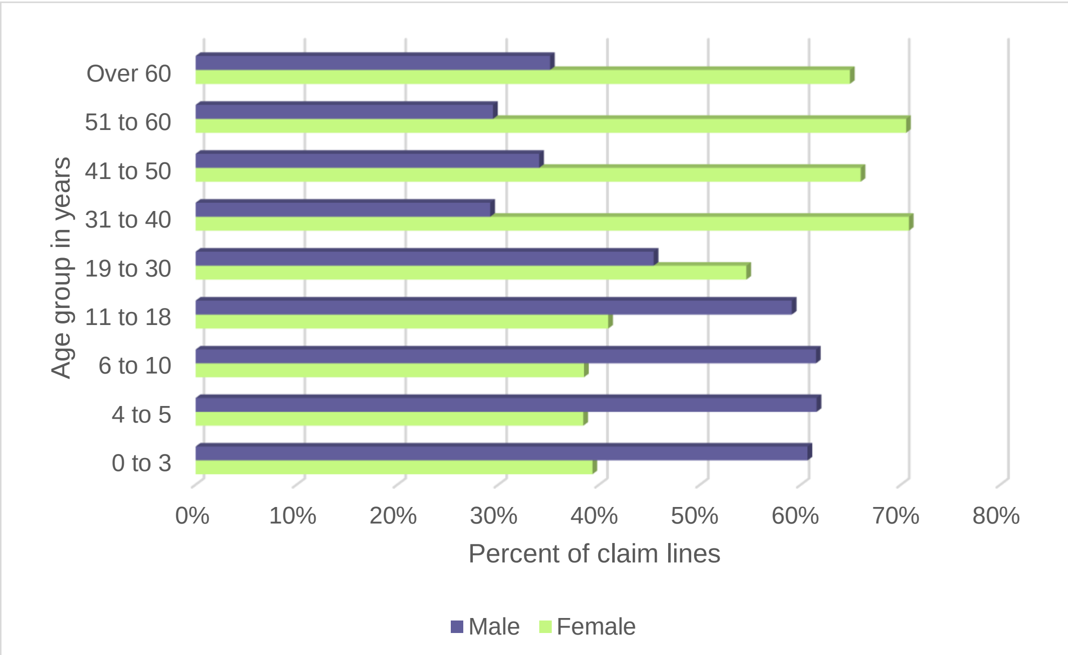

Figure 17. Claim lines with peanut allergy diagnoses by age group and gender, 2007-2016.

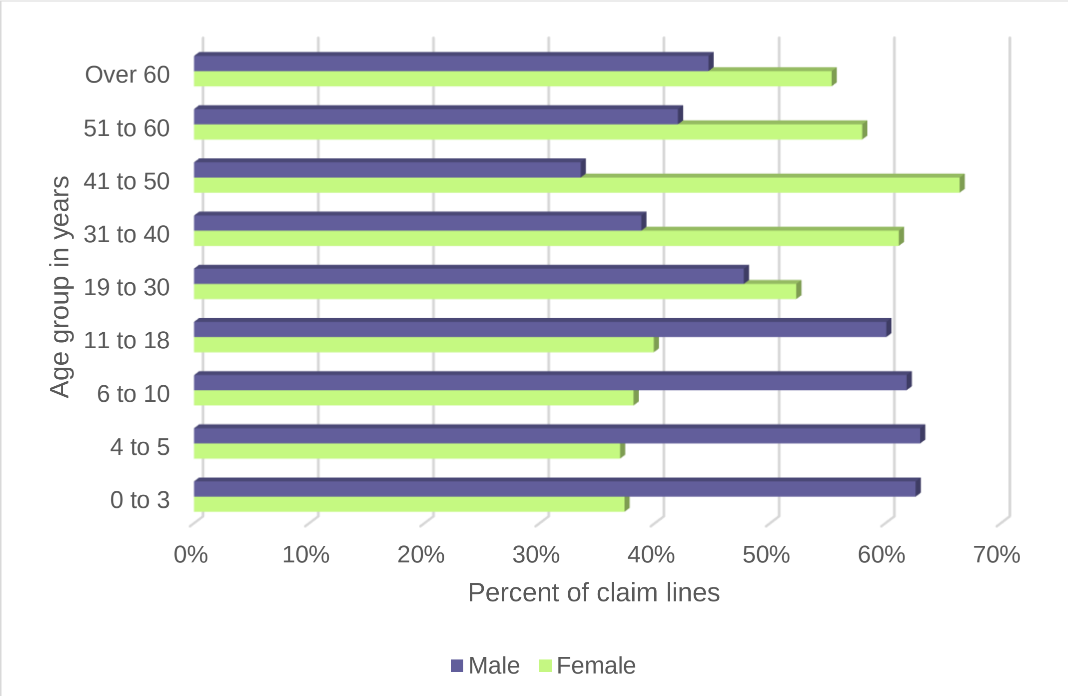

Figure 18. Claim lines with diagnoses of anaphylactic reaction to peanut by age group and gender, 2007-2016.

Place of Service for Anaphylactic Food Reactions

An anaphylactic food reaction is typically considered a medical emergency.[31] Nevertheless, FAIR Health data show that the vast majority of claim lines with diagnoses of anaphylactic food reaction are associated with an office setting rather than an emergency room. In an analysis of claim lines with a diagnosis of anaphylactic food reaction in the period 2007-2016, 70 percent of claim lines were associated with an office as place of service, and only 2 percent specifically with an emergency room (figure 19). The second most common place of service was the outpatient facility setting (13 percent), which can include emergency rooms. The inpatient setting accounted for 9 percent of claim lines, laboratory 3 percent and all others 3 percent.

