



Pediatric food allergy-related household costs are influenced by age, but not disease severity

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ABSTRACT

Objective: The economic burden of food allergy on households is poorly understood. We evaluated the household costs associated with specialist-diagnosed pediatric food allergy, with focus on age and disease severity.

Study design: A cross-sectional study of 70 Swedish case-control pairs (59% boys) was conducted using Food Allergy Economic questionnaire. Household costs were analyzed between age- and gender-matched cases (children aged 0-17 years, with specialist-diagnosed food allergy) and controls (non-food allergic households).

Results: Parents were predominantly university-educated and employed full-time. Most cases had parent-reported previous anaphylaxis. Mean total annual household costs were comparable between cases and controls. However, compared to controls, cases had significantly higher direct medical-, and non-medical related costs; higher indirect medical-related costs, and higher intangible costs (all $p < 0.05$). In a sensitivity analyses of only cases aged 0-12 years, direct household costs, including lost earnings due to child's hospitalization, were significantly higher than controls. Results from only children with severe disease paralleled those of all cases vs. controls.

Conclusions: Although pediatric food allergy is not associated with higher total annual household costs, these households have significantly higher direct medical-related, indirect and intangible costs vs. non-food allergic households. Higher household costs were identified amongst younger children, but not disease severity.

Keywords: Adolescents, Children, Costs, Food allergy, Household

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INTRODUCTION

Food allergy affects as many as 7-10% of children worldwide.^{1,2} This disease requires both healthcare-related, and non-healthcare-related resources, and has a substantial economic burden.³⁻⁶ We previously reported excess household costs of €4000 to €4800 for Swedish families with milk, egg and/or wheat allergic children and adolescents, respectively, compared to non-allergic families.³ Such differences were predominantly driven by indirect household costs, but also include direct and intangible costs, such as health-related quality of life. As few previous studies have considered all three types of household costs of specialist-diagnosed allergy to any food(s), we aimed to describe the household costs associated with specialist-diagnosed pediatric food allergy, with focus on age and disease severity.

METHODS

Parent-reported costs were analyzed at the household level amongst cases (households with a food-allergic child aged 0-17 years) and controls (non-food allergic households, with a child matched with cases by age (± 1 year) and gender). This cross-sectional design permitted the calculation of cost differences related to food allergy.

Cases with a specialist diagnosis of food allergy were recruited from tertiary care pediatric allergology clinics from two Swedish cities: Stockholm and Linköping. Their parents/guardians were invited to complete the Food Allergy Economic Questionnaire (Eco-Q; see below). Exclusion criteria were: an unclear diagnosis of food allergy, other chronic health conditions (e.g. celiac disease, diabetes), and/or an inability to read Swedish. Controls from non-food allergic households were recruited from the same cities via social media, websites, and community-based organizations.

Parents reported their children's previous food allergic symptoms, which we classified as mild vs. severe symptoms. *Mild symptoms* included itchy or rashy skin; swollen lips; itchy or runny eyes or nose; nausea, vomiting or diarrhea, fatigue, lethargy, weakness, anxiety or depression. *Severe symptoms* included dizziness, shortness of breath,

wheezing, rattling in the throat, fainting, or low blood pressure. Anaphylaxis was also considered, based on an affirmative response to the statement, "My child has had allergic shock."

Parents completed the Eco-Q, a questionnaire developed by the European Union project Euro-Prevall,⁷ translated to Swedish per World Health Organization guidelines⁸ and modified to reflect the Swedish healthcare system. In Sweden, healthcare is tax-funded, and, since 2016 (i.e. prior to participant recruitment) prescription medications for children <18 years are dispensed without any additional out-of-pocket expenses to the household.⁹ Likewise, there are no additional costs to the household for pediatric hospitalizations. Using these data, we estimated the total household costs based on three cost categories: direct and indirect costs (collectively termed total costs); and, intangible costs.⁷

Direct costs are paid by the household for medical, non-medical and household expenses.¹⁰ Examples of medical-related costs are co-payment costs to the healthcare provider for emergency- and acute care visits, and over-the-counter drugs (OTCD). Non-medical direct costs include food, including preparation, and transportation and lost wages associated with healthcare visits.

