The Economic Impact of Peanut Allergies

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ABSTRACT

The prevalence of peanut allergies, the most common food allergy in children, has tripled in the past 2 decades. Today, up to 2.5% of the pediatric population has been diagnosed with a peanut allergy. Peanut allergies result in significant medical, out-of-pocket, and opportunity costs to payers, parents, and employers. They are also a leading cause of food allergy–related deaths in children. Although there is evidence that peanut oral immunotherapy may be effective in reducing the severity of the allergy, such approaches require a long intervention with no standardized protocol available. The introduction of biologic compounds to treat peanut allergies has the potential to revolutionize how these patient cases are managed. Their anticipated high cost, however, raises several issues for payers as to how to integrate these new therapies into formularies and treatment continuums.

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For author information and disclosures, see end of text.

Peanut allergies affect an estimated 1.2% of the overall US population and about 2.5% of the pediatric population.[1-3] They are the most common food allergy in children, affecting about 25% of those with a food allergy, and are a leading cause of allergy-related death in children.[4,5]

The prevalence of peanut allergies in the United States more than tripled between 1997 and 2008, with a recent study finding another 21% increase since 2010.[2,3,6,7] Given that just 20% of children "outgrow" their peanut allergy, it can be expected that there will be a continued increase in the number of adults living with peanut allergy (**Figure 1**[8]) over the next 2 decades.[9] This places a tremendous burden on the US healthcare system, employers, schools, and the parents and children affected.

Burden of Peanut Allergies

Direct Medical and Indirect Costs

The economic cost of food allergies, which includes peanut allergies, varies based on the study, but in all cases is significant. Data from a 2012 survey of the parents of 1643 children with a food allergy (28.7% to peanuts) estimated the economic cost of any food allergy in US children at $24.8 billion annually, or $4184 per child, with $4.3 billion in direct medical costs. Hospitalizations accounted for $1.9 billion, followed by outpatient visits to allergists ($819 million), emergency department (ED) visits ($764 million), and pediatrician visits ($543 million).[10]

Although nearly all the children (88.9%) in this cohort had health insurance, parents still encountered $5.5 billion in out-of-pocket costs from co-payments and deductibles, special diets their children needed, and childcare costs related to the allergy. Annual opportunity costs due to lower work productivity, which affected 9.1% of caregivers, were $14 billion, or $2399 per child. Overall, 4.9% of caregivers reported quitting a job because of their child's condition, 2.5% had to change jobs, and 1.9% lost their jobs.[10] This, in turn, places an economic burden on employers, as they must recruit, hire, and train replacements, and it can cost an average of $4129 to fill the position, according to the Society for Human Resource Management.[11] **Tables 1-3** show the direct medical costs,

out-of-pocket costs, and opportunity costs, respectively, of food allergies.[10]

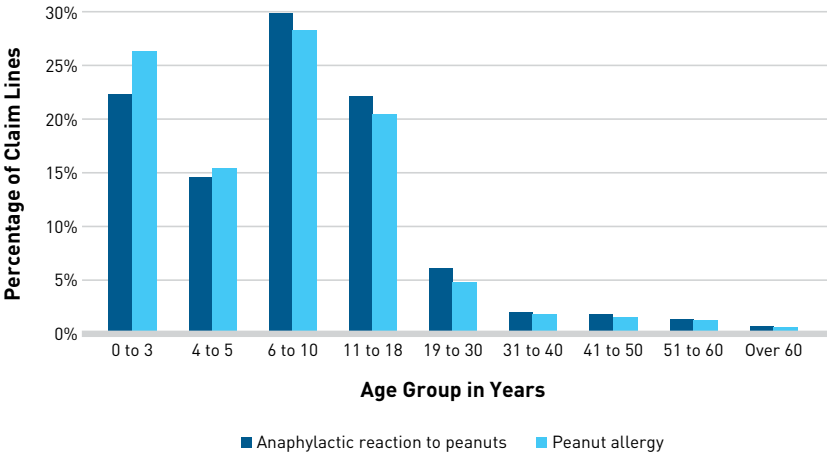
The majority of medical costs associated with food allergies are related to ED visits and inpatient hospitalizations as a result of anaphylaxis, which is a severe life-threatening reaction to an allergen that can lead to airway obstruction, shock, and death. An estimated 40% of children with a food-related allergy have experienced at least 1 anaphylactic event.[12]

Overall, food allergies account for approximately one-fourth of all ED visits for anaphylaxis, a figure that increased 124% between 2005 and 2014 (P <.001), with a 285% increase in those aged 5 to 17 years.[13] However, the true figures are likely higher, given that anaphylaxis is often undiagnosed, underreported, and undertreated.[14]

