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Original Article

Household Costs Associated with Objectively Diagnosed Allergy to Staple Foods in Children and Adolescents

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What is already known about this topic? Amongst children and adolescents, parent-reported allergies to a wide variety of foods are associated with substantial household costs, including out-of-pocket costs and lost opportunity costs.

What does this article add to our knowledge? Total annual costs are higher for households with a child or adolescent with an objectively diagnosed allergy to staple foods compared with controls. Amongst children only, overall direct and indirect costs are also higher. Intangible costs are adversely affected for both age groups.

How does this study impact current management guidelines? As the drivers of various household costs have different impacts on children and on adolescents, discussions on the impacts of objectively diagnosed allergy to staple foods should be age group-specific.

BACKGROUND: We previously reported that indirect and intangible costs burden households with a food allergic adult. We now extend our investigation to households with food allergic children and adolescents.

OBJECTIVE: The objective of this study was to estimate direct, indirect, and intangible costs of food allergy in households with a child and/or adolescent with objectively diagnosed allergy to staple foods (cow's milk, hen's egg, and/or wheat), and to compare these costs with age- and sex-matched controls.

METHODS: Direct and indirect cost parent-reported data collected via the Food Allergy Socio-Economic Questionnaire of 84 children (0-12 years) and 60 adolescents (13-17 years) with objectively diagnosed allergy to staple foods ("cases") and age- and sex-matched controls (n = 94 children; n = 56 adolescents) were compared. Annual household costs were calculated. Total household costs included direct plus indirect costs. Intangible costs included parent-reported health of their child and/or adolescent, standard of living, and perceptions of well-being.

RESULTS: Amongst cases, total household costs were higher by €3961 for children and €4792 for adolescents versus controls ($P < .05$), and were driven by direct (eg, medications) and indirect (eg, time with health care professionals) costs. For children only, a history of anaphylaxis was associated with higher direct costs than no anaphylaxis (€13,016 vs €10,044, $P < .05$). Intangible costs (eg, parent-reported health of a child and/or adolescent) were significantly impacted amongst cases versus controls ($P < .01$).

CONCLUSION: Households with a child and/or adolescent with objectively diagnosed allergy to staple foods have higher total household costs than controls. Direct and indirect costs were significantly higher for cases versus controls amongst

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Abbreviations used
AAI- Adrenaline autoinjector
EQ-5D- EuroQol Health Questionnaire, 5 Dimensions
FA-EcoQ- Food Allergy Socio-Economic Questionnaire
HRQL- Health-related quality of life
IgE- Immunoglobulin E
95% CI- 95th percent confidence interval

children only. Amongst both age groups, such allergy adversely impacted intangible costs. **© 2015 The Authors. Published by Elsevier Inc. on behalf of the American Academy of Allergy, Asthma & Immunology. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/3.0/)** **(J Allergy Clin Immunol Pract 2015;3:68-75)**

Key words: *Adolescents; Children; Direct costs; Food allergy*

Direct, indirect, and intangible health care costs are likely higher amongst households with children and adolescents who have food allergy compared with control households. Societal direct and indirect costs related to pediatric food allergy have been estimated to be nearly 25 billion dollars in the United States,[1] thereby placing considerable demand on health care resources. In Europe, these costs have not yet been estimated. Although the prevalence of food allergy amongst children and adults appears to be similar,[2] these costs for society are disproportionately higher in childhood than adulthood.[3] For households, food allergy-related costs are also highest in the first year after diagnosis[4] and amongst those less than 4 years of age.[3] Children with food allergies have higher costs related to office visits and outpatient department visits than adults.[3] Others have shown that heightened parental anxiety regarding their child's food allergies[5] and poor health-related quality of life (HRQL)[5] may contribute to these higher costs in food allergic children. However, much research in this field has focused on children and adolescents as a single group,[3,4] or was restricted only to children,[6] despite suggestions that the two age groups will likely behave differently due to their developmental stages.[5]

Previous reports on food allergy-associated costs are separated into direct and indirect costs,[1,3] and include socioeconomic costs and lost time and productivity, respectively. Intangible costs, which include health status (including HRQL), standard of living, and perceptions of well-being, also warrant consideration.[7] Although difficult to assess monetarily, these costs are estimated to be high.[7,8]

On the basis of an algorithm to estimate costs of immunoglobulin E (IgE)-mediated food allergy to society,[7] we recently identified that the total annual costs for households with one food allergic adult were €8164 higher than those for age- and sex-matched controls.[8] Notably, the driving factor was indirect, rather than direct, costs. Intangible costs were also higher in households with one food allergic adult, compared with controls.[8] We now extend this work to households with children and adolescents. The objective of this study was to estimate the direct, indirect, and intangible costs of food allergy in households with a child or adolescent with objectively diagnosed allergy to the staple foods such as cow's milk, hen's egg, and/or wheat, and to compare these costs with age- and sex-matched controls.

