



Food allergy: how expensive are they?

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Purpose of review

Food allergy remains a disease of global public health significance well known to impact social, emotional, and financial well being. This review aims to summarize the existing literature focused on the direct, indirect, and intangible costs of food allergy at the household and healthcare system levels, and begin to discuss how emerging treatment and prevention strategies may be leveraged to comprehensively care for the food allergic population with the efficient use of health resources.

Recent findings

Food allergy imposes significant costs to multiple stakeholders and largely impact families at the household level. Recent studies elucidate the need to balance the household management of food allergy with the efficient use of health resources. Overall, it remains critical that safe foods and medications remain affordable while further exploring the cost-effectiveness of early introduction, emerging food allergy therapies, and the wider use of stock epinephrine to adequately meet the public health needs of the food-allergic community.

Summary

Better understanding how the cost of food allergy impacts populations will help to inform more progressive policies aimed at lessening socioeconomic disparities and ultimately improve quality of life for children and adults with food allergies.

Keywords

disparities, economic, food allergy

INTRODUCTION

Food allergy remains a disease of global public health significance well known to impact social, emotional, and financial well being among affected individuals and families at the household level with emerging evidence of significant costs to the healthcare and food industry economic sectors [1–3]. In the United States, recent population-based studies estimated that food allergies impact 7.6% of children [4[•]] and 10.8% of adults [5[•]]. Although global estimates of food allergy among children and adults remain limited, childhood estimates of food allergy across the European Union have been estimated to impact 5.3% of children in Greece [6], 6.7% of children in France [7], and 6.7% of children in Sweden [8]. As food allergies continue to affect a large proportion of both children and adults globally, describing the economic impact of food allergies on individuals and societies has emerged as a priority for multiple stakeholders, including: individuals, families, schools, workplaces, healthcare systems, the food industry, and policymakers [3,9] (Fig. 1). Economic studies assessing the cost of food allergy strive to ultimately quantify direct costs (e.g. medications), indirect costs (e.g. restricting

employment to care for a food-allergic child), and intangible costs [3,10^{••}] (e.g. quality of life).

Although few studies have systematically estimated the cost of food allergy with validated measurement tools or have used small clinical samples that are not representative of country-level populations, previous research has described costs within the household, healthcare, and societal levels within American and European contexts [10^{••},11]. For example, Gupta *et al.* [12] in 2013 estimated that the overall cost of food allergy in the United States was \$24.8 billion annually with significant costs borne by families themselves at the household level.

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KEY POINTS

- As food allergies continue to affect a large proportion of both children and adults globally, describing the economic impact of food allergies on individuals and societies has emerged as a priority for multiple stakeholders, including: individuals, families, schools, workplaces, healthcare systems, the food industry, and policymakers.
- Economic studies assessing the cost of food allergy strive to quantify direct costs (e.g. medications), indirect costs (e.g. restricting employment to care for a food-allergic child), and intangible costs (e.g. quality of life) with few studies systematically estimating the cost of food allergy with validated measurement and representative, country-level populations.
- Due to the variability of healthcare financing systems (e.g. single payer/universal), it is expected that direct medical costs will vary when comparing country-level direct medical costs.
- The largest US-based study assessing the economic impact of childhood food allergy estimated that direct medical costs was \$4.3 billion annually, with the highest mean annual costs per patient attributed to hospitalizations (\$352.39), outpatient visits to allergists (\$212.11), and emergency department visits (\$144.77).
- Household level costs remain significant across several studies, including: lost opportunity; special food and diets; food allergy informed childcare arrangements (e.g. school, camps); and out-of-pocket and related healthcare costs borne by families themselves (e.g. travel for healthcare visits, medications not covered by insurance).

Furthermore, as the field continues to elucidate our understanding of the economics of food allergy, we are beginning to consider that the cost of food allergies may impact populations differently, suggesting the existence of socioeconomic disparities within the food allergic population [12–15]. Moreover, as treatment options become more widely available to the allergic population, cost considerations regarding emergency management (e.g. epinephrine auto-injectors), immunotherapy (e.g. oral immunotherapy) [16,17], and potential prevention strategies (e.g. early introduction) [18] are beginning to emerge at the forefront of economic discussions regarding how to best care for the food-allergic population. To this end, this review aims to summarize the existing literature focused on the direct, indirect, and intangible costs of food allergy at the household and healthcare system levels, and begin to discuss how emerging treatment and prevention strategies may be leveraged to comprehensively care

for the food allergic population with the efficient use of health resources.