[31] Centers for Disease Control and Prevention, "Voluntary Guidelines for Managing Food Allergies In Schools and Early Care and Education Programs"; Washington, DC: US Department of Health and Human Services, 2013; https://www.cdc.gov/healthyschools/foodallergies/pdf/13_243135_A_Food_Allergy_Web_508.pdf.

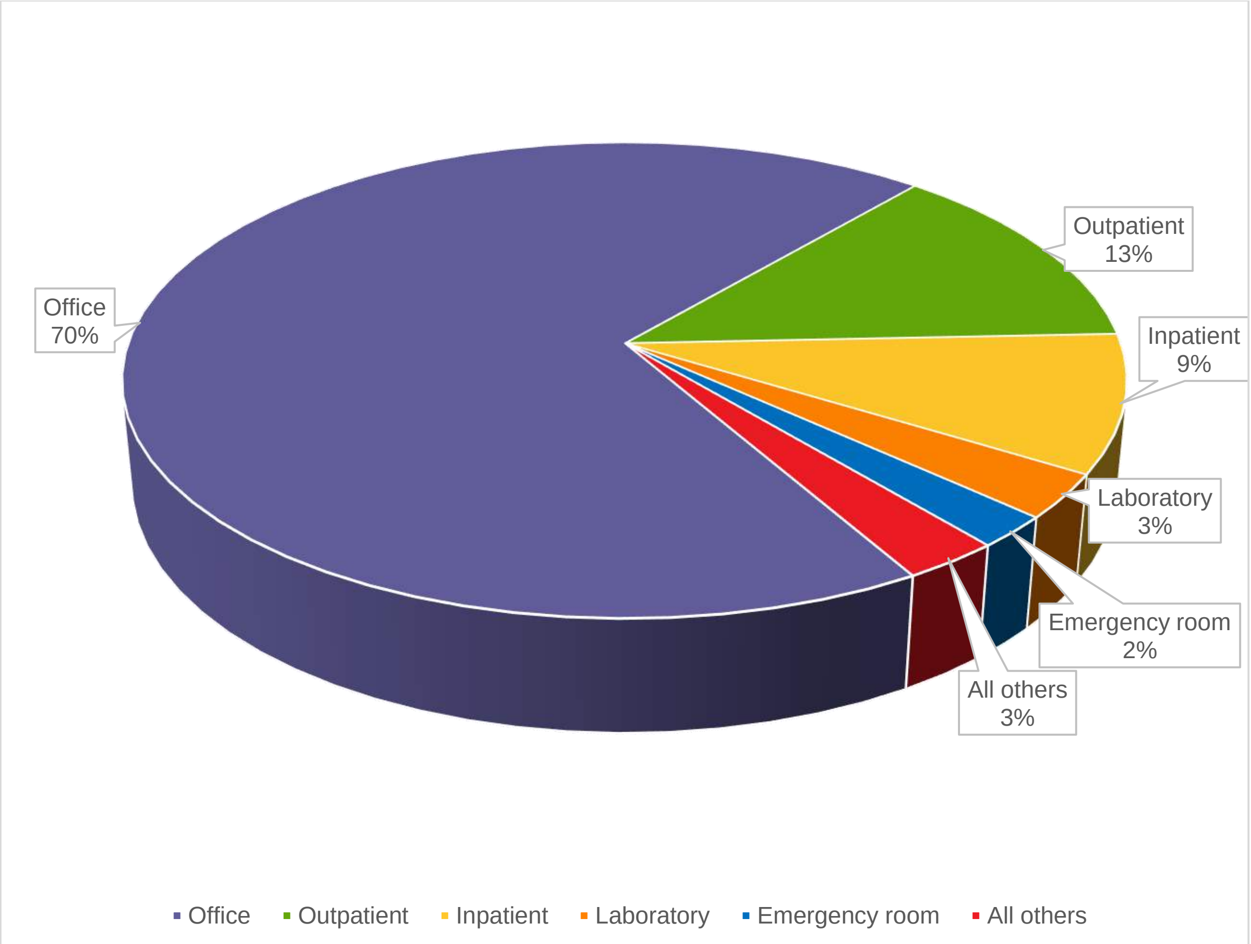

Figure 19. Distribution of claim lines with diagnoses of anaphylactic food reaction showing utilization of places of service, 2007-2016.

Although the office was the most common place of service associated with claim lines with an anaphylactic food reaction, it increased relatively little from 2007 to 2016, growing 216 percent (figure 20). Emergency room utilization also grew relatively little in that period, at 161 percent. The place of service with the highest growth was the outpatient facility setting, with an increase of 1,070 percent. Laboratory had the next highest increase, at 871 percent. Inpatient utilization grew at 229 percent.