METHODS

Study design and participants

This study involved outpatients from the allergy clinic at Sachs' Children and Youth Hospital, Södersjukhuset, in Stockholm, Sweden, with a specialist's diagnosis of allergy to the staple foods such as cow's milk, hen's egg, and/or wheat. These staple foods were selected as they are difficult to avoid in a typical Swedish diet. Participants were identified from medical records and recruited in 2010-2012 by a pediatric nurse who specialized in allergy. Inclusion criteria were a convincing history of allergy to at least one staple food ascertained either by a positive food challenge with evident symptoms, or by food-specific IgE antibody levels associated with a 95% probability for food allergy in a double-blind placebo-controlled food challenge and a convincing history of allergy to the same food.[9] Most cases also had parent-perceived and/or doctor-diagnosed allergies to foods other than these staple foods. Participants were excluded if they had an unclear food allergy diagnosis, coeliac disease, diabetes, or a malignancy, or did not understand Swedish. Parents of cases responded to questions about whether their child had experienced "difficulty breathing," and/or "inability to stand," and/or "collapse" and/or "loss of consciousness" as a result of food allergy. Such symptoms were used to define anaphylaxis in our study population, as these symptoms align with the current criteria for anaphylaxis.[10,11] Information on concomitant allergic disorders (asthma, allergic rhinitis, allergic conjunctivitis, eczema) was obtained for both cases and controls. In total, households of 133 children (0-12 years) and 86 adolescents (13-17 years) who fulfilled the criteria were sent the Food Allergy Socio-Economic Questionnaire (FA-EcoQ; described in detail below), of which 144 (65.5%) were included after 2 reminders (Figure 1). Both cases and controls received 2 movie passes on the return of completed questionnaires.

A convenience sample of 226 age- and sex-matched children and adolescents whose parents reported no allergy to cow's milk, hen's egg, and/or wheat in the household were recruited from the same geographical area via advertisements on websites, notice boards, and e-mailing lists. This strategy was applied for convenience of recruitment, and paralleled that used to recruit controls for our study of household costs of objectively diagnosed allergy to staple foods in adults.[8] Exclusion criteria for controls paralleled those of cases. The age-matching was done in 2-year intervals, so that the controls were born in the same year plus/minus 1 year as the cases. A total of 150 control families (66.4%) were included (Figure 1).

Eighty-four children (58.8% boys; mean age 6 years) and 60 adolescents (69.0% boys; mean age 14 years) served as cases. Ninety-four children (57.4% boys; mean age 7 years) and 56 adolescents (66.1% boys; mean age 15 years) served as controls. There were no statistically significant differences in mean household income between cases and controls for either age group.

Questionnaires

The FA-EcoQ parent version was used to collect data for this study. First, this validated questionnaire, developed by the European Union's project, "The Prevalence, Cost and Basis of Food Allergy across Europe" (EuroPrevall),[12] was translated into Swedish as per World Health Organization guidelines[13] and piloted to ascertain comprehension. From this, we were able to capture total household, direct, indirect, and intangible costs (defined below). To facilitate integration with the existing