DIRECT MEDICAL COSTS AND CONSIDERATIONS

Due to the variability of healthcare financing system (e.g. single payer/universal), it is expected that direct medical costs will vary when comparing across countries. A previous systematic review by Bilaver *et al.* [10¹¹] in 2019 found that countries with universal health insurance coverage (e.g. single payer) had lower mean direct medical costs than those without universal health insurance. Countries with universal health insurance included Iceland, Spain, and Greece were compared with the United States and Poland. Direct medical costs included estimates of health services utilization, including: outpatient visits, emergency department visits, inpatient hospitalization, ambulance transports, and epinephrine auto-injectors. The largest US-based study assessing the economic impact of childhood food allergy found that direct medical costs totaled \$4.3 billion annually, with the highest mean annual costs per patient was attributed to hospitalizations (\$352.39), outpatient visits to allergists (\$212.11), and emergency department visits (\$144.77) [12]. A previous study by Patel *et al.* [19] in 2007, found much lower direct medical expenses (\$225 million) with the largest cost attributed to office-based physician visits (\$118 million). It remains difficult to compare direct medical costs because of inconsistency among survey designs (e.g. case-control versus population-based surveys), ages included in the studies, and the utilization of different data sources (e.g. individual surveys versus administrative health data). Future global economic research on food allergy should work to consistently collect comparable health outcomes in order to make meaningful cross-country comparisons regarding food allergy-associated direct medical costs.

OUT-OF-POCKET HOUSEHOLD LEVEL COSTS

Household and healthcare costs not typically covered by insurance, yet associated with the economic burden of a given disease are categorized as out-of-pocket costs. Within the domain of food allergies, these costs include: allergen-free food products, medications, transportation costs, copayments, deductibles, and coinsurance [10¹²]. The reported total out-of-pocket costs associated with food allergies in the United States is \$5.5 billion annually [12]. Mean (SD) household-level out-of-pocket costs totaled \$3339 (\$843)

