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# Among Children with Food Allergy, Do Sociodemographic Factors and Healthcare Use Differ by Severity?

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## Abstract

Among children with food allergy, we aim to describe differences in allergy severity by sociodemographic characteristics and potential differences in healthcare characteristics according to food allergy severity. Using the 2007 National Survey of Children's Health, we identified children with food allergies based on parental report (n = 4,657). Food allergic children were classified by the severity of their food allergy, as either mild (n = 2,333) or moderate/severe (n = 2,285). Using logistic regression, we estimated the odds of having moderate/severe versus mild food allergy by sociodemographic characteristics and the odds of having selected healthcare characteristics by food allergy severity. Among children with food allergy, those who were older (ages 6 through 17 years) and those who had siblings were more likely to have moderate/severe allergy compared to their younger and only-child counterparts. There were no significant differences in severity by other sociodemographic characteristics. Children with a moderate/severe food allergy were more likely to report use of an Individual Education Plan (OR = 1.88 [1.31, 2.70]) and to have seen a specialist than those with mild food allergy. Among younger children with food allergy, those with moderate/severe food allergy were more likely to require more services than is usual compared with those with mild allergy. Associations between allergy severity and health care-related variables did not differ significantly by race/ethnicity, income level, or maternal education. We report few differences in allergy severity by sociodemographic characteristics of food allergic children. In addition, we found that associations between allergy severity and use of health related services did not differ significantly by race/ethnicity or poverty status among children with food allergy. Given the importance of food allergy as an emerging public health issue, further research to confirm these findings would be useful.

### Keywords

Food allergy; Health survey; Healthcare disparities

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*Disclaimer*: The findings and conclusions in this paper are those of the authors and do not necessarily represent the views of the National Center for Health Statistics, Centers for Disease Control and Prevention.

## Introduction

Food allergy is an increasingly common condition in the US, with a spectrum of severity ranging from mild discomfort to anaphylaxis and death. Between 1997 and 2007, reported food allergy in children increased at least 18 % [1] and continues to be a growing health concern among physicians, parents, and researchers worldwide. The reason for this apparent rise in prevalence is not clear and is similar across population subgroups. As identified through parental report, the prevalence of food allergy is similar for boys and girls and by race/ethnicity, although is higher among young children compared to older children [1, 2]. However, there are substantial differences in food-specific serum Immunoglobulin E (IgE) levels by race/ethnicity, sex, and age [1, 3]; non-Hispanic black children, boys, and younger children are more likely to have biochemical evidence of food allergy than their respective counterparts. The wide range of morbidity associated with food allergy coupled with the population-level differences in serum IgE suggest that even among children reported to have food allergy, certain groups of people may be at higher risk of severe food allergy and related adverse outcomes. However, that relationship has not yet been explored.

Access to and use of health care has the potential to mitigate the potential adverse effects of severe food allergy [4, 5]. A thorough clinical evaluation is necessary for a proper diagnosis of food allergy [6]. In addition, since there is no cure for food allergy, regular communication and education with healthcare professionals can help manage the condition, particularly more severe food allergy, and prevent potential anaphylactic reactions [6]. Visits to physician offices and hospital facilities related to food allergy have increased in recent years, paralleling the increase in prevalence [1]. However, the relationship between food allergy severity and healthcare use, and whether there are differences in that relationship by socioeconomic status, race/ethnicity, or other characteristics, is not known. Certainly, differences in access to care by race/ethnicity and socioeconomic status are seen among the general pediatric population, raising the possibility of disparities in healthcare access and use among children with food allergy [7].

Although based on self or parental-report measures, large population surveys can help fill gaps in knowledge regarding sociodemographic factors and health care use among food allergy-affected children. Using the 2007 National Survey of Children's Health (NSCH), we describe the sociodemographic correlates of severity of food allergy among children reported to have food allergy. We also examine potential differences in healthcare and other services among children with food allergy according to food allergy severity.

## Methods

### Study Sample

We use data from the 2007 NSCH for analyses. The NSCH is a nationally representative telephone survey of children in the US and is designed to examine aspects of emotional and physical health [8]. We identified any child whose parent (approximately 94 % of respondents) or proxy answered "yes" to the question "During the past 12 months, have you been told by a doctor or other health care provider that [child name] had any kind of food or digestive allergy?" This resulted in an unweighted sample of 4,657 children with parent-

reported food allergy. Respondents for 140 children (0.2 %of the original unweighted sample size) did not know or refused to answer the question. Food allergic children were classified by the severity of their food allergy, as indicated by responses to the question "Would you describe [child name]'s food or digestive allergy as mild, moderate, or severe?" Of these, 2,333 children were classified as having mild food allergy, 1,340 as having moderate, and 945 as having severe food allergy (39 respondents representing 0.8 % of food allergy-affected children did not know or refused to answer the question on severity). To ensure adequate sample size for analyses, children with moderate and severe food allergy were combined into one group for comparison with children who have mild food allergy.

