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SCIENTIFIC PAPER

THE DIRECT AND INDIRECT COSTS ASSOCIATED WITH FOOD HYPERSENSITIVITY IN HOUSEHOLDS: A STUDY IN THE NETHERLANDS, POLAND, AND SPAIN

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Abstract:

Background

Recent studies show that food hypersensitivity, such as food allergy or food intolerance, has the potential to affect direct, indirect and intangible economic costs experienced by individuals and their families. This research assesses the direct and indirect economic costs of food hypersensitivity at the household level in the Netherlands, Poland, and Spain.

Methods

A self-administered postal survey was conducted (n=1558). Respondents with food hypersensitivity were clinically diagnosed cases recruited through clinical centres in Poland and Spain. In the Netherlands, food hypersensitivity cases were recruited through hospitals, patient organisations and advertisements. The controls formed the baseline sample and were obtained from households in which none of the members had food hypersensitivity. The monetary value of indirect costs, forgone time, was calculated using the opportunity cost method. The indirect and direct costs were expressed in purchasing power parity. Analysis of co-variance on the cost items was used to test the within-country differences between respondents with food hypersensitivity and respondents without food hypersensitivity, as well as across the three countries.

Results

The average total direct and indirect costs across all countries for families with food hypersensitive family members are not higher than for households without food hypersensitive members. However, the intangible costs for food hypersensitive individuals appear to be higher than for individuals in the control group.

Conclusions

These results do not support the hypothesis that all food allergies incur high costs to the individual. However, being hypersensitive to foods may have a negative impact on quality of life compared to people who are not food hypersensitive.

Background

Food allergy is a chronic disease for which, at the present time, no general treatment is available, although research is being conducted which aims to curing the disease [1-5]. The only treatment currently available, is managing the disease through avoidance of problematic allergens in the diet of food allergy sufferers [4-6]. Despite the application of precautionary measures, accidental exposure to allergenic proteins may result in allergic responses. The socio-economic burden of food allergy is experienced not only by food allergy sufferers themselves, but also other family members and caregivers [7-11].

A meta-analysis of existing epidemiology surveys suggests that the prevalence of self-reported food allergy also varies across the population, with self-reported allergy rates reaching 35% [1, 12-16]. Estimates of prevalence derived from oral food challenges, such as double blind placebo controlled food challenges (DBPCFC), tend to be more conservative, but nevertheless suggest that food allergy affects a substantial percentage of the population [10, 14]**.** There is some evidence to suggest that the prevalence of food allergy is increasing. Studies focusing on peanut allergy indicate that prevalence rates in children have increased, exceeding 1% in school-aged children. A 2008 Centres for Disease Control and Prevention report indicated an 18% increase in childhood food allergy from 1997 to 2007, with an estimated 3.9% of children currently affected [17-20]. In addition, data collected in 2003 and 2007 from the National Survey of Children's Health also suggests that the prevalence of food allergy increased [17].

The increase in prevalence of food allergies affects the economic burden of food–allergy management. Although various studies have provided estimates of the economic costs of respiratory allergies [22,23], very little research has been conducted which focuses on the economic costs of food allergy to households and individuals. A French study estimated the costs per patient for the health care sector for severe anaphylaxis resulting from food allergy to vary from 1895 to 5610 euro in nonfatal cases, together with three working or school days per year lost due to ill health [24]. There is more information about the aggregate costs of major allergic diseases, which were estimated at 10 billion ECU (European currency unit) for direct costs and 19 billion ECU for indirect costs in Europe [9]. In addition, a recent study has reported that food allergic individuals self-report spending more time on food shopping, lose more time because of inability to perform everyday (household) tasks, and face higher societal costs, including health care costs and work-related absences, compared to non-allergic individuals [7].

Miles *et al*. [25] developed a framework which could be applied to measure the costs of food allergy. This study suggested that the costs can be divided into three categories, namely, direct costs, indirect costs and intangible costs [25]. The *direct costs* can be defined as the financial (out-of-pocket) costs food allergic individuals and their family incur as a result of the disease. The *indirect costs* can be defined as time loss, lost productivity and opportunity costs due to illness [32]. *Intangible costs* are defined as loss of value or utility, which are difficult to measure in monetary terms but can be indicated by self-reported health status, well-being and economic welfare experienced as a consequence of food allergy. This suggests that food allergy may potentially have a negative effect on the quality of life and economic functioning of food allergic individuals and their households. In addition, intangible costs may comprise restrictions concerning job and career opportunities, education, leisure and social life.