Peanut and tree nut allergies, which often coexist, appear to be the most common cause of food-related anaphylactic shock. A retrospective cohort study conducted at 37 children's hospitals between 2007 and 2012 found that peanuts were the allergen responsible for 37% of food allergy anaphylaxis cases and 35% of hospital admissions due to anaphylaxis.[15]

Dyer et al found a 29.3% annual increase in ED visits and hospitalizations for food-related anaphylaxis in Illinois between 2008 and 2012, from 6.3 visits per 100,000 children in 2008 to 17.2 per 100,000 children in 2012. Visits and hospitalizations for peanut allergies increased from 2.2 per 100,000 children in 2008 to 5.6 per 100,000 children in 2012, a 30% annual increase (**Figures 2** and **3**).[16] Eleven percent of children seen in the ED for food allergies were hospitalized.[16] Patel et al estimated direct and indirect costs of anaphylaxis related to food allergies, including ED visits, physician visits, and pharmacotherapy, as well as quality-of-life (QOL) issues, lost productivity, and mortality, at $340 million a year ($225 million for direct medical costs; $115 million in indirect costs; both in 2007 USD).[17]

FIGURE 1. Claim Lines With Diagnoses of Peanut Allergy and Anaphylactic Reaction to Peanuts by Age Group in Years, 2007-2016[8,a]



[a]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.

TABLE 1. Direct Medical Costs of Childhood Food Allergy[10,a]

Characteristic	Children with Visit, % (SE)	Visits per Child, Mean (SE)	Cost, USD		
			Visit	Child	Overall Annual (in millions)
Visits					
Pediatrician	42 (2)	0.82 (0.05)	112[b]	92	543
Allergist	41 (2)	0.79 (0.05)	175[b]	138	819
Pulmonologist	14 (1)	0.07 (0.01)	175[b]	12	71
Nutritionist	17 (1)	0.16 (0.04)	100[b]	16	96
Alternative provider	17 (1)	0.23 (0.05)	100[b]	23	136
Emergency department	13 (1)	0.18 (0.02)	711	129	764
Inpatient hospitalization stays	4 (1)	0.05 (0.01)	6269	314	1863
Total direct medical costs				724	4292

SE indicates standard error; USD, US dollars.
[a]Direct medical costs are medical costs, borne by the healthcare system, that are associated with the prevention, diagnosis, and treatment of food allergies.
[b]Source: Hospital Outpatient Prospective Payment System.
Reprinted from Gupta R, Holdford D, Bilaver L, Dyer A, Holl JL, Meltzer D. The economic impact of childhood food allergy in the United States. *JAMA Pediatrics*. 2013;167(11):1026-1031.

Meanwhile, an analysis of private payer claims covering more than 150 million individuals from 5 states found annual charges of $236.73 per patient diagnosed with peanut-related allergies (including outpatient and ED visits, inpatient admissions, and allergy testing) with allowable charges of $100.11. The authors also reported that the number of claims for anaphylactic food reactions increased 377% between 2007 and 2016, with about one-third attributable to adults. Of those, claims with a diagnosis of peanut anaphylactic reactions increased 445%, and those with diagnoses of tree nut/seed anaphylactic reactions increased 603% (**Figure 4**).[8] Peanut allergies were the most common cause of anaphylaxis (26%), followed by tree nut/seed at 18%.[8]

TABLE 2. Out-of-Pocket Costs of Childhood Food Allergy[10,a]

Variable	% Reporting Cost (SE)	Mean Direct Out-of-Pocket Costs, USD (SE)	Cost per Child, USD	Overall Annual Cost (in millions), USD
Visits to the physician's office or health clinic (including co-pays)	52.5 (2.2)	160 (14)	84	499
Visits to the emergency department (including co-pays)	16.1 (1.6)	247 (42)	40	235
Overnight stays at the hospital	10 (1.4)	411 (182)	41	244
Travel to and from healthcare visits (including ambulance use and parking expense)	27.7 (1.8)	91 (14)	25	149
Epinephrine injectors	35.9 (1.9)	87 (4)	31	184
Antihistamines (fexofenadine, diphenhydramine, loratadine, cetirizine)	50.8 (2.2)	62 (4)	32	188
Other prescription/nonprescription medication	29.3 (1.9)	122 (13)	36	211
Nontraditional medicine (eg, herbal products)	15 (1.6)	123 (30)	19	110
Costs associated with special diets and allergen-free foods	37.7 (2)	756 (59)	285	1689
Additional/change in childcare	6.7 (0.8)	2158 (323)	145	857
Legal guidance	2.3 (0.6)	402 (122)	9	55
Counseling or mental health services	4.5 (0.7)	571 (123)	26	152
Special summer camp	3 (0.7)	702 (183)	21	125
A change in schools was needed due to this child's food allergy	4.2 (0.7)	2611 (497)	110	650
Other out-of-pocket expenses (eg, cleaning supplies, skin-care products, transportation)	9.2 (1.1)	396 (96)	36	216
Any out-of-pocket costs	74.3 (2.1)	1252 (90)	931	5516

SE indicates standard error; USD, US dollars.