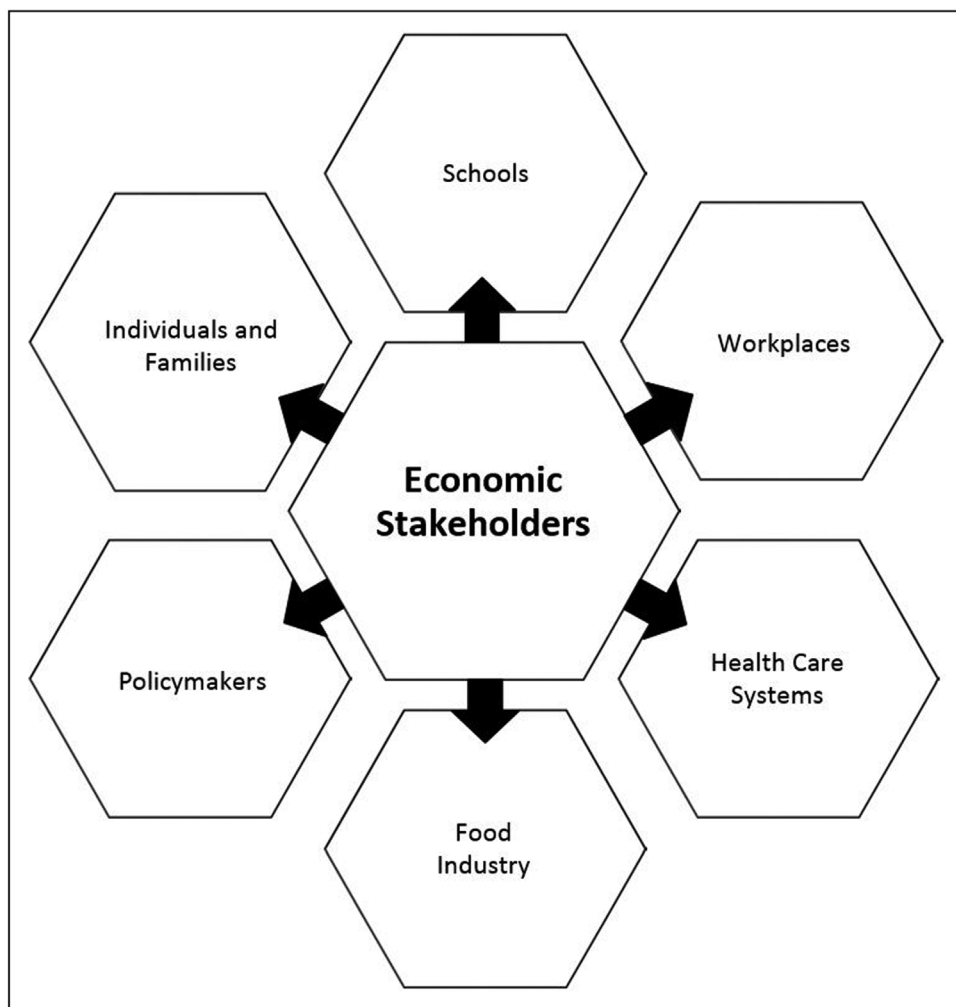


FIGURE 1. Food allergy economic stakeholders.

across four samples in three studies identified by Bilaver *et al.* in 2019. Both the incremental cost of living and the cost of special diets and foods constituted the largest proportion of out-of-pocket costs [10¹¹]. Gupta *et al.* [12] reported the highest proportion of out-of-pocket costs stemmed from changes in child care, special schools or camps, and counseling for allergy (\$349.02 per patient) followed closely by costs of special diets and foods (\$319.84). Similarly, two studies measuring household-level out-of-pocket costs of food allergies in Sweden found that the most burden was related to cost of living. This amounted to \$1427.92 for adults, \$2702.48 for children ages 0–12 years, and \$3504.95 for children ages 13–17 years annually per patient [20,21].

Although not systematically quantified across all studies, evidence signals that the additional time spent on food-related household management tasks, such as grocery shopping and with food preparation in addition to the costs of special foods remains an economic issue [22,23]. For example,

Cerecedo *et al.* [14] in 2014 estimated that the combined cost of information seeking in addition to time spent on household food allergy-related tasks among child and adult populations in Spain and Poland was \$155.23 and \$5769, respectively. Similarly, in a Swedish population of adults diagnosed to cow's milk, hen's egg, and/or wheat, more time was spent on general food allergy-related domestic tasks, food shopping, preparing food, and on food allergy information seeking. Emerging data collection strategies that may allow for better estimation of time spent on household tasks and information-seeking behaviors include ecological momentary assessments, which aim to assess behavior throughout one's daily life through brief, repeated assessments administered via mobile devices [24,25]. Better understanding how time costs impact households managing food allergy can inform the development of technologies or policy.

Better understanding how to appropriately respond to a food allergy emergency remains critical

to both ensuring the safety of an affected child how and when to use epinephrine auto-injectors to effectively manage allergic reactions. Food-induced anaphylaxis is potentially life-threatening, known only to be alleviated by the administration of epinephrine [26]. Previous research by Fleming *et al.* [26] in 2015 reported a significant decreased risk of hospitalization and its associated risks for children with anaphylaxis who were treated with epinephrine prior to emergency department arrival. Annual US direct costs for EAI prescriptions were estimated to be \$294 million in 2010 [27]. The cost of epinephrine remains significant at both the societal and household levels, potentially creating additional burden to families. For example, over half of all epinephrine auto-injector prescriptions are left unfilled when the two-pack cost exceeds \$300 [27]. Socioeconomic factors influence access to epinephrine auto-injectors as previous literature has shown that high-income and white children with private insurance plans are most likely to receive recommended EAI prescription and administration [27]. Stock or supplemental epinephrine auto-injectors, notably in school or on aircrafts, are warranted to both increase access and may be a more cost-effective solution to address the shortage of epinephrine auto-injectors while expanding access to medication as new treatments for FAI through keeping epinephrine auto-injectors affordably priced [28,29].

HOUSEHOLD LEVEL: LOST OPPORTUNITY COSTS

Food allergy remains a unique condition where the affected person remains physically healthy outside of an accidental ingestion. Not surprisingly, the majority of food allergy-associated costs are borne by families themselves at the household level with the goal of preventing an unintentional ingestion [10²²,20,30]. A recent review found that household level costs remain significant across several studies, including: lost opportunity; special food and diets; food allergy informed childcare arrangements (e.g. school, camps); and out-of-pocket and related healthcare costs borne by families themselves (e.g. travel for healthcare visits, medications not covered by insurance) [10²²]. For example, in a study by Alanne *et al.* [31] in 2012 of Finnish infants, cost estimations highlight small differences in infancy (0–24 months), where slight increased costs were seen within families who purchased hydrolyzed formulas. Furthermore, type of allergy was associated with higher costs of allergic diseases for the Finnish society, with cow's milk allergy emerging as the highest allergy cost in infants and young children [31].