The burden on health care services associated with chronic diseases leads to an increased interest in their economic impact. In making decisions about optimal allocation of health care resources, it is important to consider the economic effects of chronic diseases, such as food allergy. Evidence is needed regarding the relative importance of food hypersensitivity, including food allergy and food intolerances, compared to other chronic diseases to justify the economic cost for development of new legislation or policies (for example, in terms of food and ingredient labelling, food production or investment in formal diagnosis within the health care system) [26].

The purpose of this study is to assess the direct, indirect and intangible cost of food hypersensitivity at the household

Table 1: Distribution of adult and parental versions of the questionnaire

		Adult version	Parental version	Total
Netherlands	Case	65	72	137
	Control	52	102	154
Poland	Case	97	153	250
	Control	224	169	393
Spain	Case	97	100	197
	Control	190	237	427
	Total	725	833	1558

level. The hypothesis to be tested is that families with food hypersensitive family members incur higher direct and indirect cost on all items compared to households without food hypersensitive members. The results could be used to prioritise resources for development of new food allergy management strategies and could help to inform legislation in this area.

Methods

Study population

This study was part of the large EU-funded project EuroPrevall. The respondents from Poland and Spain were collected as part of the epidemiological study performed within EuroPrevall. The protocol on the sampling strategy is described elsewhere [22, 23]. This epidemiological study was designed as a clinical case-control study to establish the prevalence of food allergy and food hypersensitivity. In the Netherlands, the protocol from the epidemiologic study was used to select the cases with food hypersensitivity and food allergy. The recruitment was conducted through hospitals and patient organisations. Respondents were included if they indicated having one or more food allergies to the 14 food allergens listed in the EC Directive 2006/142/EC, or reported experiencing symptoms following accidental ingestion of problematic foods, or reported that they had been diagnosed as having food allergy by a health care professional. A pre-analysis was performed to test if the cases from each sampling method were comparable. No significant differences between the recruitment methods were identified. The target group of respondents with food allergy or food hypersensitivity and their family were compared to a baseline control sample. The control groups in Spain and Poland were recruited as part of the epidemiological study. In the Netherlands, the control group was selected to be comparable on the demographic characteristics of the case sample. Pre-analysis showed that the sampling method in the baseline group was not significantly different between countries. The cases recruited through the epidemiological study were tested through double blind placebo controlled food challenges (DBPCFC), resulting in the majority of the cases being classified as *food hypersensitive* and the minority *food allergic*. Therefore, in this study, we will use the broader term food hypersensitivity indicating all cases with food allergy and food intolerances.

The survey was conducted in the Netherlands, Poland, and Spain[1] to estimate potential cost differences between households with and without food hypersensitive members, by comparison of the target food hypersensitive group to the baseline sample. The participants were matched with the controls with respect to their zip code area such that they were roughly comparable with respect to income, education, and residence (urban *versus* rural). The participants received written information about the study together with the questionnaire inquiring about the costs incurred at the level of the household. Their participation was voluntary and had no consequences for their treatment. Participants did not receive any incentive for their contribution. The questionnaires were assigned unique codes to provide a data set with anonymous records. Only the Europrevall researcher could match the unique codes with the personal data of the participants. Ethical approval from the medical ethical committees in the participating hospitals, clinical centres and universities was obtained.[2]

In total, 1558 respondents were included in this study (see Table 1). The target sample comprised both food hypersensitive adults, and food hypersensitive children. In the case of the latter, the parent of the child completed the questionnaire. The food hypersensitive adults from the target sample and the healthy adults from the baseline sample received the *adult version* of the questionnaire which was designed to estimate the household costs experienced by adults with or without (perceived) food sensitivities. The families with food allergic children received the *parental version* which was designed to provide the same estimates in households including children with or without food hypersensitivity. A household without a food hypersensitive child (control) reported the cost of the oldest child living at home.

1 Although the survey was also conducted in the UK, the number of participants was too small (69) to be included in the analysis.

2 Medical Ethical Committee of University Medical Centre Groningen, The Netherlands; Ethics Committee of the Hospital Ramon y Cajal, Madrid, Spain; Bioethical Committee of Medical University of Lodz.