[a]Out-of-pocket costs: medical costs borne by patient associated with the prevention, diagnosis, and treatment of food allergies. Includes all costs associated with protecting the child from exposure to allergens, including special childcare arrangements. The out-of-pocket costs exclude the top 1% of reported costs in each category. Reprinted from Gupta R, Holdford D, Bilaver L, Dyer A, Holl JL, Meltzer D. The economic impact of childhood food allergy in the United States. *JAMA Pediatrics*. 2013;167(11):1026-1031.

TABLE 3. Opportunity Costs of Childhood Food Allergy[10,a]

Characteristic	Cost			
		USD		
	Reporting % (SE)	Opportunity Mean (SE)	Per Child	Overall Annual (in billions)
Choice of career has been restricted	5.7 (0.9)	15,655 (2471)	892	5.3
A job had to be given up	4.9 (0.7)	29,657 (4151)	1453	8.6
A job was lost through dismissal	1.9 (0.6)	14,849 (7479)	282	1.7
A job change was required	2.5 (0.6)	10,605 (3161)	265	1.6
Any job-related opportunity cost (total amount)[b]	9.1 (1)	32,719 (4166)	2977	17.6
Any job-related opportunity cost (maximum amount)[c]	9.1 (1)	26,363 (2545)	2399	14.2

SE indicates standard error; USD, US dollars.

[a]Opportunity cost is the additional cost associated with activities forgone as a result of a child's allergy. The opportunity costs exclude the top 1% of reported costs in each category.

[b]All possible responses were used to calculate job-related opportunity cost.

[c]Only the maximum of 4 possible responses was used to calculate job-related opportunity cost.

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Quality of Life

Food allergies take a tremendous toll on the QOL of parents and children. Studies report increased bullying of children with food allergies; a significant impact on family social activities, such as dining out and attending sporting or other entertainment events; and missed social activities, such as play dates, birthday parties, and camps for the affected child. Food allergies also put a strain on a marriage or other relationships, and mothers experience more, not less, stress as their child matures and their influence over their child's environment wanes.[18] In addition, children usually require special food, may be separated from other children at school during mealtimes, and are often not allowed to visit friends' homes to play, all increasing a sense of isolation. As a further precaution, 10% of children with food allergies are homeschooled because of the child's allergy.[19]

In 1 study, investigators used 2 disease-specific QOL questionnaires to assess QOL in 20 children with peanut allergy and 20 children with insulin-dependent diabetes (IDD). Questionnaire 1 was investigator-designed; questionnaire 2 was adapted from the Vespid Allergy Quality of Life Questionnaire, which has been used to measure health-related QOL in those with severe insect allergies. Participants also used cameras and a notebook to record the effects of their disease on their QOL over a 24-hour period.[20]

Overall mean scores on both questionnaires were higher for children with peanut allergy than with IDD (54.85 vs 46.40 on questionnaire 1, $P = .004$; and 54.30 vs 34.50 on questionnaire 2, $P \leq .001$). Children with peanut allergies were more afraid of accidentally eating peanuts than children with IDD were of an incident of hypoglycemia. The children with allergies also felt restricted in physical activities, whereas those with diabetes felt positive toward physical activity as a way of managing their disease. The peanut allergy group also reported greater anxiety at social activities, such as birthday parties, than children with diabetes.

Another study used a vertical visual analog scale and the Impact on Family Questionnaire (IFQ) to compare outcomes between the parents of 153 children with peanut allergies and parents of 69 children with a rheumatic disease. The IFQ was also given to 37 adults with peanut allergies and 42 adults with a rheumatic disease. The IFQ measures the impact of the disease on the family's social activities (ie, seeing friends and family less because of worry about accidental exposure); personal strain resulting from the psychological burden of illness; financial burden; and coping strategies.[21]

Parents of the children with peanut allergies reported greater disruption in their children's lives and demonstrated greater impairment in the familial-social dimension of the IFQ than parents of children with rheumatic disease. The adults with peanut allergies and rheumatic conditions had similar disruptions in their QOL, but the adults with peanut allergy reported less disruption in family relations compared to adult patients with rheumatic disease.