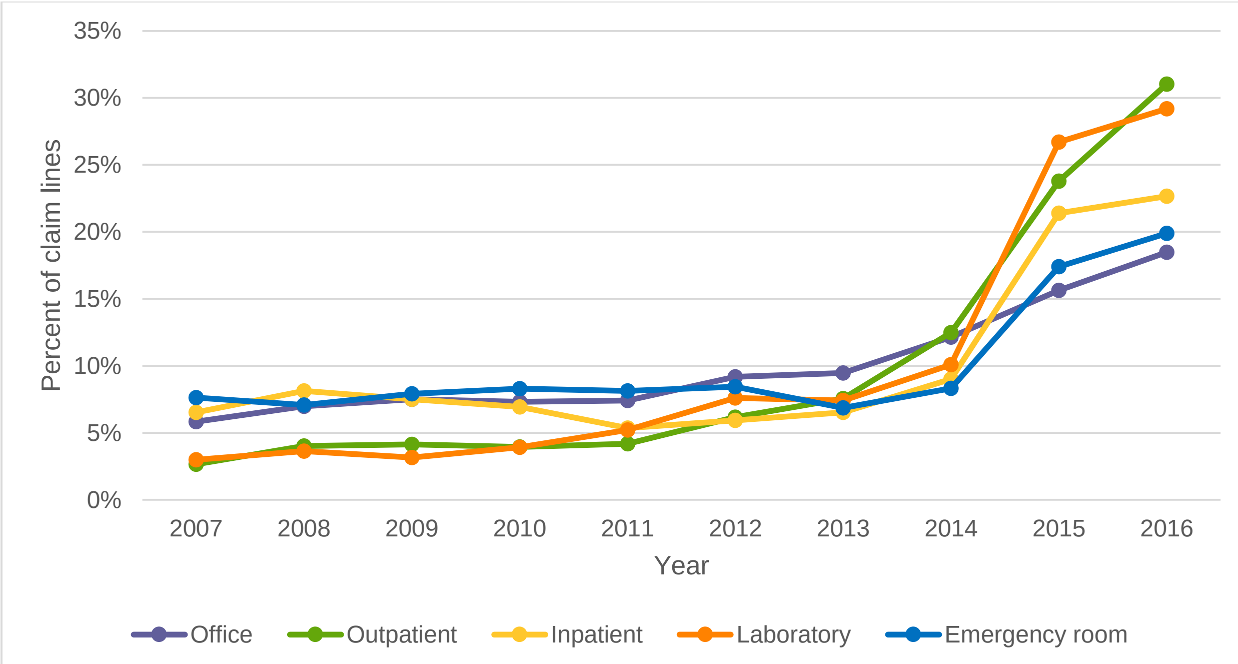

Figure 20. Trends in utilization of services associated with anaphylactic food reaction diagnoses, by place of service, 2007-2016.

The 2007-2016 distribution of providers' billed charges associated with anaphylactic food reaction claim lines (figure 21) was very different from the distribution of places of service by utilization in the same period (figure 19). Whereas 70 percent of such claim lines were associated with an office as place of service, only 51 percent of the charges were associated with the office setting, suggesting that the office was not as costly as the other places of service. Those other places of services, which made up 30 percent by utilization, accounted for 49 percent of charges. Specifically, outpatient facility, inpatient, laboratory and emergency room visits, which, respectively, comprised 13 percent, 9 percent, 3 percent and 2 percent of total services by utilization, accounted for, respectively, 17 percent, 13 percent, 8 percent and 7 percent of the total charges.

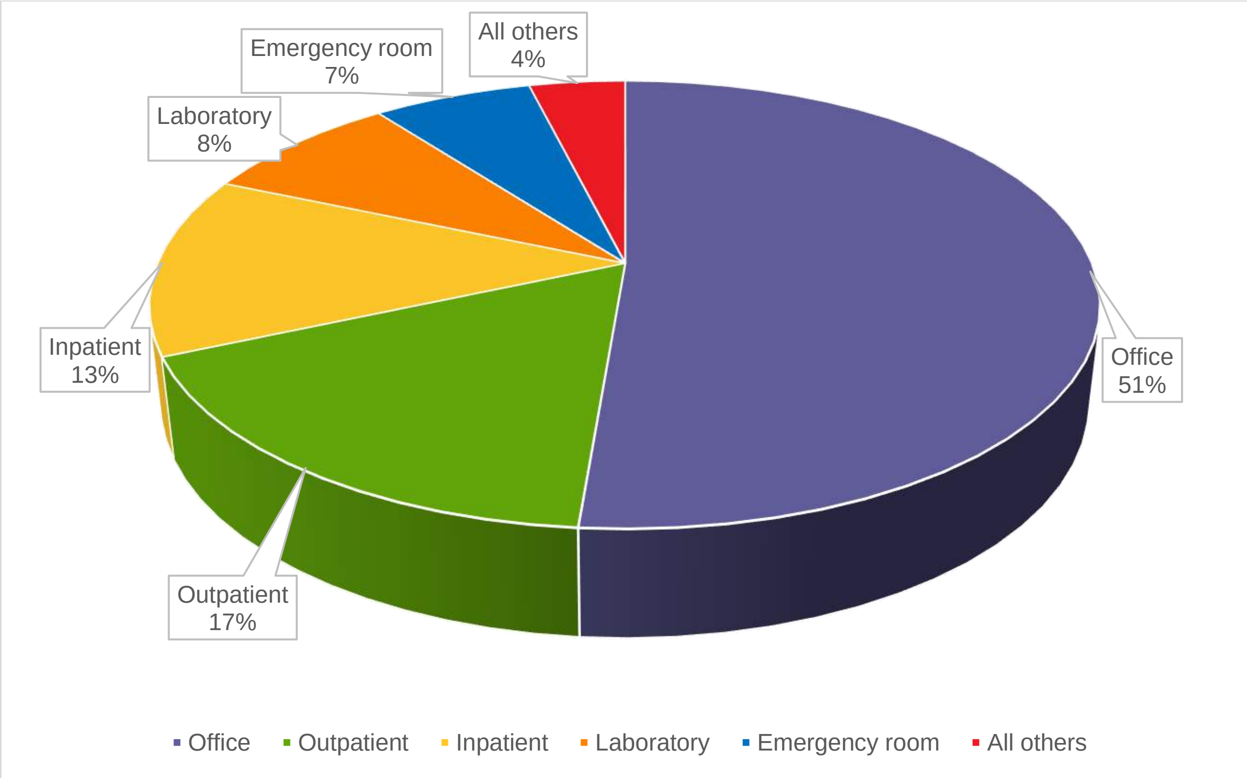

Figure 21. Distribution of charges associated with places of service for claim lines with anaphylactic food reaction diagnoses, 2007-2016.