Survey

The data was collected through a patient-based resource and expenditure cost survey (a copy of the "household costs of food allergy" questionnaire can be obtained on request from the authors).

A detailed description of the development and validation of this questionnaire has been provided elsewhere [10, 29]. The questionnaire used in this study gathered structured information on all aspects of health and social care resource use. To summarise, the questionnaire development was performed in three stages: (1) identification of cost items through a review of literature, patient organisations and focus groups; (2) formulation of the questionnaire; (3) pilot testing and validation. The framework developed by Miles *et al*. [25] was used to structure the questionnaire into the three cost sections. This study will analyse the direct and indirect costs of living and seeking health care for families with and without food-hypersensitive members.

The costs will be calculated using the Purchasing power parity (PPP) of the Geary-Khamis dollar with base line year 2007 to compare the costs across the different countries. PPP is a device which assumes that exchange rates between currencies in different states are in equilibrium when their purchasing power is the same [30]. The international Geary-Khamis dollar, often used together with PPP, is a hypothetical unit of currency with the same purchasing power as the US dollar at a given point in time.

A methodology which values the time loss of household production as a monetary value was used to calculate the indirect costs. In the *opportunity cost method,* the individual's own market wage rate is used to evaluate the time loss or household production [31]. In economic models used for analysing the choice between labour market participation and home production, it is frequently assumed that the value of the first hours spent on home production is higher than an individual's labour time in the job market (represented by their wage rate). The income the individual foregoes by spending time on home production is found by the multiplication of the wage rate by these hours. The opportunity cost method is widely used in the literature and is well-validated [32]. This method was used in the analysis of the indirect costs. When a person was not employed in paid work the minimum wage rate per country was used (4.8% of case respondents, 5.1% of their partners; 4.4% of control respondents, 4.4% of their partners). When the person reported they were working but did not state their income, the national average wage rate was used (1.0% of case respondents, 63.2% of their partners; 0.9% of control respondents, 63.2% of their partners). The direct cost was calculated by summing all out-of-pocket cost items from the questionnaire. When no direct or indirect cost was incurred zero cost was used in the analysis. If, in previous questions, it was stated that costs were made on a particular item without mentioning the amount, the cost item was entered as a missing value.

The direct costs included costs for medical treatment not covered by insurance and thus paid by the individual, travel costs to obtain medical treatment, costs for medication, including over-the-counter and prescribed medicines, and cost of health insurance; costs of living, including food expenses, holiday expenses, costs during leisure activities, costs for equipment required to prepare safe meals, and domestic help. The societal costs, covered by government and insurance companies were excluded from our analysis. The indirect costs included lost working days, loss of education or working opportunities, lost earnings, lost human capital (i.e., limitations of job, schooling, leisure, and family life), time spent on searching for information on health related issues, and time spent obtaining medical treatment (e.g., travel time, consultation time).

Analysis

All significance tests have been conducted on the logarithms of the cost variables, in order to reduce the skewness of the cost distributions. Analysis of covariance (ANCOVA) with planned contrast and post-hoc tests using Bonferroni corrections were used in all comparisons for each cost item to identify significant differences between cases and controls within countries and across the three countries. Each analysis included fixed factors of country by case–control interaction, and a number of covariates: age, gender, education, total working hours, household income, household composition, and severity and type of food allergy. All covariates were categorized and converted into dummy variables (except for the reference category) in order to deal with non-linear relationships between the dependent and independent variables. In the case of substantial partial non-response, a dummy variable was constructed which was equal to one if the variable was missing and zero otherwise. This way, as many participants as possible could be included in the analysis.