## Study Variables

Analytic variables were chosen based on both important characteristics identified from previous analyses of food allergic children and reported associations with other atopic outcomes that have not yet been reported with food allergy, such as having a sibling [9]. Sociodemographic characteristics included gender, race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and non-Hispanic multiracial or other race), age group (0–5 years, 6–11 years, 12–17 years), sibling status (only child, child with sibling), family structure (two parent household, single parent/other), mother's education (high school graduate or less, more than high school graduate), mother US born (yes or no) and poverty status (poor: <100 % of the poverty level, near poor: ≥100 and <200 % of the poverty level, not poor: ≥200 % of the poverty level). Approximately 9 % of children had unknown poverty status in the NSCH. NSCH staff [8] imputed missing data on income and/or household size five times, resulting in five different data sets with reported and imputed values. Analyses were conducted using each separate data file and then combined using standard multiple imputation combining rules per instructions in the NSCH 2007 methodology report [8].

Healthcare related variables included both indicators of access to health care and health care use. Indicators of health care access included any type of healthcare coverage (uninsured, insured consistently over past year, insured inconsistently over past year), and whether the child has a usual source of care. Indicators of health care use included whether the child had seen a specialist in the past year, number of preventive visits in past year (none, one, two or more), use of an Individual Education Plan (IEP), and whether the child needed or used more medical care, mental health, or educational services than is usual for most children of the same age. Some survey respondents answering "yes" to the question of "does child have a usual source of care" stated that the emergency department was the source of care. We re-classified these children as not having a usual source of care.

## Statistical Analysis

Frequencies of sociodemographic and health care related characteristics were compared between children according to food allergy severity. Pearson's Chi-square was used to assess statistical significance of any differences in these characteristics by food allergy severity. Logistic regression was used to estimate the unadjusted odds of moderate/severe food allergy associated with selected sociodemographic characteristics, with mild food allergy being the reference group. Adjusted odds of moderate/severe food allergy for each sociodemographic characteristic were also estimated, controlling for all other

sociodemographic characteristics. In order to assess potential differences in healthcare access and use by food allergy severity, we estimated the odds of healthcare characteristics using food allergy severity status as the main independent variable. To test for possible differences in the relationship between food allergy status and healthcare use characteristics by sociodemographic characteristics, interactions terms with age, sex, race/ethnicity, and poverty were also added to models to assess significance. Missing data for any covariates were dropped from regression analyses and ranged from 0.1 to 5 %. Analytic weights were used for all analyses; multiple imputation and the complex sampling design were accounted for using the multiple imputation and survey procedures in Stata (v. 11).

## Results

In 2007, 4.8 % of US children had a reported food allergy. Of those, 50.5 % reported having a mild food allergy, 29.0 % reported having a moderate food allergy, and 20.5 % reported having a severe food allergy. Overall, severe food allergy was reported in 1.5 % of US children. Unweighted sample sizes and weighted proportions with 95 % confidence intervals of sociodemographic and healthcare use characteristics according to food allergy severity are shown in Table 1. Among children with food allergy, the only sociodemographic characteristics that differed by food allergy severity were age group ($p < 0.01$) and sibling status ($p < 0.01$). For the healthcare related characteristics, use of an IEP ($p < 0.0001$) and requiring more services than is usual ($p < 0.0001$) was associated with greater food allergy severity among those with food allergy.

In the bivariate logistic regression analyses of food-allergic children (Table 2), the crude odds of moderate/severe food allergy were increased among older children (OR for 6–11 years = 1.43 [1.01, 2.04]; OR for 12–17 years = 1.70 [1.21, 2.38]). Odds of moderate/severe food allergy were also greater for children with siblings (OR for child with sibling(s) = 1.55 [1.16, 2.06]). After adjustment for all sociodemographic factors, the increased odds of moderate/severe food allergy with both older age and having siblings remained statistically significant.

Using healthcare characteristics as outcomes (Table 3), potential interactions of allergy severity with age, race/ethnicity, and poverty status were tested. For the healthcare related variables, “requires more services than is usual” and “saw a specialist in the last year”, interaction terms between allergy severity and age were statistically significant and so age-stratified results are presented for these variables. No other significant interactions were found.