A more recent cross-sectional study measuring QOL, anxiety, and stress in 46 families with a child with peanut allergy found high levels of stress and anxiety in the parents, with significantly higher levels in mothers than fathers. Mothers also rated their QOL lower than did fathers. The children had higher separation anxiety than their siblings and poorer emotional QOL, psychosocial health, physical health-related QOL, and QOL within school.[22] Such findings are not surprising, given the relentless need for both children with peanut allergies and their parents to be hypervigilant about contact with even a trace of peanut product and the constant uncertainty under which they live.

Current and Future Management of Peanut Allergies: Implications for Managed Care

Currently, peanut allergies are managed with strict avoidance, prompt recognition of allergic reactions, and rapid initiation of intramuscular epinephrine and other supportive therapy for anaphylaxis. However, none of these approaches works well in this population.

Avoiding peanut allergens entirely is nearly impossible in today's world, given the nearly ubiquitous presence of peanut-related molecules in many foods, whether deliberately or through

FIGURE 2. Rates of Emergency Department Visits and Hospital Admissions Due to Food-Induced Anaphylaxis Among Children in Illinois[16]

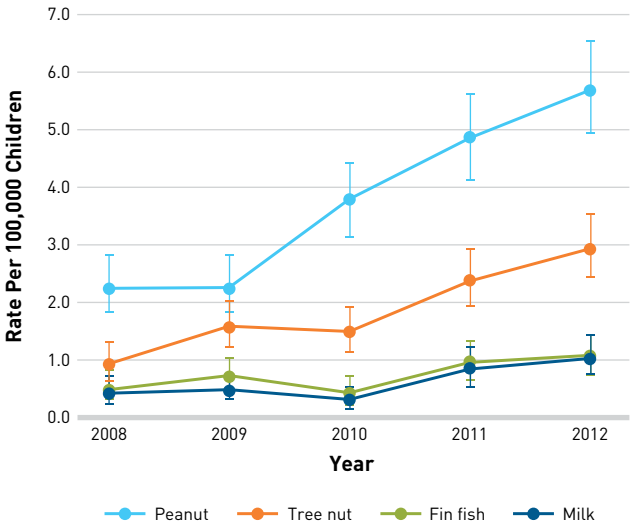

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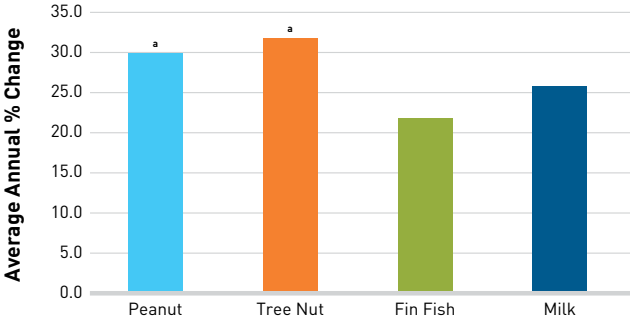
FIGURE 3. Annual Percentage Increase in Emergency Department Visits from 2008 to 2012 by Allergen[16]



[a]Indicates a statistically significant increase from 2008 to 2012 ($P < .005$).
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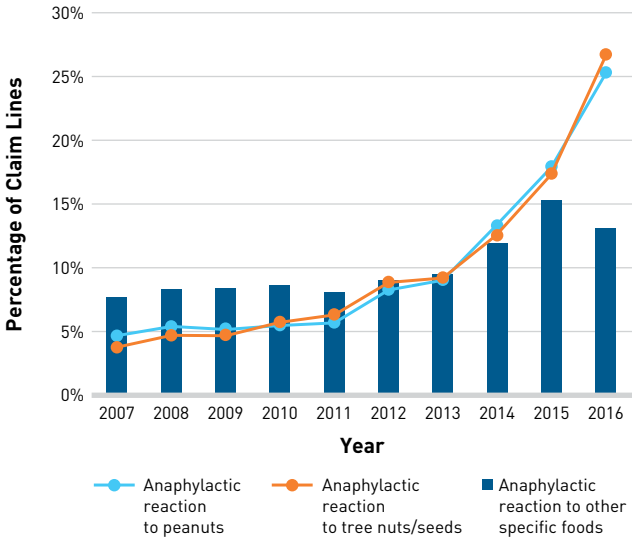
FIGURE 4. Claim Lines With Anaphylactic Food Reaction Diagnoses Attributed to Peanuts, Tree Nuts/Seeds, and "Other Specific Foods," 2007-2016[8]