Indirect costs are the parent/guardian's productivity and opportunity losses due to their child's food allergy.¹⁰ Indirect costs are calculated based on time losses multiplied by the Swedish average wage.¹¹

Intangible costs included the parent/guardian's perceived health status of their child and themselves, and the household's standard of living. At present, there is no instrument by which to convert intangible costs to monetary terms.⁷

Statistical analysis

Descriptive statistics were used to calculate the sociodemographic characteristics of the study population. Categorical variables were compared amongst the matched pairs by using McNemer test. Household costs were compared using paired t-tests. Direct and indirect costs were converted from Swedish Krona to Euro (European Central Bank; www.ecb.europa.eu 16th April 2018).

Missing values were not counted. All costs were extrapolated to the period of one year to get annual household cost.

We first considered all matched case-control pairs ($n = 70$). Subsequently, we performed two sensitivity analyses. First, we considered only cases aged 0–12 years who may have different allergy phenotypes, and thus different costs, compared to older children. Second, we considered only cases with severe food allergy, excluding those with only staple food allergy, and including those with anaphylaxis and/or severe symptoms.

Analyses were performed using SPSS 24.0 (Armonk, NY, US), with $p < 0.05$ considered statistically significant. The study was granted ethical permission (Linköping: DNR 2014/458-31; Stockholm: DNR 2016/436-32). All personal information was handled according to the Swedish Ethical Review Act, 2003 and the European Union's General Data Protection Act.

RESULTS

In total, 70 case-control pairs were recruited (E-Table 1). Most participants were boys (62% cases; 59% controls) and most lived in four-member households (46% cases; 59% controls). Compared to controls, cases had more allergic comorbidities. About half of parents/guardians of both cases and controls were university graduates and employed full time.

Most cases had 3 or more food allergies (E-Table 2), including 25% who had 5 or more food allergies. Mild symptoms were most common. Yet, nearly half of cases had previously experienced anaphylaxis. Most cases had been diagnosed with food allergy in infancy (by age 2 years), and many came from households with more than 1 food allergic person.

I. All case-control pairs

On average, mean annual household costs were €791 higher amongst cases compared to controls

	Cases		Controls		P-value
	Mean	SD	Mean	SD	
Total Household Costs	10544.62	3956.83	9610.53	2969.61	0.14
Direct Household Costs	595.47	860.65	309.65	301.97	0.03
Direct-Medical Related Costs	259.54	311.86	134.53	131.06	0.02
Healthcare and Hospitalization	25.23	70.39	11.56	62.69	0.06
OTCD	234.31	293.64	122.98	118.49	0.04
Direct Non-Medical Related Cost	335.93	669.16	175.12	275.72	0.16
Transportation	20.36	35.03	5.37	15.02	<0.001
Lost earnings due to child's healthcare visit	155.06	437.50	14.79	65.52	0.01
Lost earning due to child's hospitalization	68.81	465.38	0	0	0.18
Cost of medical Insurance	91.69	175.42	154.95	277.66	0.28
Indirect Household Costs (Time losses)	9949.15	3618.39	9300.89	2928.43	0.29
Indirect Medical-Related Costs	467.88	526.68	149.72	164.15	<0.001
Seeking healthcare visit	330.92	416.61	73.44	111.93	<0.001
Child's hospitalization	7.88	43.01	1.23	5.49	0.29
Seeking healthcare information	129.08	253.20	75.05	96.29	0.49
Indirect Non-Medical Related Cost	9481.27	3531.83	9151.17	2911.52	0.75
Meal preparation	6748.76	3056.63	6831.28	2335.57	0.76
Food shopping	2732.51	1548.57	2319.88	1085.94	0.05

Table 1. Comparison of direct-, indirect- and total annual costs (€) between cases and controls, a sensitivity analysis restricted to children aged 0–12 years ($N = 56$ pairs) Abbreviation: OTCD Over-the-counter-drugs. Bold text denotes statistically significant differences

($p > 0.05$; E-Table 3). Compared to controls, cases had higher direct medical-related costs, healthcare and hospitalisation costs, OTCD costs, transportation costs, and lost earnings due to healthcare visits (difference: €123.22; $p = 0.003$). Significant differences in indirect medical-related costs were driven by time losses seeking healthcare (difference: €254,35; $p < 0.001$).