The greatest increase in charges for services associated with diagnoses of anaphylactic food reaction from 2007 to 2016 occurred in the laboratory setting (figure 22). Though laboratory services increased in utilization 871 percent during that period, charges for those services increased 5,390 percent. The next greatest increase in charges was for emergency room services, which grew by 1,387 percent, even though utilization of emergency room services grew by only 161 percent.

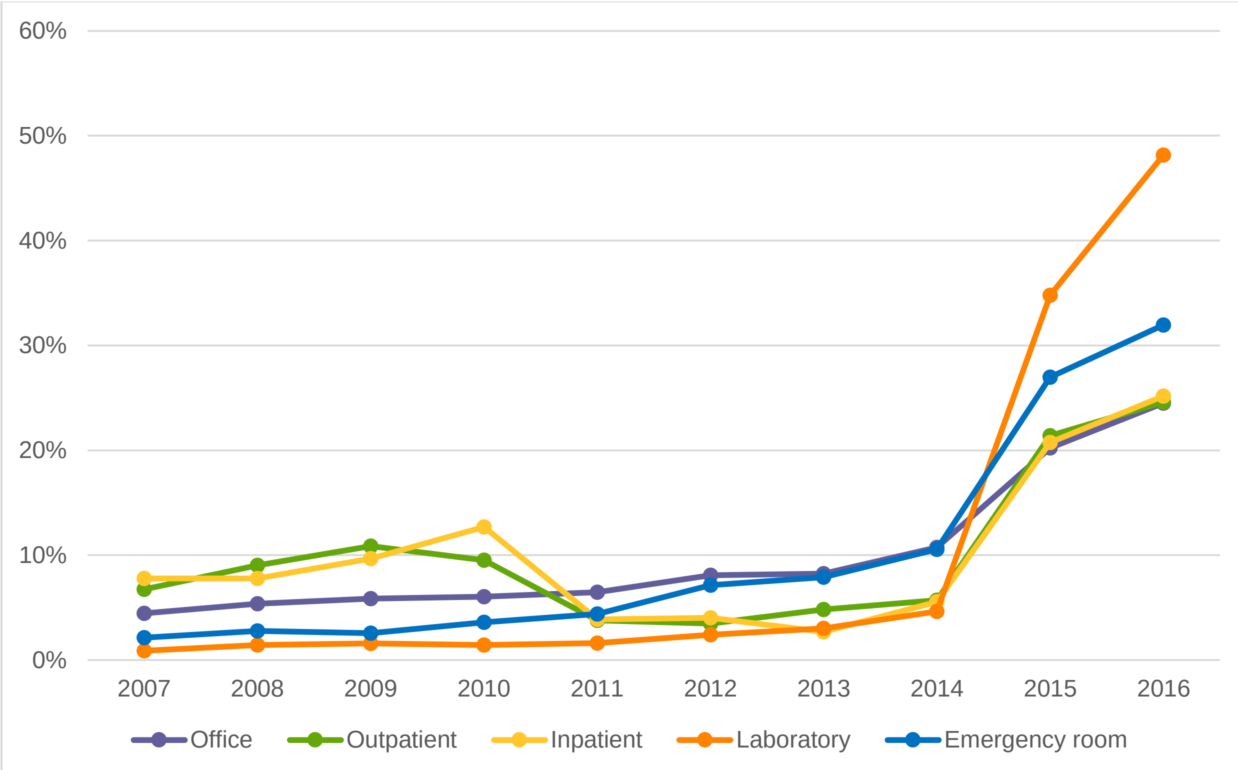

Figure 22. Trends in charges for services associated with anaphylactic food reaction diagnoses by place of service, 2007-2016.

Procedure Code Categories

The most common procedure code category associated with food allergy diagnoses in the period 2007-2016 was office or outpatient services to an established patient, which made up 21 percent of procedures (figure 23)—for example, CPT code 99213, office outpatient visit—15 minutes.