We estimated the effects for each type of cost using equation (1), in which the βs denote coefficients, ε is a normally distributed error term, *C* denotes the logarithm of the costs, all other terms are dummy variables which equal zero for the reference category. *All* denotes severity of allergy (5 categories, the first of which is included in the constant term, β_0), *Version* is a dummy which equals 1 for the parental version (0 elsewhere), *Educ* denotes education level (5 categories, the first of which is included in the constant term), *WorkR* denotes hours worked by the respondent (3 categories, the first of which is included in the constant term), *WorkP* denotes hours worked by the respondent's partner (3 categories, the first of which is included in the constant term), *Inc* denotes income level (3 categories, the first of which is included in the constant term, plus a category for non-reported income), *AgeR* denotes age categories of the respondent in case of the adult version of the questionnaire (4 categories, the first of which is included in the constant term, plus a category for non-reported age, all dummy variables equal zero in case of the parental version), *AgeCh* denotes age categories of the child in case of the parental version of the questionnaire (4 categories, the first of which is included in the constant term, plus a category for non-reported age, all dummy variables

$$C = \beta_0 + \sum_{j=2}^{4} \beta_{1j} All_j + \beta_2 Version + \sum_{k=2}^{5} \beta_{3k} Educ_k + \sum_{l=2}^{3} \beta_{3l} WorkR_l + \sum_{m=2}^{3} \beta_{4m} WorkP_m + \sum_{n=2}^{4} \beta_{5n} Inc_n +$$

$$\sum_{o=2}^{5} \beta_{6o} AgeR_o + \sum_{p=2}^{5} \beta_{7p} AgeCh_p + \beta_8 SexR + \beta_9 SexCh + \sum_{q=2}^{4} \beta_{10\,q} H_q + \sum_{r=2}^{16} \beta_{11\,r} Food_r + \beta_{12} NLCase + \beta_{13} NLCtrl +$$

$$+ \beta_{14} PLCase + \beta_{15} PLCtrl + \beta_{16} ESCase + \varepsilon$$

equal zero in case of the adult version), *SexR* denotes a female respondent in the adult version of the questionnaire (zero for male respondent in the adult questionnaire, and for parental questionnaire), *SexCh* denotes a female child in the parental version of the questionnaire (zero for male child in the parental questionnaire, and for adult questionnaire), *HH* denotes household category (4 categories, the first of which is included in the constant term), *Food* denotes type of allergy (16 categories, the first of which is included in the constant term; for controls all food allergy type dummy variables equal 0), the remaining terms refer to cases and controls in each of the three countries, resp. (Spanish controls are included in the constant term).

All analysis were conducted using the Univariate Anova procedure in SPSS. After each analysis, the marginal means, corrected for the effect of covariates, evaluated at their respective means, were calculated for each cost item. The natural exponent of the difference in mean cost items between cases and controls indicate the percentage difference of their respective geometric means. For example, if the difference in the average logarithmic costs was 0.22, the proportional difference equaled exp(0.22) = 1.25 resulting in 25% difference.

Results

The reported results are based on the pooled sample, including responses to the adult version and parental version of the questionnaire, because the analysis on the separate samples did not show significant differences in cost items between the groups.

Direct costs

Although analysis of variance was performed on each cost item, we only report the parameter estimates of the analysis of variance of the total direct household costs in Table 2. However, the marginal means for each country and case–control group, based on separate analyses of variance, will be reported for each cost item in Table 3. Since the variance of total direct costs differed significantly across country and case–control groups and the groups were of different size, we took a conservative approach in setting the significance level at $p<.01$ (cf. Stevens, 1990). The distribution of residual terms was normal, as it should be. The distribution of covariates was roughly the same in the case and control groups.

Table 2a shows that respondents with more severe reactions to food allergens did not incur significantly higher total direct costs than those with very mild reactions to food allergens (reference group) using Mueller's severity grading scale [33,34]. Apparently, allergy severity did not significantly affect total direct cost.

For both food hypersensitive and control respondents, the direct costs were relatively high for households with more highly educated respondents, and higher household incomes as compared with the respective reference groups. They were also higher for households composed differently to two adults with children. These variables are highly correlated with income (i.e. the more educated people are the higher the income, and not having children also frees people to enable working longer hours and earning more money). Higher income means people have more resources to spend on holidays and food. No significant differences were observed for the other demographic variables included in the analysis.

Regarding the type of food allergy, it appeared that respondents hypersensitive to nuts had higher total direct household costs than respondents hypersensitive to milk and dairy products (which was the most common type of food allergy).

Next, the analysis of variance was used to compute marginal means, i.e., average direct costs of control respondents, and food hypersensitive respondents in each of the three countries, corrected for the influence of the covariates (that is, each covariate was set at its respective mean to calculate the marginal means). Contrary to expectations, for all three countries the total direct costs were not significantly different between the control respondents and the food hypersensitive respondents, given the influence of the covariates.