Intangible costs, or the non-monetary costs of a disease, were significantly different between cases and controls (E-Table 4). Compared to controls, cases had worse parent/guardian-reported health status and more negative life events.

II. Ages 0-12 only

Most participants were aged 0-12 years, and had some age-specific differences in types of foods to which they were allergic, compared to older children (E-Fig. 1). For example, milk, egg and wheat allergies tended to be more common, but were not statistically different in the younger group than the older group (e.g. milk: 42% vs. 17%, respectively). In contrast, fruit and sesame allergies were less common in the younger group than the older group (e.g. sesame: 3% vs. 10%, respectively). Tree nut and peanut allergies were common amongst both the younger and older groups (e.g. tree nut: 51% vs. 60%, respectively).

In this sensitivity analysis, direct- and indirect household costs were comparable to those for all case-control pairs, with some notable exceptions (Table 1). For example, compared to controls, cases aged 0-12 years had significantly higher direct household costs and certain indirect non-medical related costs, such as time lost to food shopping (both $p < 0.05$). Intangible costs differed between cases and controls (Table 2), but paralleled those seen between all case-control pairs.

III. Severe disease only

Unlike results comparing all case-control pairs or ages 0-12 years, households with a child with severe food allergy did not report significantly different direct medical related costs (E-Table 5). In contrast, indirect costs for those with severe disease were significantly different to the same magnitude as the other 2 groups.

Perceived health and well-being tended towards a significant difference amongst those with severe disease, compared to controls (E-Table 6). Other intangible costs were comparable to the other groups.

DISCUSSION

This study reported the household economic burden of allergies to any food(s) in Swedish

	Cases		Controls		P- value
	n	%	n	%	
Health^a					
Excellent or very good	35	63	4	7	0.007
Poor, fair or good	17	30	0	0	
Well-being ^{a,b}	8		9		0.03
Negative life events^a					
Parent/guardian					
Restricted job/career	8	14	0	0	0.008
Anger, fear, anxiety, feeling left out, trauma	29	52	4	7	<0.001
Child					
Restricted social life	17	30	0	0	<0.001
Hospitalization	20	36	1	2	<0.001
Anaphylaxis	25	45	1	2	<0.001
Anger, fear, feeling left out, trauma	26	46	3	5	<0.001

Table 2. Comparison of intangible household costs between age- and gender-matched cases and controls, a sensitivity analysis restricted to children aged 0-12 years (N = 56 pairs) a. Parent/guardian-reported perceptions of child. b. Median; on a scale of 1 (worst possible) to 10 (best possible) perceived well-being

children, and compared these costs to age- and gender-matched controls, with consideration to age and disease severity. Total-, direct- and indirect costs did not differ between all case-control pairs. However, there were important and significant differences within several cost sub-categories including, direct and indirect medical-related cost, cost of transportation and loss of earning for seeking healthcare, etc. Households with food allergic children aged 0-12 had higher direct household costs and certain indirect non-medical related costs, such as time lost to food shopping, whereas households with a child with severe food allergy did not report significantly different direct medical related costs. This raises the possibility that households with a child who has food allergy may shift some of their direct and indirect costs, in order to offset the costs associated with food allergy. Although this possibility cannot be comprehensively answered based on our survey data, it warrants future investigation, including through qualitative explorations of the costs of food allergy. Furthermore, cases reported substantially higher intangible costs than controls, including negative life events, and restricted opportunities. These differences persisted in analyses of the entire study population, and within sensitivity analyses.

Our cost estimates are based on parent-report. However, as such estimates were provided by both cases and controls, and thus likely to occur to the same degree, any misclassification is non-differential. Our study was performed in Sweden, where healthcare and prescribed medications are free for children to age 18 years. Thus, our findings may underestimate food allergy-related direct household costs in jurisdictions where households must absorb such costs. However, given that we did find significant differences in an almost fully subsidized healthcare system, our findings serve to underscore the substantial economic burden of food allergy for households.