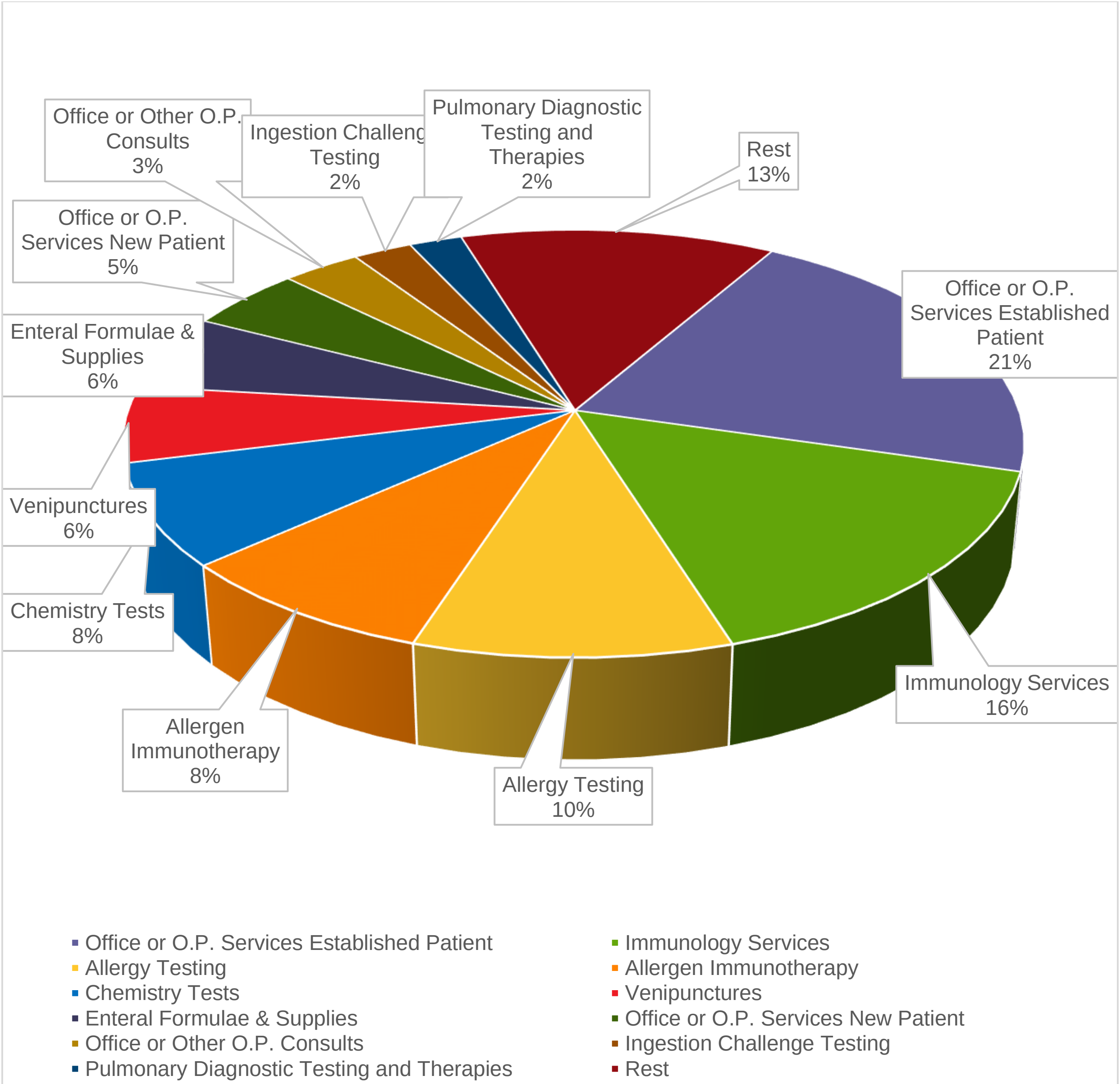

Figure 23. Most common procedure code categories associated with food allergy diagnoses, 2007-2016. "O.P." is "outpatient."

Immunology services were the second most common procedure code category (16 percent). An example was a laboratory test to identify specific allergens, CPT 86003, allergen specific IgE. Allergy testing was the third most common (10 percent). An example was CPT 95004, percutaneous tests (scratch, puncture, prick) with allergenic extracts, immediate type reaction, including test interpretation and report. Allergen immunotherapy and chemistry testing, each 8 percent, were the fourth and fifth most common categories. An example of allergen immunotherapy was CPT 95117, professional services for allergy immunotherapy not including provision of allergenic extracts (i.e., allergy shots). An example of a chemistry test was CPT 82785, gammaglobulin (immunoglobulin); IgE.

Although not in the top five procedure code categories associated with food allergy diagnoses, enteral formulae and supplies were notable for making up 6 percent of all procedures. This category included substitutes for milk for children allergic to milk products. It included HCPCS codes such as B4161 (enteral formula, for pediatrics, hydrolyzed/amino acids and peptide chain proteins; includes fats, carbohydrates, vitamins and minerals; may include fiber, administered through an enteral feeding tube, 100 calories = 1 unit) and B4158 (enteral formula, for pediatrics, nutritionally complete with intact nutrients; includes proteins, fats, carbohydrates, vitamins and minerals; may include fiber and/or iron; administered through an enteral feeding tube, 100 calories = 1 unit). Although typically used when providing nutrition through a feeding tube, these enteral formulas also can be used for orally provided formulas that are prescription based.

Just as in the case of food allergy, the most common procedure code category associated with diagnoses of anaphylactic food reaction in the period 2007-2016 was office or outpatient services to an established patient, which made up 20 percent of procedures (figure 24). This could be a follow-up visit with a physician after an anaphylactic food reaction, or it could be a visit in which anaphylactic food reaction was diagnosed, and the patient could potentially be redirected to the emergency room.