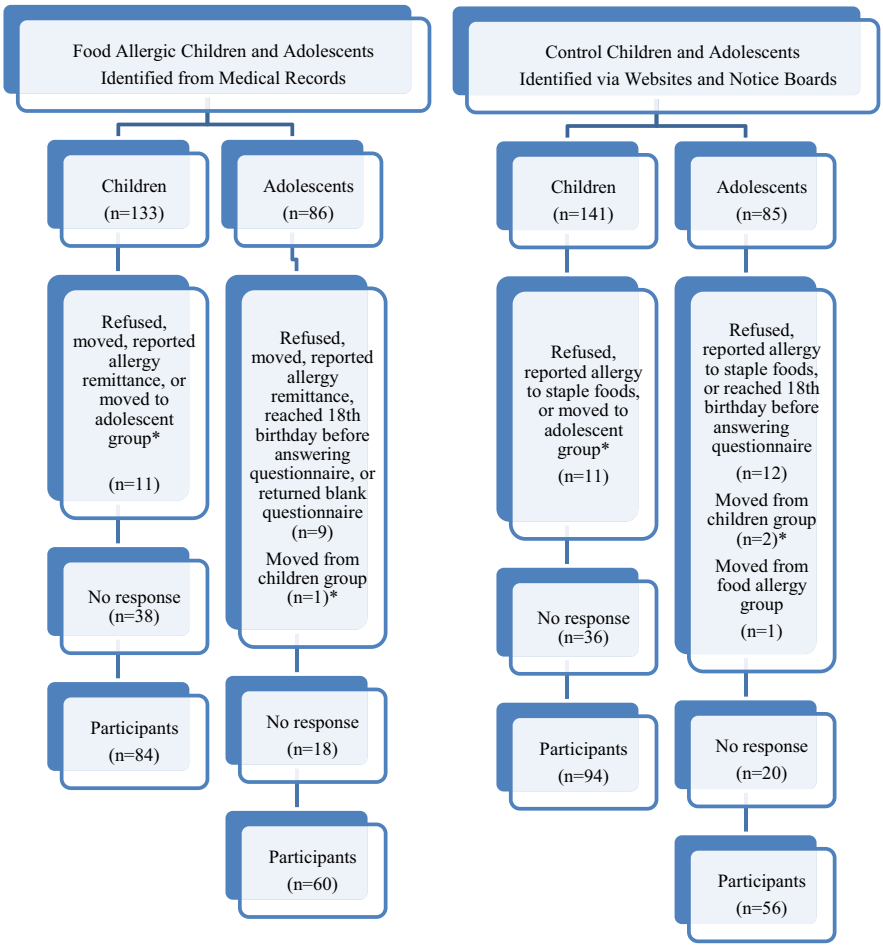

FIGURE 1. Flow chart detailing enrollment of participants with objectively diagnosed allergy to staple foods. *Moved from children to adolescents because the subject reached 13th birthday between the time of enrollment and the time questionnaires were administered.

literature, these costs were converted to Euros (€) (Sveriges Riksbank, www.riksbank.se; January 2, 2014). From questionnaire data, we derived four outcome variables:

Total household costs: These are the sum of annual direct and indirect costs. Absolute total household cost differences were calculated as total household costs for cases minus total household costs for controls. Direct costs: Costs borne annually by individuals and their households as a result of food allergy, including costs related to living, consulting, medications, health insurance, as well as travel to visit the child and/or adolescent in a hospital or to visit health care professionals.[7] Absolute direct cost differences are direct costs for cases minus direct costs for controls.

Indirect costs: Include annual costs such as losses of time (due to being unable to perform domestic tasks, seeking food allergy-related information, shopping and preparing food, time spent visiting the child and/or adolescent in hospital, and time spent with health care professionals), and productivity and opportunity costs (lost earnings and lost days at school and/or work).[14] Indirect costs were calculated as the number of hours lost multiplied by the average wage in Sweden. Absolute indirect cost differences are calculated as indirect costs for cases minus indirect costs for controls.

Intangible costs: Are not included in the calculation of total household costs as there is no monetary value assigned to intangible costs. Thus, intangible costs are based on 3 categories: (1) parent-reported health status of the child and/or adolescent (from EuroQol Health Questionnaire, 5 Dimensions [EQ-5D][15] and the Self-Perceived Health scale[16]), (2) standard of living (perceptions of income below or above the sufficient level), and (3) perceptions of well-being of the responding parent, other parent in the household, and the child and/or adolescent as a result of food allergy.[7]

Statistics

Descriptive statistics (n, %, mean, standard deviation) were used to characterize cases and controls. Cost data were found to approximate a normal distribution. Multivariable linear regression analyses were used to establish the point estimates for total household, direct, and indirect costs. Confounders in the fully adjusted model included the number of individuals in the household, the number of other household members with food allergy, household education level, and other chronic illnesses excluding concomitant allergic disorders. Consideration was given to the potential confounder, concomitant allergic disorders. However, this was found to insubstantially alter the point estimates (<0.10), and thus was not included in the final model. Differences were established via a t-test between the two groups. The 95th percent confidence intervals (95% CI) for the

TABLE I. Descriptive characteristics of cases allergic to staple foods*

	Children (0-12 y) (n = 84) n (%)	Adolescents (13-17 y) (n = 60) n (%)
Objectively diagnosed offending staple foods		
Cow's milk	49 (58)	29 (49)
Hen's egg	55 (65)	40 (67)
Wheat	8 (9)	9 (15)
Other major offending foods†		
Tree nuts	34 (40)	32 (53)
Peanuts	33 (39)	31 (53)
Other foods	67 (80)	59 (98)
Total number of offending foods‡		
1	24 (28)	12 (20)
2	18 (21)	10 (17)
3	13 (15)	14 (23)
>3	29 (34)	24 (41)

*Cow's milk, hen's egg, and/or wheat.
†Based on parent-reported and/or doctor-diagnosed allergy to fish, shellfish, chocolate, soy, sesame, celery, meat/poultry, mustard; nonmutually exclusive categories.
‡Includes both objectively diagnosed allergy to staple foods and parent-perceived or doctor-diagnosed allergies to other foods.

difference are reported. Statistical significance was set at $P < .05$. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) Statistics 20 (IBM, Somers, NY).

Ethics

The Regional Ethical Review Board in Stockholm, Sweden, approved this study (Dnr 2009/84-31/5). Personal data were handled in accordance with the Swedish Personal Data Act.

RESULTS

For both children and adolescents, there were no statistically significant differences between cases and controls in regard to standard of living. The allergy characteristics of the cases for age groups are shown in Table I. The most common offending staple food was hen's egg among both children (65%) and adolescents (67%). Of other reported offending foods amongst cases, tree nuts and/or peanuts were the most common, which affected 40% of children and 53% of adolescents. Approximately 90% of cases were affected by multiple concomitant allergic disorders (on average, 2.1 for children and 2.6 for adolescents). This differed significantly from controls, who had few concomitant allergic diseases (on average, 0.3 for children and 0.5 for adolescents; both $P < .001$, vs cases of the same age groups).