In 2015, we reported on the household economic burden of pediatric staple food allergy.¹² However, these estimates were made at a time when Swedish households were required to pay some out-of-pocket expenses for pediatric healthcare and prescription medication. In 2016, such out-of-pocket expenses were eliminated, and are now absorbed by the national healthcare system, thus warranting a

new estimate.^{9,13} The analyses presented herein also provide an opportunity to identify the age-specific household economic burden of allergy to any foods, rather than only staple foods. Taken together, the findings support that allergy to staple foods has a higher impact on household costs than allergy to a wider range of food items.

More notable is that direct medical-related costs, and specifically costs relating to over-the-counter drugs, are significantly higher in cases than controls, including in analyses restricted to those aged 0-12 years. No such differences, other than fees associated with late cancellations or missed healthcare appointments were identified between controls and children with severe food allergy.

Cases had greater indirect costs including time losses related to healthcare visits, including consideration to age and disease severity. This finding parallels our previous work¹² as well as results from the USA.⁵ Interestingly, time losses associated were only reported by households with food allergic children aged 0-12 years, which we did not previously identify.¹² This difference may be driven by both the challenges of multiple food allergies, the relative newness of a food allergy diagnosis in younger children, fewer healthcare visits for older children, and that older children do more by themselves.

Over half of our study population had allergies to 3 or more foods, which almost certainly mandates greater dietary restrictions than a single food allergy. The necessity of multiple restrictions is likely to be reflected in all costs, not only out-of-pocket direct costs. Indirect costs, as measured by time and social losses, and intangible costs, such as feelings of exclusion, are likely to be greater in our study population than one in which participants had a single food allergy.

The impact of food allergy on mental health is only beginning to be recognized, and is likely underestimated.¹⁴ Our study provides insight into the intangible household burden of food allergy, including perceptions of significantly more negative life events amongst cases than controls. Amongst households with food allergy, about half of parents reported that both they and their children experienced anger, fear, feelings of exclusion, and trauma. Such negative events were rarely reported by non-food allergic households.

Whether these negative events were associated with, or contributing factors to restricted job/career- and social life opportunities amongst food allergic households cannot be determined from our data. However, it warrants mention that non-food allergic households reported no such negative events. Elsewhere, Annunziato et al reported that 70% of mothers with food allergic children reported that mental health support would be beneficial.¹⁵ Yet, to our knowledge, these types of sustained supports are not commonly available.

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Avoidance of the allergenic food is a cornerstone in food allergy management. In our study, nearly half parents/guardians with a food allergic child, regardless of age or disease severity, reported that they believed they would spend less money on food shopping if they were not a food allergic household. The food industry is a key stakeholder on which food allergic households rely. to avoid accidental exposure. This is achieved through food industry safety legislations, strict management of food production process, and using precautionary "may contain" labels. Our findings reinforce that, despite strict rules and regulations for food industry, many food allergic households believe that they spend more on food than non-food allergic households, which may further result in greater intangible costs associated with negative life events, including anger.

To conclude, pediatric food allergy is associated with significantly higher direct medical-related, indirect and intangible costs compared to non-food allergic households. Further differences were noted amongst younger children, but not by disease severity.

Abbreviations

EAI: Epinephrine Autoinjector; Eco-Q: Food Allergy Economic Questionnaire; IgE: Immunoglobulin E; OTCD:

Over-the-Counter Drugs; USA: United States of America; USD: American dollars

Consent for publication

All authors have approved the manuscript for submission.

Conflict of interests

All authors declare that they have no competing interests.

Ethics approval and consent to participate

The study was granted ethical permission (Linköping: DNR 2014/458-31; Stockholm: DNR 2016/436-32). All personal information was handled according to the Swedish Ethical Review Act, 2003 and the European Union's General Data Protection Act. Written informed consent was obtained from the parents or guardians of all the study subjects.

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Appendix A. Supplementary data

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