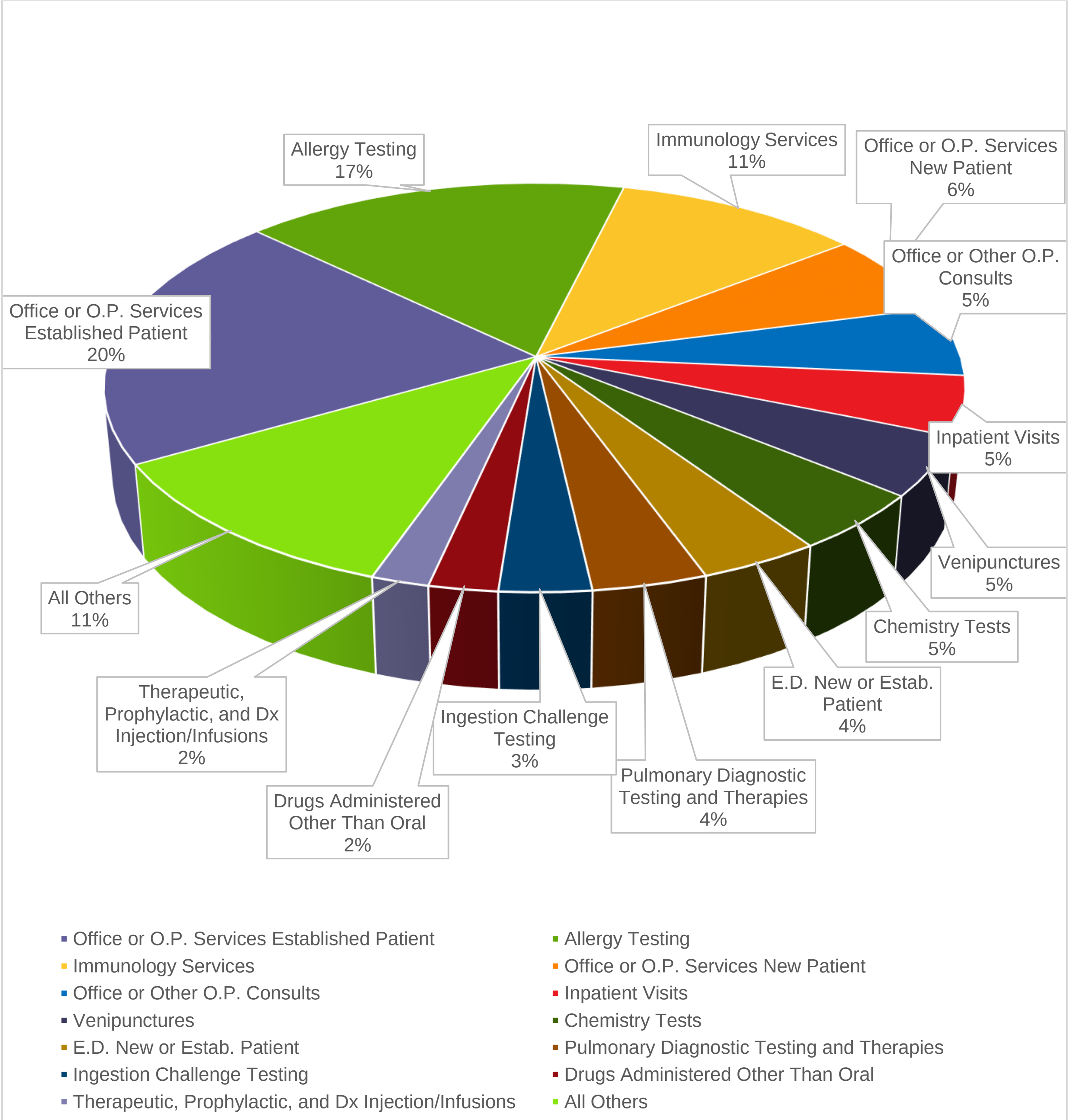

Figure 24. Most common procedure code categories associated with anaphylactic food reaction diagnoses, 2007-2016. "O.P." is "outpatient"; "E.D." is "emergency department" or "emergency room"; "Dx" is "diagnostic."

Immunology services and allergy testing—respectively, the second and third most common procedure code categories associated with food allergy diagnoses—were very common with diagnoses of anaphylactic food reactions, but in reverse order: allergy testing was second (17 percent), immunology services third (11 percent). In the context of anaphylactic food reactions, allergy testing and immunology services are typically performed to assess what the patient reacted to and to see if there are any additional foods or substances to which the patient may be severely allergic.

Although not among the most common procedure code categories associated with food allergy diagnoses, codes for new or established patients in the emergency room were common (4 percent) with diagnoses of anaphylactic food reaction, because of the emergency nature of that diagnosis.

Costs and Services per Patient

Food allergy has a substantial economic impact on the healthcare system, but its dimensions have been hard to measure. One 2013 study calculated direct annual medical costs of childhood food allergy as $4.3 billion nationally, or $724 per child with food allergy, based on a survey of parents with children who had food allergies and standard measures of costs for different services, such as outpatient visits and emergency room visits.[32] By analyzing claims associated with food allergy diagnoses, FAIR Health was able to get more precise estimates of the average number of services and the average costs per patient in a single year, 2016 (figure 25). Costs included both the charges that providers billed for their services and the allowed amounts, the maximum amount an insurer will pay for a covered health service. The allowed amounts were imputed by FAIR Health based on its data on allowed amounts. Patients included both children and adults, and the results were broken down by type of allergy.

[32] Ruchi Gupta et al., "The Economic Impact of Childhood Food Allergy in the United States," *JAMA Pediatr* 167, no. 11 (2013): 1026-1031; doi:10.1001/jamapediatrics.2013.2376.