Indirect costs

Table 4 shows the parameter estimates of the analysis of variance of the total indirect household costs (analyses of variance of separate cost items is not reported here). The parameter estimates indicate that severity of food hypersensitivity did not significantly affect total indirect costs.

The higher the educational level, the higher were the indirect costs, regardless of food hypersensitivity status. The level of income had a positive effect on total indirect cost because the costs of time were converted into money by using the wage rate.

For the respondents to the adult version, either case or control, the higher the age the higher were the total indirect costs. This could be partly explained by a higher wage rate of respondents with more working experience as they become older, although the effect may tail off and reduce when people

Table 2: Parameter estimates of analysis of variance on total direct costs

		Coeff.	SE	
Intercept		7.51	0.16	*
Mild food allergy		0.09	0.11	
Moderate food allergy		0.15	0.11	
Severe food allergy		0.13	0.14	
Very mild food allergy	Reference group			
Parental version		–0.01	0.10	
Adult version	Reference group			
University degree respondent		0.46	0.08	*
High school diploma respondent		0.24	0.12	
Secondary Education respondent		0.30	0.10	*
Education level not reported		–0.02	0.08	
Primary education respondent	Reference group			
Respondent working 40 hours per week		0.14	0.07	
Respondent working >40 hours per week		0.15	0.09	
Respondent working <40 hours per week	Reference group			
Partner/spouse working 40 hours per week		0.28	0.07	*
Partner/spouse working >40 hours per week		0.32	0.08	*
Partner/spouse working <40 hours per week	Reference group			
Household income €2,000 – 3,000		0.18	0.09	
Household income ≥ €3,000		0.25	0.09	*
Household income not reported		–0.72	0.11	*
Household income < €2,000	Reference group			
Adults version: Age adult 30–39 years		0.08	0.10	
Adults version: Age adult 40–49 years		0.21	0.10	
Adults version: Age adult ≥ 50 years		0.32	0.11	*
Missing data age		–0.52	0.14	*
Adults version: Age adult ≤ 29 years	Reference group			
Parental version: Age child 8–9 years		0.15	0.11	
Parental version: Age child 10 years		0.08	0.12	
Parental version: Age child > 10 years		0.00	0.10	
Parental version: Age child ≤ 9 years	Reference group			
Adults version: female respondent		0.01	0.08	
Adult version: male respondent	Reference group			
Parental version: female child		–0.04	0.08	
Parental version: male child	Reference group			
Household composition single adult		0.84	0.15	*
Household composition one adult and child/children		0.54	0.12	*
Household composition two adults without children		0.39	0.09	*
Household composition two adults and child/children	Reference group			
Chocolate and Sweets * case		0.17	0.11	
Celery * case		0.33	0.17	
Eggs * case		0.08	0.12	
Fish * case		0.05	0.15	
Fruit * case		0.04	0.09	
Meat or poultry * case		–0.05	0.27	
Mustard * case		–0.21	0.19	
Nuts * case		0.17	0.10	
Sesame seed * case		0.06	0.23	
Shellfish and crustacean * case		–0.35	0.17	
Soy * case		–0.05	0.17	
Sulphites * case		–0.05	0.57	
Wheat and gluten * case		0.26	0.21	
Vegetables * case		.73	0.24	
Other food allergy		0.86	0.36	
Milk and dairy * case	Reference group			
Netherlands * case		–0.61	0.15	*
Netherlands * control		–0.32	0.11	*
Poland * case		–0.49	0.11	*
Poland * control		–0.39	0.08	*
Spain * case		–0.02	0.13	
Spain* control	Reference group			

Note. * $p < .01$.
$F = 1023.83$ (df=47), $p < .01$; adjusted $R^2 = 0.16$.
ln is the natural logarithm to the base e ($\ln(x) = \log_e(x)$).