The largest food allergy-associated household level costs are those attributable to lost opportunity. Lost opportunity costs include the significant loss of income if a parent or an affected adult has to decrease or give up employment to adequately care for their child or themselves. Previous research by Bilaver *et al.* in 2019 on household level opportunity costs drawn from studies in the United States, Finland, Spain, and Poland was estimated to be \$4881 (SD=\$2201) per food allergic individual per year. On a national level, Gupta *et al.* in 2013, estimated that the overall opportunity cost of a childhood food allergy in the United States caused significant burden, at \$14 billion (\$2,399 per child per year). In addition to restricting employment, Bilaver *et al.* in 2019 estimated that lost opportunity costs also include decreased productivity, which previous research estimated to be \$1038 (SD=\$1273) per individual per year.

Previous research demonstrates that mothers shoulder much of the burden of health management, and still today typically earn less than male partners in heterosexual relationships, thus typically report either restricting their career or giving up a job altogether to care for an affected child. When surveyed, mothers of children with food allergy generally report lower quality of life (QoL) compared with fathers of children with food allergy [32]. In particular, this could potentially be attributed to having to put her career on hold or forfeiting employment altogether in order to ensure she was able to appropriately care for an affected child. As biological sex and gender remain large drivers of health outcomes, future economic research may want to further explore the potential gendered differences as it pertains to a caregiver's role in relationship to caring for a child with food allergy and how this impacts opportunity costs stratified by the gender of the caregiver [33].

COST-EFFECTIVE CARE: SCREENING/EARLY INTRODUCTION, IMMUNOTHERAPY

Utilizing cost-effectiveness studies to guide decisions for determining food allergy best practices remains critical [34²²,35]. In a 2019 review of food allergy management strategies by Shaker and Greenhawt [34²²], the study assessed the utility of food allergy management finding that many aspects are not cost-effective; however, incorporating patient preferences as well as value-based pricing and school resourcing of epinephrine auto-injectors may yield more cost-effective care. Current evidence suggests that children with an egg allergy and severe eczema have the ability to lower the risk of developing a peanut allergy through the early introduction of

peanuts. Guidelines regarding screening prior to early introduction (i.e. children undergoing allergy testing and potentially introducing peanut in the office setting) have varied across countries. Regarding both health and economic outcomes, previous research has found that early introduction of peanut in the office setting and/or skin prick testing led to over diagnosing peanut allergy and delayed the introduction of peanuts to at-risk children, which yield significant economic costs and poorer health outcomes at the societal level [36]. Although the global food allergy community has focused on better understanding the prevention and treatment of peanut allergy with no guidelines yet developed for other food allergens, emerging evidence signals that early egg introduction may also yield significant health and economic benefits.

Regarding emerging food allergy treatments, limited data exist assessing the cost-effectiveness of food allergy immunotherapy as commercial products are not widely available at the population level [37,38]. Previous research assessing the cost of immunotherapy has found that caregivers are willing to pay between \$1568 and \$6568 for epicutaneous peanut immunotherapy (EPIT) and between \$1235 and \$5235 for probiotic plus peanut oil immunotherapy (POIT), with the potential for cost-savings should the immunotherapy elicit sustained unresponsiveness [39]. Additional management strategies and treatment modalities that should be considered in future cost-effective analyses include: best practices regarding oral food challenges (e.g. cost of delayed oral food challenges) [40], the utility of observation post-anaphylaxis [41], and the use of integrative medicine (e.g. Chinese herbal therapies) [42] and nutritional interventions (e.g. probiotics) [23].

CONCLUSION

Food allergy imposes significant costs to multiple stakeholders across economic sectors, and largely impact families on the household level. To balance the need for comprehensive management of food allergy with the efficient use of health resources, it remains critical that safe foods and medications remain affordable while further exploring the cost-effectiveness of early introduction, emerging food allergy therapies, and the wider use of stock epinephrine to adequately meet the public health needs of the food-allergic community. In moving forward, better understanding how the cost of food allergies impacts populations differently will help to inform more progressive food allergy policies aimed at lessening socioeconomic disparities and ultimately improve quality of life for children and adults with food allergy.

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Conflicts of interest

There are no conflicts of interest.

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Papers of particular interest, published within the annual period of review, have been highlighted as:

- of special interest
- of outstanding interest

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