Total household costs were significantly higher for cases than controls, for both children (€20,819 vs €16,858, $P < .05$, a difference of €3961) and adolescents (€23,468 vs €18,676, $P < .05$, a difference of €4792), as shown in Figure 2. Amongst cases, a history of anaphylaxis did not statistically significantly affect total household costs among either children (n = 45) or adolescents (n = 22), compared with no history of anaphylaxis. Similarly, neither concomitant allergic disorders nor the number of offending foods statistically significantly affected total household costs among children or adolescents. Overall direct costs differed significantly between cases and controls in households with children, but not between cases and controls in households with adolescents. Despite a null finding in direct costs between cases and controls for adolescents, household medication costs were significantly higher for cases than for controls, amongst both children and adolescents ($P < .001$; Table II). No significant differences were found in the other cost items among direct costs for adolescents. Cases with a parent-reported history of anaphylaxis among children had significantly higher annual direct household costs compared with cases without a history of anaphylaxis (€13,016 vs €10,044; $P < .05$). However, concomitant allergic disorders and the number of offending foods (≥4 vs ≤3) for both children and adolescents were not associated with differences in direct costs.

Many types of overall indirect costs, except time spent on domestic tasks, such as shopping and preparing food, and lost household earnings, were significantly higher for cases than controls among children (Table III). Although overall indirect household costs did not differ between cases and controls amongst adolescents, some clinical states and situations, such as food allergy severity, concomitant allergic disorders, and the number of offending foods, were statistically associated with higher indirect costs. For example, the indirect costs for adolescent cases with a history of anaphylaxis amounted to €11,915 compared with €7159 for those without a history of anaphylaxis ($P < .05$). The corresponding figures for concomitant allergic disorders and the number of food items were €11,493 versus €7006 and €12,353 versus €7563, respectively ($P < .05$). Time spent visiting the child and/or adolescent in hospital was statistically significantly different between cases and controls for children (0.06 vs 0.00; $P < .05$), but is unlikely to be clinically or practically significant. No differences were found for adolescents (cases 0.10 vs controls 0.15; $P = .67$).

Intangible costs associated with allergy to staple foods are shown in Table IV. The total EQ-5D score was significantly lower among cases compared with controls among both age groups ($P < .001$). Similarly, parents of cases reported lower health status, as assessed via the Self-Perceived Health scale, compared with controls for both age groups ($P < .001$). More controls than cases among children had incomes above own sufficient level ($P = .001$). There was no difference in standard of living between cases and controls among adolescents. Compared with controls, parents of cases reported significantly lower perceptions of well-being, for both themselves ($P < .05$) and their child and/or adolescent ($P < .005$).

DISCUSSION

Our study of the total, direct, indirect, and intangible household costs of both children and adolescents with objectively diagnosed allergy to cow's milk, hen's egg, and/or wheat gleans enhanced insight into others' reports of the food allergy-related burdens to the health care system and direct and opportunity costs to households.[1,3,4] In our case-control study, total household costs were significantly higher for Swedish households with a child or adolescent allergic to cow's milk, hen's egg, and/or wheat, compared with households without children or adolescents allergic to these staple foods. These differences may have been further accentuated as many cases also had parent-perceived or doctor-diagnosed allergies to other foods. Overall, direct costs and overall indirect costs were also significantly higher for