Table 3: Estimated means of direct costs of cases and controls in three countries (logarithms)

		NL and case	NL and control	Poland and case	Poland and control	Spain and case	Spain and control	All cases	All controls
Cost of living	ln mean	6.98	7.36	6.94	7.03	7.79	7.83	7.24	7.41
	SE	0.16	0.16	0.15	0.15	0.19	0.19	0.09	0.11
Travel cost to obtain health care	ln mean	2.20	1.22	1.21	1.00	1.43	1.04	1.61	1.09
	SE	0.17	0.17	0.15	0.15	0.19	0.19	0.10	0.12
Cost of consultation health professional	ln mean	1.21	0.43	0.60	0.35	0.77	0.52	0.86	0.43
	SE	0.18	0.18	0.17	0.17	0.21	0.21	0.11	0.13
Medicine (prescribed and OTC)	ln mean	2.37	2.02	5.14	5.04	4.06	3.32	3.86	3.46
	SE	0.24	0.24	0.22	0.22	0.28	0.28	0.14	0.17
Medical insurance	ln mean	2.26	2.24	2.86	2.92	2.54	2.76	2.55	2.64
	SE	0.07	0.07	0.07	0.07	0.08	0.08	0.04	0.05
Total direct costs	ln mean	7.41	7.64	7.54	7.61	8.09	8.10	7.68	7.78
	SE	0.12	0.12	0.11	0.11	0.14	0.14	0.07	0.08

Note: figures based on unweighted means.

reach retirement age. Furthermore, household composition seemed to influence total indirect costs. Namely, households with one adult and children incurred higher indirect costs compared to households with two adults and children, regardless of whether they had a food hypersensitive family member or not. Neither the other demographic variables nor the type of food allergy had significant effects on total indirect cost.

The analysis of variance of each indirect cost item was used to compute marginal means, i.e., average direct costs of respondents who were not sensitive to food, and food hypersensitive respondents in each of the three countries, corrected for the influence of the covariates (that is, each covariate was set at its respective mean to calculate the marginal means).

The costs of time spent on obtaining health care from a health care professional across all countries was 45% ($p<.01$) higher for food hypersensitive respondents than for respondents asymptomatic to foods. Within-country analysis shows that food hypersensitive respondents in the Poland had 36% ($p<.01$) higher costs than control respondents. In the other countries, no significant differences were found. These results are partially in line with our expectation that food hypersensitive respondents incur greater costs than controls, at least in Poland. However, the effect is not generalizable to the Netherlands and Spain, suggesting that this may reflect local variations in national health care services.

No significant differences were found for the other types of indirect costs.

Finally, the intangible costs of having a food allergy were assessed by comparing cases and controls regarding a number of human capital issues. Respondents were asked to report about radical changes in their life, due to their health situation. Table 6 shows a number of differences between the groups concerning career and schooling opportunities, social life, leisure and emotional life. Cases were significantly more likely than controls to report restrictions concerning job, giving up a job, changing job, restrictions on leisure activities and social life, change of residence, delayed family expansion, and change of emotions. Although these restrictions are hard to quantify in monetary terms, they may be associated with substantial opportunity costs, i.e., the costs of foregoing more pleasurable or profitable activities due to food allergy.

Discussion

This study reports the differences in household costs associated with having a family with food hypersensitive members, compared to households without food hypersensitive members. Contrary to our expectations, households with food hypersensitive respondents had almost equal direct and indirect costs across all countries. One reason for the lack of greater incurred costs in the case of food hypersensitive respondents/households might be due to a restriction in food choices and related behaviours, insomuch as shopping and cooking may be more routine due to the limited variety of foods people with a food allergy can safely consume, and by the avoidance of more expensive processed foods leading to less expenses on groceries and less time spent buying and preparing meals [7,35]. Moreover, families with food hypersensitive members may also restrict social and recreational activities where the food provided cannot be managed to an appropriate level (for example, going out for dinner, ordering takeaway food, or recreational travel) leading to less expenses when compared to a family without food hypersensitive members (see [7, 35]). An important issue which needs to be raised at this point relates to the relation between household expenditure and household activity. Spending less on recreation and recreational travel