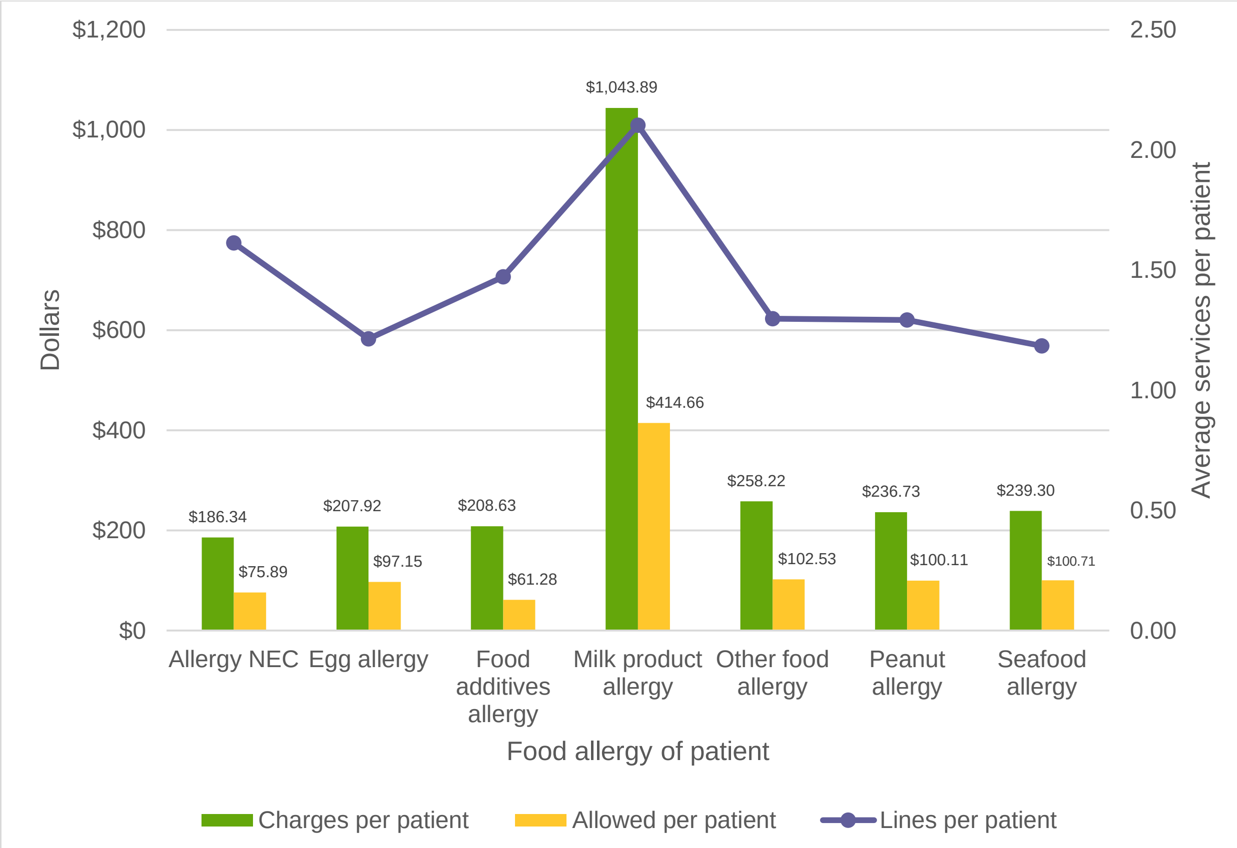

Figure 25. Average annual costs and services per patient diagnosed with food allergy, by type of allergy, 2016. "Lines" are "services." "NEC" is "not elsewhere classified."

The average number of services per patient varied from 1.18 for seafood allergy to 2.10 for milk product allergy. There was similar variation in average charges and allowed amounts: Average charges varied from a low of $186.34 for allergy not elsewhere classified to a high of $1,043.89 for milk product allergy; average allowed amounts varied from a low of $61.28 for food additives allergy to a high of $414.66 for milk product allergy. Milk product allergy stood out consistently for greatest average number of services and greatest average costs. This is likely because milk product allergy is associated with the youngest population, infants and toddlers, and poses risks to their nutrition and growth.[33] This allergy tends to be associated with prescription-based formulas, as described in relation to figure 23.

Average services and costs per patient diagnosed with anaphylactic food reaction in 2016 (figure 26) presented a somewhat different picture from that associated with food allergy diagnoses (figure 25). With anaphylactic food reaction there was less variation in average number of services (1.25 to 1.39), charges ($276.31 to $820.52) and allowed amounts ($145.49 to $272.27). The highest average number of services was for anaphylactic reaction to milk product, but the highest average costs (both charges and allowed amounts) were for anaphylactic reaction to fish. This may be in part because anaphylactic reaction to fish is relatively uncommon, accounting for just 2 percent of the claim lines with anaphylactic food reaction diagnoses in the period 2007-2016 (figure 9). In addition, fish products may be found in

[33] Karen A. Robbins, Robert A. Wood and Corinne A. Keet, "Milk Allergy Is Associated with Decreased Growth in U.S. Children," *J Allergy Clin Immunol* 134, no. 6 (2014): 1466–1468.e6; doi:10.1016/j.jaci.2014.08.037.

unexpected places, such as barbecue sauce, Caesar salad and Worcestershire sauce,[34] and there may have to be extensive testing until the trigger for the anaphylactic reaction is found.