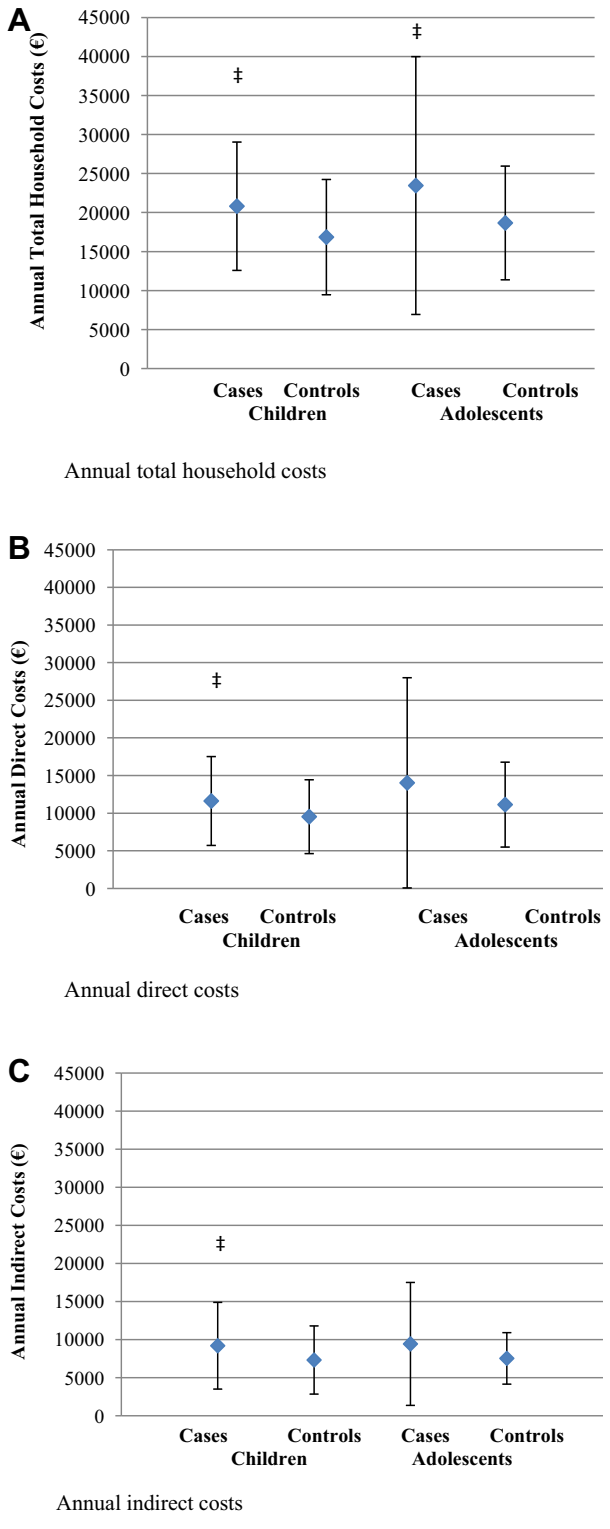

FIGURE 2. Annual total household costs*, with 95% confidence intervals, direct costs, and indirect costs (in €) of Swedish households with cases allergic to staple foods† compared with controls, adjusted for the number of individuals in the household, number of other household members with food allergy, household education level, and other chronic illnesses. *Sum of direct costs and indirect costs; excludes intangible costs as these costs have no monetary value. †Cow's milk, hen's egg, and/or wheat. ‡$P < .05$ between cases and controls within each age group (children or adolescents).

households with children, but not adolescents, allergic to staple foods compared with controls. Further, intangible costs of parent-reported health and children's and/or adolescents' perceptions of well-being were significantly impacted by allergy to staple foods.

The initial period after a diagnosis of allergy is stressful for families with children, particularly until they are knowledgeable about food allergy and have learned to trust others caring for their food allergic child.[17] Although adolescents continue to face food allergy-associated challenges, they begin to develop skills to cope with their food allergy (eg, bringing "safe" foods to social events, inquiring restaurant-prepared foods, reading food labels) and accept it as a way of life.[18] Yet, total household costs were higher in both children and adolescents allergic to staple foods compared with controls from their respective age groups. However, one might also speculate that future total household costs may be higher in cases than controls for these children if their allergies persist through adolescence and beyond. Interestingly, total costs did not differ by food allergy severity in children or adolescents.

Direct household costs, overall and by type of costs, for families with children were significantly higher in cases than controls. Households with young children allergic to staple foods may seek to purchase allergen-free staple foods, which are often more expensive than traditional staple foods. Likewise, these households may also seek significantly more contact with health care professionals than households without a food allergic child.[6] Among adolescents, we did not find a significant difference in overall direct costs between cases and controls. We suggest that there are at least 4 explanations for this observation. First, as has been reported for adolescents with other chronic conditions,[19-21] households with food allergic adolescents may have normalized their lives and seek health care professionals' services less often. It remains unclear if this is attributable to adolescents' perceived confidence in managing their food allergies or the more dynamic nature of food allergies (tolerance vs persistence) in children. Second, adolescents may experience challenges or delays in transitioning from pediatric to adult care, similar to those reported by adolescents living with other chronic diseases.[22-25] Third, adolescents may be contacting health care professionals and/or accessing health care information via digital means without parental involvement or knowledge. Although few food allergy-focused e-learning platforms currently exist, the internet is widely used by adolescents seeking health information.[26] Fourth, the nonstatistically significant difference in direct costs between adolescent cases and controls parallels our recent report of food allergy-related costs in adults.[8] In adults, we theorized that the nonstatistically significant result in the absolute difference in direct costs may be the consequence of the redistribution of money from discretionary spending to additional food allergy-related costs. For adolescents, this may be true. However, they may also bear some direct costs (eg, eating in restaurants, public transportation) which their parents may not be aware of and thus may not have been captured in our questionnaire. Amongst cases, direct costs were higher for those with versus without a

TABLE II. Annual direct costs, overall and by type (in €) of Swedish households with cases allergic to staple foods* compared with controls, adjusted for the number of individuals in the household, number of other household members with food allergy, household education, and other chronic illnesses

	Children (0-12 y)				Adolescents (13-17 y)			
	Cases (n = 84)	Controls (n = 94)	95% CI of the Difference	*P*-value	Cases (n = 60)	Controls (n = 56)	95% CI of the Difference	*P*-value
Type of direct costs								
Living†	11,028	9169	291 to 3453	.021	13,226	10,815	−1578 to 6291	.227
Consulting	11	1	3 to 16	.003	32	2	−11 to 70	.147
(Alternative) medications	420	129	199 to 374	<.001	517	143	242 to 517	<.001
Health insurance	102	217	−226 to −1	.042	206	147	−82 to 195	.415
Travel for household member of visiting the child and/or adolescent in hospital	2	0	−0 to 5	.052	1	0	−0 to 2	.056
Travel for visiting health care professionals	46	9	23 to 52	<.001	38	22	−11 to 42	.256
Overall direct costs (€)	11,609	9524	490 to 3699	.011	14,021	11,129	−1103 to 6780	.148

*Cow's milk, hen's egg, and/or wheat.
†Includes costs of food, additional equipment to prepare safe meals, and the costs of domestic help.