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contamination during processing. Thus, accidental reactions are quite common, with US studies finding rates as high as 37% over 5 years in 1 cohort and 75% over 14 years in another cohort.[23,24] In addition, children and their parents often do not recognize the nut to which they are allergic.[23,24] Parents and children also often do not recognize foods that may contain allergens; labeling in stores and restaurants may be missing or inaccurate; and a low percentage of parents and older children carry the 2 epinephrine autoinjectors that may be required during an anaphylactic event.[25,26]

A Canadian study of a cohort of 1941 children found that 567 accidental exposures occurred in 429 patients, with an annual incidence rate of 12.4%. Of the 377 moderate or severe exposures, just 28.9% (109) sought medical attention and, of those, just 36.7% (40) received epinephrine.[27] Indeed, results of studies find that less than half of those requiring anaphylactic treatment receive it.[14,28,29] Given the high costs of anaphylaxis discussed earlier, interventions to better control or even eliminate peanut allergies could provide not just a significantly improved QOL for parents and children, but a significant savings for the healthcare system, as well.

Economic Analysis of Oral Immunotherapy

There is just 1 published economic analysis of oral immunotherapy (OIT). It evaluated a double-blind, placebo-controlled randomized trial to investigate OIT combined with a probiotic over 18 months in 62 children aged 1 to 10 years (56 of whom completed the trial). Possible sustained unresponsiveness (the primary outcome) occurred in 82.1% of those receiving OIT and in 3.6% receiving placebo (P <.001) between 2 and 5 weeks after discontinuing therapy. Desensitization occurred in 89.7% of the treated patients and 7.1% of those receiving placebo (P <.001).[30]

Using the standard $50,000 per quality-adjusted life-year as the indication of cost-effectiveness, the authors concluded that OIT was cost-effective over a prolonged time. They noted, however, that if the cost of the therapy increases over time, their analysis could change. If long-term rates of anaphylaxis drop below 6% per year, OIT may prove favorable in reducing anaphylaxis when compared with strict avoidance, they wrote.[31]

Barriers to OIT

Although OIT has the potential to be an effective disease-modifying approach for peanut allergy, a 2016 survey of 28 community and academic allergists (14 of whom offered OIT) and 6 nurse food allergy specialists who managed more than 100 patients with peanut allergies found several barriers to its use[32]:

- Lack of a medicinal product meeting the required standards for FDA approval
- Lack of standardized dosing regimens
- Medical and legal implications of offering non–FDA-approved OIT
- Unclear defined criteria for appropriate patient selection
- Insufficient long-term safety and efficacy data
- Lack of correlation between maintenance of OIT dosing and level of protection

Looking Forward

The pathway to decreasing the prevalence of peanut allergies is multifactorial and starts with awareness and education for parents to incorporate peanut protein when infants are first introduced to solid foods. Given the results of the Learning Early About Peanut Allergy trial, which demonstrated a significant decrease in the frequency of peanut allergies in high-risk children, and the National Institute of Allergy and Infectious Diseases–sponsored expert panel guideline report,[33] there is potential for a slowdown in the trend of increased incidence.[34] Desensitization with oral, sublingual, or subcutaneous peanut proteins has the potential to mitigate the severity of allergic reactions. As highlighted in the second part of this supplement, several compounds with unique mechanisms of action are under investigation as immunotherapy for peanut allergy, most of which are biologics. However, given the high cost of these drugs in other conditions (omalizumab currently costs about $1081 for a single vial), and the high prevalence of peanut allergy in the pediatric and adult population, it is imperative that payers prepare for the economic impact of these treatments.[32] To date, no cost-effectiveness analyses have been published on the potential impact of these new therapies.

Conclusions

The growing prevalence and severity of peanut allergy among US children and adults has shown no sign of abating. Given the high medical and indirect costs of peanut allergy, as well as its impact on the parents' and children's QOL, it is imperative that new methods of treating peanut allergies be implemented. Several investigational immunotherapy approaches may provide the first FDA-approved treatment for peanut allergies within the next few years. Although there is little evidence defining the cost-effectiveness of current or future methods of managing peanut allergy, it is possible to theorize that reducing outpatient and ED visits and the need for rescue therapy with epinephrine, as well as missed work and school days, could lead to lower direct medical and indirect costs. Thus, payers must consider the implications of adding these therapies to their formularies from the economic, adherence, and educational perspectives. ■

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