Table 4: Parameter estimates of analysis of variance on total indirect costs

		Coeff.	SE	
Intercept		7.99	0.18	*
Mild food allergy		–0.09	0.12	
Moderate food allergy		–0.04	0.13	
Severe food allergy		0.02	0.16	
Very mild food allergy	Reference group			
Parental version		–0.11	0.12	
Adult version	Reference group			
University degree respondent		0.53	0.10	*
High school diploma respondent		0.40	0.13	*
Secondary Education respondent		0.34	0.11	*
Education level not reported		–0.16	0.09	
Primary education respondent	Reference group			
Respondent working 40 hours per week		0.02	0.08	
Respondent working >40 hours per week		–0.06	0.10	
Respondent working <40 hours per week	Reference group			
Partner/spouse working 40 hours per week		0.17	0.08	
Partner/spouse working >40 hours per week		0.14	0.09	
Partner/spouse working <40 hours per week	Reference group			
Household income €2,000 – €3,000		0.08	0.10	
Household income ≥ €3,000		0.25	0.10	*
Household income not reported		0.75	0.12	*
Household income < €2,000	Reference group			
Adults version: Age adult 30–39 years		0.05	0.11	
Adults version: Age adult 40–49 years		0.23	0.11	
Adults version: Age adult ≥ 50 years		0.51	0.12	*
Missing data age		–0.47	0.16	*
Adults version: Age adult ≤ 29 years	Reference group			
Parental version: Age child 8–9 years		0.05	0.12	
Parental version: Age child 10 years		–0.04	0.14	
Parental version: Age child > 10 years		–0.07	0.12	
Parental version: Age child ≤ 9 years	Reference group			
Adults version: female respondent		0.02	0.09	
Adult version: male respondent	Reference group			
Parental version: female child		–0.08	0.09	
Parental version: male child	Reference group			
Household composition single adult		–0.42	0.17	
Household composition one adult and child/children		0.39	0.13	*
Household composition two adults without children		–0.02	0.10	
Household composition two adults and child/children	Reference group			
Chocolate and Sweets * case		0.19	0.13	
Celery * case		0.46	0.20	
Eggs * case		0.08	0.13	
Fish * case		0.18	0.17	
Fruit * case		0.09	0.10	
Meat or poultry * case		–0.07	0.31	
Mustard * case		0.00	0.22	
Nuts * case		0.13	0.12	
Sesame seed * case		0.42	0.26	
Shellfish and crustacean * case		–0.39	0.19	
Soy * case		0.06	0.20	
Sulphites * case		0.22	0.65	
Wheat and gluten * case		0.19	0.24	
Vegetables * case		–0.03	0.28	
Other food allergy		0.79	0.41	
Milk and dairy * case	Reference group			
Netherlands * case		–0.19	0.17	
Netherlands * control		0.03	0.13	
Poland * case		–0.70	0.13	*
Poland * control		–0.68	0.10	*
Spain * case		0.07	0.15	
Spain * control	Reference group			

Note. * $p < .01$.

$F = 691.73$ (df=47), $p < .01$; adjusted $R^2 = 0.22$.

ln is the natural logarithm to the base e ($\ln(x) = \log_e(x)$).

Table 5: Analysis of variance of indirect costs of cases and controls in four countries (logarithms) (Value of time equals spent time by household partners multiplied by the respective wage rates.)

		NL and case	NL and control	Poland and case	Poland and control	Spain and case	Spain and control	All cases	All controls
Total value of time spent on household tasks	ln mean	7.74	7.48	7.30	7.46	7.91	8.12	7.65	7.69
	SE	0.38	0.38	0.33	0.33	0.47	0.47	0.14	0.21
Total value of time spent with and travelling to health professional	ln mean	2.99	2.77	2.57	1.49	3.64	3.27	3.06	2.51
	SE	0.43	0.43	0.37	0.37	0.51	0.51	0.15	0.23
Value of time spent by family members visiting family members in hospital	ln mean	-0.05	-1.49	0.56	-0.01	-0.26	0.71	0.09	-0.26
	SE	0.49	0.49	0.43	0.43	0.60	0.60	0.18	0.26
Total indirect costs	ln mean	7.77	7.47	7.36	7.43	7.91	8.21	7.68	7.71
	SE	0.35	0.35	0.30	0.30	0.43	0.43	0.13	0.19

Note: figures based on unweighted means.

may actually reflect a reduced quality of life as experienced by food hypersensitive individuals and their families. From this, it can be concluded that reduced, as well as increased, household expenditure may reflect a reduced quality of life associated with having a chronic disease.