TABLE III. Annual indirect costs*, overall and by type (in €) of Swedish households with cases allergic to staple foods† compared with controls, adjusted for the number of individuals in the household, number of other household members with food allergy, household education, and other chronic illnesses

	Children (0-12 y)				Adolescents (13-17 y)			
	Cases (n = 84)	Controls (n = 94)	95% CI of the Difference	*P*-value	Cases (n = 60)	Controls (n = 56)	95% CI of the Difference	*P*-value
Type of indirect costs								
Losses of time (cost value in h) resulting from:								
Inability to perform domestic tasks due to sick child and/or adolescent	92	37	−9 to 121	.089	96	32	−33 to 157	.187
Seeking information on food allergy	7	3	1 to 7	.021	10	3	−1 to 16	.087
Time spent on food shopping and preparing food	494	459	−30 to 99	.287	538	530	−92 to 104	.898
Time spent with all health care professionals for household (travel and consult) of respondent and partner child	11	2	7 to 11	<.001	11	5	0 to 11	.037
Indirect cost value of lost time for household (h)	604	501	3 to 205	.044	655	571	−66 to 229	.264
Productivity and opportunity costs								
Lost earnings (€)	1799	1183	−157 to 1415	.116	1408	544	8 to 1696	.043
Lost days school and/or work in household due to illness (days)	92	45	12 to 82	.009	45	35	−12 to 34	.342
Overall indirect costs	9210	7334	1686 to 6317	.001	9447	7547	−35 to 9415	.105

*Calculated as the cost value (h) multiplied by the average wages in the study catchment area.
†Cow's milk, hen's egg, and/or wheat.

history of anaphylaxis, but were not affected by concomitant allergic disorders or the number of offending foods. Thus, children and adolescents who have experienced anaphylaxis may be more likely to carry an adrenaline autoinjector (AAI), which is associated with substantial out-of-pocket expenses.

Similar to direct costs, overall indirect household costs were significantly higher for cases versus controls amongst children, but not adolescents. This result is in keeping with the theory that households with adolescents, but not children, allergic to staple foods have become more confident in managing the condition, thereby decreasing some of the household's losses of time. Nonetheless, it warrants mention that cases, compared with controls, had a significantly greater cost value (hours) associated with time spent with all health professionals for household (travel and consult) of child and/or adolescent and parent. Also notable is that, amongst adolescents only, households of cases report significantly greater lost earnings than controls. Adolescents may engage in more risk-taking behaviors, including knowingly consuming unsafe foods or failing to carry an AAI.[18] These behaviors may warrant more regular contact with health care professionals and, subsequently, greater lost household earnings. This theory also aligns with our observation that food allergy severity, concomitant allergic disorders, and the number of offending foods were associated with indirect costs among adolescents.

Intangible costs encompassed 3 categories. HRQL, within the broader category of parent-reported health status of child and/or adolescent, was poorer in cases versus controls for both age groups. Approximately half the number of households with food allergic children, but not adolescents, perceived their standard of living to be above a level of sufficiency. Parent-reported perceptions of well-being supported that both children and

TABLE IV. Annual intangible costs* of Swedish households with cases allergic to staple foods† compared with controls, adjusted for number of individuals in the household, number of other household members with food allergy, household education level, and other chronic illnesses

	Children (0-12 y)				Adolescents (13-17 y)			
	Cases (n = 84)	Controls (n = 94)	95% CI of the Difference	*P*-value	Cases (n = 60)	Controls (n = 56)	95% CI of the Difference	*P*-value
Parent-reported health status of child and/or adolescent								
EQ-5D (mean)‡	0.84	0.94	−0.16 to −0.05	<.001	0.91	1.00	−0.12 to −0.06	<.001
Perceived health status (mean)§	2.12	1.42	0.47 to 0.92	<.001	2.26	1.41	0.52 to 1.19	<.001
Standard of living								
Income below own sufficient level (n, %)	18 (21)	20 (21)		.987	8 (14)	12 (21)		.266
Income above own sufficient level (%, percentage)	24 (28)	50 (53)		.001	24 (41)	23 (41)		.966
Perceptions of well-being								
Responding parent	7.1	7.7	−1.10 to −0.09	.022	7.1	7.8	−1.25 to −0.03	.041
Other parent in the household	7.3	7.7	−1.03 to 0.10	.106	7.1	7.6	−1.25 to 0.25	.184
Child and/or adolescent	7.9	8.5	−1.02 to −0.18	.005	7.0	8.3	−1.87 to −0.64	<.001

*As assessed using FA−EcoQ.
†Cow's milk, hen's egg, and/or wheat.
‡Lower score indicates lower health-related quality of life.
§Higher score indicates lower perceived health status.

adolescents allergic to staple foods perceived their own well-being, as well as that of their child and/or adolescent to be poorer than controls. Others have previously reported that 8- to 12-year-old Dutch children perceive the impact of their food allergy differently than their parents.[27] To our knowledge, we are the first to extend this observation to a wider age range of children (0-12 years), and to adolescents.