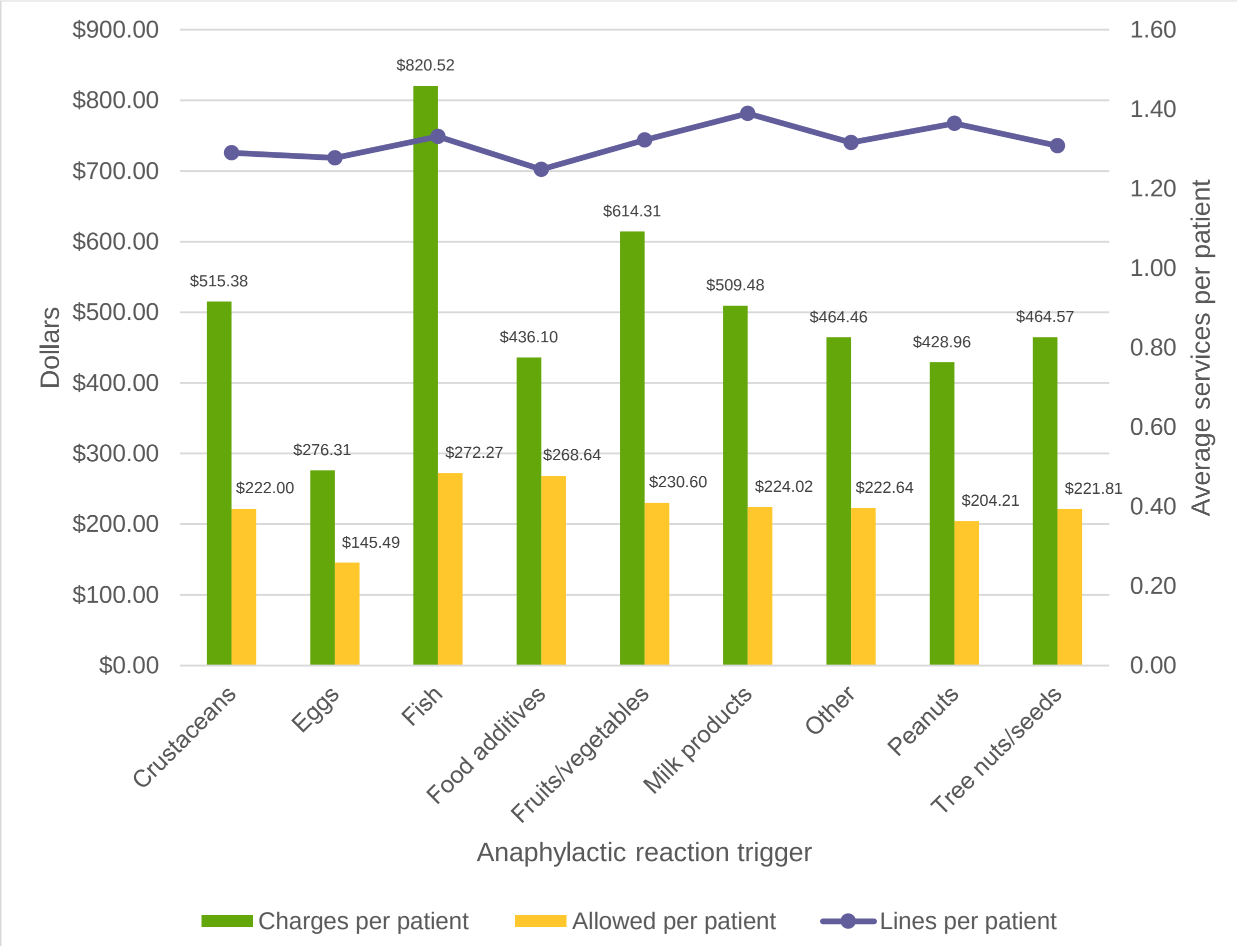

Figure 26. Average annual costs and services per patient diagnosed with anaphylactic food reaction, by trigger, 2016. "Lines" are "services."

Conclusion

This analysis by FAIR Health is consistent with findings of other studies that food allergy is increasing. Furthermore, it has shown the states in which the increase appears to have been greatest, the higher growth in rural than urban areas and the excess in growth of claim lines with diagnoses of anaphylactic food reaction over those of food allergy. Also of note is the extent to which food allergy affects all age groups and both genders, in a pattern in which food allergy is seen more often in male patients in childhood and in female patients in adulthood. By looking into place of service, procedure code category and average costs and services per patient, this study emphasizes the impact of food allergy on the healthcare system. The office setting has been overwhelmingly utilized for diagnoses of anaphylactic food

[34] Food Allergy Research & Education (FARE), "Fish Allergy," accessed October 5, 2017, https://www.foodallergy.org/common-allergens/fish.

reaction, but the costs have been disproportionately greater in other places of services. Office or outpatient services to an established patient was the largest category of procedure codes associated with both food allergy and anaphylactic food reaction. The food allergy with the highest costs and average services per patient in 2016 was milk product allergy, although, among anaphylactic food reactions, anaphylactic reaction to fish had the highest costs per patient that year. FAIR Health hopes that this research will be of interest to all healthcare stakeholders, including payors, providers, government agencies, policy makers and patient advocates, and that it will spark further research into this public health concern and how best to address it.

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About FAIR Health

FAIR Health is a national, independent, nonprofit organization dedicated to bringing transparency to healthcare costs and health insurance information through data products, consumer resources and health systems research support. FAIR Health possesses the nation's largest collection of private healthcare claims data, which includes over 24 billion claim records contributed by payors and administrators who insure or process claims for private insurance plans covering more than 150 million individuals. FAIR Health also holds separate data representing the experience of more than 55 million individuals enrolled in Medicare. Certified by the Centers for Medicare & Medicaid Services (CMS) as a Qualified Entity, FAIR Health receives all of Medicare Parts A, B and D claims data for use in nationwide transparency efforts. FAIR Health licenses its privately billed data and data products—including benchmark modules, data visualizations, custom analytics, episodes of care analytics and market indices—to commercial insurers and self-insurers, employers, hospitals and healthcare systems, government agencies, researchers and others. FAIR Health has earned HITRUST CSF and Service Organization Controls (SOC 2) certifications by meeting the rigorous data security standards of those organizations. As a testament to the reliability and objectivity of FAIR Health data, the data have been incorporated in statutes and regulations around the country and designated as the official, neutral data source for a variety of state health programs, including workers' compensation and personal injury protection (PIP) programs. FAIR Health data serve as an official reference point in support of certain state balance billing laws that protect consumers against bills for surprise out-of-network and emergency services. FAIR Health also uses its database to power a free consumer website available in English and Spanish and an English/Spanish mobile app, which enable consumers to estimate and plan their healthcare expenditures and offer a rich educational platform on health insurance. The website has been honored by the White House Summit on Smart Disclosure, the Agency for Healthcare Research and Quality (AHRQ), URAC, the eHealthcare Leadership Awards, appPicker, *Employee Benefit News* and *Kiplinger's Personal Finance*. FAIR Health also is named a top resource for patients in Elisabeth Rosenthal's book, *An American Sickness: How Healthcare Became Big Business and How You Can Take It Back.* For more information on FAIR Health, visit fairhealth.org.

FAIR Health, Inc.
530 Fifth Avenue, 18th Floor
New York, NY 10036
212-370-0704
fairhealth.org
fairhealthconsumer.org
consumidor.fairhealth.org