It is possible that food hypersensitive cases needed to travel further and more often to seek a (food) allergy specialist due to the small number of clinicians with expertise in this area, resulting in higher travel costs. Once a food allergy patient has been diagnosed and is adequately informed about the avoidance diet and emergency treatments, cases will be monitored at least yearly with a follow-up consultation (some cases outgrow food allergy whereas others develop new allergies), leading to relatively low consultation costs compared to other chronic diseases which require regular check-ups by a specialist. The medication for food allergy mainly consists of emergency treatment, such as carrying an epinephrine auto-injector or oral antihistamines [36, 37], resulting in higher medication costs for cases than controls. The differences in health care insurance systems across the countries make it difficult to develop a sensitive measure to establish the impact of food hypersensitivity on health care insurance. However, taking into consideration the above (low consultation costs and low medicine costs in several countries), it may be concluded that food hypersensitive cases do not need more expensive health insurance than people without food hypersensitivity.

Table 6: Changes in life situation due to one's health

	Case	Control
My choice of job or career has been restricted	15.4	6.7*
I gave up my job	9.4	4.4*
I was dismissed from my job	2.7	1.8
I changed jobs	5.8	2.9*
I moved to a different home/city	7.0	2.4*
I have been unable to participate in sports and hobbies	11.1	7.7*
My social life is restricted	16.1	7.3*
I changed schools	2.1	1.3
I have delayed having children/expanding my family	6.0	1.5*
The relationship with my partner broke down	2.4	1.1
I have experienced a change in emotions (anger, fear, anxiety, feeling left out, trauma)	25.9	10.9*
My child has experienced a change in emotions (anger, fear, anxiety, feeling left out, trauma)	5.8	1.6*

Note. * p<.01

The severity of the food hypersensitivity was not associated with significantly higher total direct costs. Concerning the indirect costs, the results only showed higher costs for time spent with and traveling to health professionals. It is of interest to note that the results do not align with the self-report data reported in references [7] and [35], suggesting that a patient's perception of relative expenditure, associated with a specific condition or disease, or in comparison to an individual not experiencing the condition, may not align with actual expenditures when these are directly measured. This may explain why many patient interest groups working in the area of food allergy report anecdotal evidence that food allergic cases have very high costs associated with their disease (see, for example, [38-45]. However, the results presented here, derived from the analysis of extensive survey data collected in different European countries, and through application of a validated instrument do not support the contention that food allergy is associated with high costs at the household level.

Our study design may have had some methodological limitations. When respondents were employed, actual wage rates were used because the respondent had chosen income over household production. When a respondent was not in paid employment, the minimum wage rate used in the country

under consideration was used to calculate the opportunity costs, because it was assumed that, regardless of educational level, the respondent could earn at least the minimum wage rate on the labour market. It could be argued that this assumption was inappropriate, as the unemployed individual could have earned more than the minimum wage if employed. A further limitation is associated with the method used to calculate the costs associated with children in the household. In the parental survey, in the control group, information was requested regarding the cost of the oldest child. Since the cost may depend on age, this can lead to bias between the case and control groups, as the cases are not necessarily also the oldest child in the household.

Although having food hypersensitivity did not increase direct and indirect costs at the household level, the results on intangible costs suggests that lost opportunities were substantial. Having food hypersensitivity might influence or indeed limit choices associated with schooling, employment, and family planning, which might result in unfulfilled aspirations. Furthermore, emotional problems appeared to add to the psychological costs of having a food allergy.

Conclusions

For policy makers, information about the cost at the household level as well as cost for the health sector and industry are important to develop adequate and cost-effective regulatory measures regarding consumer protection and provision of health care services. Since both direct and indirect costs of food hypersensitive respondents differed little to those incurred by controls, our results suggest that compensating cost measures for cases are not necessary. Further research is required to confirm our preliminary finding concerning intangible costs of cases as compared with controls. Policy makers might consider putting resources into services to better diagnose and manage food allergy to avoid or mitigate such intangible costs.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

JV was involved in the design and organization of the study, drafted the manuscript, and

performed the statistical analysis. MF, IC, JZ, BH, ER, JC, and MM were involved in the design and organization of the study and have revised the manuscript critically. GA and LF were involved in the design and organization of the study and supervised the statistical analysis and data interpretation and made substantive contributions to the manuscript. MJ, PS, MK, MJ, SV, SC, BF and AD have revised the manuscript critically, and were involved in acquisition of the data. All the authors have read and approved the final manuscript.

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Global Allergy and Asthma European Network (GA_LEN) [www.ga2len.net/hp/homepage2.cfm]

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