With the exception of parent-reported health status of the child and/or adolescent (including HRQL), intangible costs associated with food allergy have previously received little attention. The focus on children and adolescents with objectively diagnosed food allergy represents a more comprehensive description of the household socioeconomic impact of allergy to staple foods. Recognition of the impact of intangible costs of food allergy also enhances the understanding that food allergy has a significant and deleterious impact on HRQL.

Recently, Gupta et al reported on the economic impact of food allergy amongst American children.[1] Similar to our results, these authors found that food allergy-associated total direct medical and out-of-pocket costs were substantial. However, in contrast to our results, direct costs assumed by American families were estimated to be less than annual opportunity costs due to foregone work force opportunities.[1] It could be debated that higher indirect costs amongst American households versus higher direct costs amongst Swedish households could be attributable to many factors, ranging from study design and variable operationalization to differences in health care systems. Alternatively, lower direct costs compared with annual opportunity costs amongst American households may reflect that the children in Gupta et al's study had parent reports of allergy to a wide variety of foods. In contrast, children and adolescents in our study were allergic to staple foods, which by definition are both difficult to avoid and often mandate the purchase of specialty items. Nonetheless, the consistent observation in these studies highlights the substantial direct and indirect cost burden borne by households with food allergic children and adolescents. Finally, although food allergy-associated direct costs are lower than those of other chronic diseases, such as diabetes, estimated to be €3930 annually, in the Swedish pediatric population,[28] they are a significant burden to households. We acknowledge the limitations of this study. Every attempt was made to age- and sex-matched cases and controls. However, difficulties in recruiting children without any type of parent-perceived or doctor-diagnosed food allergy mandated that some controls had parent reports (ie, not objectively diagnosed) of allergy to foods other than cow's milk, hen's egg, and/or wheat. This inclusion may have increased their household costs. However, we believe that our results serve to reinforce the socioeconomic impact of allergy to staple foods, even when compared, in part, with those living with allergy to nonstaple foods. Economic costs, especially direct costs, may be conservative as health care and medication costs are highly subsidized by public insurance in Sweden. Moreover, every preschool- and school-aged child (1-12 years) and adolescent (13-15 years) in Sweden are entitled to a free school lunch.[29] Thus, in jurisdictions where such subsidies and programs are not available, the differences between cases and controls for children may be even greater.

As direct costs differed amongst children and adolescents with food allergy by a history of anaphylaxis, clinicians ought to be aware of the financial burden of food allergy severity. In additionally, clinicians ought to query adolescents as to from where they obtain food allergy information, correct any misinformation, and redirect adolescents, children, and their primary care providers to reputable sources of information.

In conclusion, we provide evidence that annual total household costs are approximately €4000 higher in households with children and €4800 higher in households with adolescents who have objectively diagnosed allergy to staple foods compared with controls. However, when considered separately, overall direct and indirect household costs are statistically higher for food allergic children, but not food allergic adolescents. Among both children and adolescents, allergy to staple foods adversely impacts intangible costs.

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REFERENCES

1. Gupta R, Holdford D, Bilaver L, Dyer A, Holl JL, Meltzer D. The economic impact of childhood food allergy in the United States. JAMA Pediatr 2013; 167(11):1026-31.
2. Rona RJ, Keil T, Summers C, Gislason D, Zuidmeer L, Sodergren E, et al. The prevalence of food allergy: a meta-analysis. J Allergy Clin Immunol 2007;120: 638-46.
3. Patel DA, Holdford DA, Edwards E, Carroll NV. Estimating the economic burden of food-induced allergic reactions and anaphylaxis in the United States. J Allergy Clin Immunol 2011;128:110-5.
4. Sladevicius E, Nagy E, Lack G, Guest JF. Resource implications and budget impact of managing cow milk allergy in the UK. J Med Econom 2010;13: 119-28.
5. Ravid NL, Annunziato RA, Ambrose MA, Chuang K, Mullarkey C, Sicherer SH, et al. Mental health and quality-of-life concerns related to the burden of food allergy. Immunol Allergy Clin North Am 2012;32:83-95.
6. Fox M, Mugford M, Voordouw J, Cornelisse-Vermaat J, Antonides G, de la Hoz Caballer B, et al. Health sector costs of self-reported food allergy in Europe: a patient-based cost of illness study. Eur J Public Health 2013;23:757-62.
7. Miles S, Fordham R, Mills C, Valovirta E, Mugford M. A framework for measuring costs to society of IgE-mediated food allergy. Allergy 2005;60:996-1003.
8. Jansson SA, Protudjer JL, Arnlind Heibert M, Bengtsson U, Kallström-Bengtsson I, Marklund B, et al. Socioeconomic evaluation of well-characterized allergy to staple foods in adults. Allergy 2014;69(9):1241-7.
9. Boyce JA, Assa'ad A, Burks AW, Jones SM, Sampson HA, Wood RA, et al. Guidelines for the diagnosis and management of food allergy in the United States: report of the NIAID-sponsored expert panel. J Allergy Clin Immunol 2010;126(Suppl):S1-58.
10. Sampson HA, Muñoz-Furlong A, Campbell RL, Adkinson NF Jr, Bock SA, Branum A, et al. Second symposium on the definition and management of anaphylaxis: summary report—second National Institute of Allergy and Infectious Disease/Food Allergy and Anaphylaxis Network symposium. Ann Emerg Med 2006;47:373-80.
11. Muraro A, Roberts G, Clark A, Eigenmann PA, Halken S, Lack G, et al. The management of anaphylaxis in childhood: position paper of the European academy of allergology and clinical immunology. Allergy 2007;62: 857-71.
12. Fox M, Voordouw K, Mugford M, Cornelisse J, Antonides G, Frewer L. Social and economic costs of food allergies in Europe: development of a questionnaire to measure costs and health utility. Health Serv Res 2009; 44(Pt 1):1662-78.
13. World Health Organization. Process of translation and adaptation of instruments; 2013. Available from: http://www.who.int/substance_abuse/research_tools/translation/en/. Accessed November 4, 2013.
14. Posnett J, Jan S. Indirect cost in economic evaluation: the opportunity cost of unpaid inputs. Health Econ 1996;5(1):13-23.
15. EuroQol Group. EuroQol—a new facility for the measurement of health-related quality of life. Health Policy 1990;16:199-208.
16. Benyamini Y, Idler EL. Community studies reporting association between self-rated health and mortality—additional studies, 1995 to 1998. Res Aging 1999; 21:392-401.
17. Rouf K, White L, Evans K. A qualitative investigation into the maternal experience of having a young child with severe food allergy. Clin Child Psychiatry 2012;17:49-64.
18. MacKenzie H, Roberts G, van Laar D, Dean T. Teenagers' experiences of living with food hypersensitivity: a qualitative study. Pediatr Allergy Immunol 2010; 21(Pt 1):595-602.
19. Protudjer JL, Kozyrskyj AL, Becker AB, Marchessault G. Normalization strategies of children with asthma. Qual Health Res 2009;19:94-104.
20. Gantt L. As normal a life as possible: mothers and their daughters with congenital heart disease. Health Care Women Int 2002;23:481-91.
21. Berntsson L, Berg M, Brydolf M, Hellström AL. Adolescents' experiences of well-being when living with a long-term illness or disability. Scand J Caring Sci 2007;21:219-25.
22. Garvey KC, Wolpert HA, Rhodes ET, Laffel LM, Kleinman K, Beste MG, et al. Health care transition in patients with type 1 diabetes: young adult experiences and relationship to glycemic control. Diabetes Care 2012;35:1716-22.
23. Oswald DP, Gilles DL, Cannady MS, Wenzel DB, Willis JH, Bodurtha JN. Youth with special health care needs: transition to adult health care services. Matern Child Health J 2013;17:1744-52.
24. Tuchman L, Schwartz M. Health outcomes associated with transition from pediatric to adult cystic fibrosis care. Pediatrics 2013;132:847-53.
25. Scal P, Davern M, Ireland M, Park K. Transition to adulthood: delays and unmet needs among adolescents and young adults with asthma. J Pediatr 2008;152(4): 471-5.
26. Kummervold PE, Chronaki CE, Lausen B, Prokosch HU, Rasmussen J, Santana S, et al. e-Health trends in Europe 2005-2007: a population-based study. J Med Internet Res 2008;44(Pt 1):1662-78.
27. van der Velde JL, Flokstra-de Blok BM, de Groot H, Oude-Elberink JN, Kerkhof M, Duiverman EJ, et al. Food allergy-related quality of life after double-blind, placebo-controlled food challenges in adults, adolescents, and children. J Allergy Clin Immunol 2012;130:1136-43.
28. Wirhn AB, Andersson A, Östgren CJ, Carstensen J. Age-specific direct healthcare costs attributable to diabetes in a Swedish population: a register-based analysis. Diabet Med 2008;25:732-7.
29. SkolmatSverige. SkolmaSveriges kartläggning av skolmåltidens kvalitet läsåret 2012/13;2012. Available from: http://www.skolmatsverige.se/sites/skolmatsverige.se/files/schoolfoodsweden_report_2013_summary.pdf. Accessed May 12, 2014.