The adjusted odds of use of an IEP (OR = 1.88 [1.31, 2.70]) among food-allergic children was significantly greater for children with moderate/severe food allergy compared to those with mild allergy. After stratifying by age, only among food allergic-children 0–5 years was the odds of requiring more services than is usual (OR = 2.67 [1.61, 4.43]) significantly greater for those with a moderate/severe food allergy compared with a mild food allergy; the odds of having seen a specialist in the last year was significantly greater for both children 0–5 years and 6–17 years of age with moderate/severe allergy compared with mild allergy, but the odds of having seen a specialist for those with moderate/severe allergy were greater for

children 0–5 years (OR = 2.83 [1.76, 4.57]) than for children 6–17 years (OR = 1.45[1.02, 2.06]).

## Discussion

Using parental and proxy-reported data, we found that among children with food allergy, older (ages 6 through 17 years) children and those with a sibling were more likely to have moderate/severe food allergy compared with their younger and only-child counterparts. Children with moderate/severe food allergy were more likely than those with mild food allergy to use an IEP, to have seen a medical specialist in the last year, and to require more services than is usual, although the findings regarding the last two characteristics were stronger among younger children. Among children reported to have food allergy, we found no significant differences in the association of food allergy severity with healthcare use according to race/ethnicity or family income.

The findings regarding the demographic differences both corroborate previous findings and demonstrate a potentially new association. The association between age and food allergy severity has been previously reported [4, 10, 11] and may be due to a greater opportunity to become sensitized to allergens or simply more opportunity to have exposure to an allergen that results in a severe reaction. Ideally, it would have been informative to know how many children who started with mild allergy became moderately/severely allergic as they aged, but we could not test that with the data set. To our knowledge, the association between severity and having a sibling among food-allergic children has not previously been shown. This may suggest a different relationship between sibship and food allergy than is found for other atopic diseases, for which having siblings is associated with lower severity. However, compared to children with no food allergy, children with moderate/severe food allergy were just as likely to have a sibling (data not shown). Therefore, future research should examine whether the presence of siblings and birth order are truly related to the presence and severity of food allergy.

Food allergic children with a moderate/severe food allergy were twice as likely as those with mild food allergy to report use of an IEP. Children with demonstrated severe food allergies, versus any food allergy, are protected from general discrimination (i.e., ensures they receive access to a free and adequate public education) in schools under Section 504 of the Rehabilitation Act of 1973 [12]. An IEP can be used as a tool under Section 504 to help detail a food-allergic child’s needs in the school setting. It would be expected that children with moderate/severe food allergy would be more likely than those with mild food allergy to use an IEP, since those children are more likely to require specific strategies to avoid exposure to allergens and to maximize availability of needed treatment. It is estimated that 20 %of food allergy anaphylactic reactions and approximately one-quarter of first-time reactions to food among allergic children occur at school [13, 14]. However, in this analysis only 20 %of children with moderate/severe food allergy reported using an IEP, and many school districts report low compliance rates with the American College of Allergy, Asthma, and Immunology recommendations of having an emergency management plan (EMP) in place for food allergic students [13, 15]. Although we found no differences in the relationship between IEP use and food allergy severity by demographic groups, future

research to investigate characteristics that may account for variation in IEP or EMP use between school districts may be useful.

Among food allergic children, we found no significant differences in reported food allergy severity according to race/ethnicity or income status. This finding was somewhat surprising given prior evidence which suggests that non-Hispanic black children have higher levels of IgE levels than non-Hispanic white children [1, 3]. IgE levels do not necessarily correspond to the presence or severity of clinical allergies [16], but at the same time, our reported measure of allergy severity may also have limitations which are discussed below. We also found no evidence of race/ethnicity or poverty status differences in healthcare characteristics by food allergy severity among food allergic children. However, our assessment of health care use does not include use of emergency services by food allergy severity, which could possibly differ by race/ethnicity and poverty status. To our knowledge there are no existing descriptions of healthcare use by food allergy severity and demographic characteristics among US children with food allergy to which we can compare our results.

This study has some limitations. Food allergy and food allergy severity were parent-reported and there were no criteria given to survey respondents to help guide their judgment of food allergy severity. Similarly, the questions regarding healthcare use and access were also based on self-report and did not have specific definitions for characteristics such as “preventive visits” or “medical, mental health, or educational services”. Therefore, responses to these questions may vary according to sociodemographic characteristics and also could be affected by the survey respondent’s perception of allergy reaction in the child. The results are subject to biases associated with telephone surveys, including the exclusion of households without landlines and low response rates relative to population-based, face-to-face surveys [8]. Data were collected using a landline telephone survey, and nonresponse and noncoverage of households without landlines may have biased our results. However, these biases were minimized to the extent possible by incorporating adjustments into the sampling weights [8], and an analysis of nonresponse bias in the NSCH found no evidence of significant bias for some estimates and none greater than 3 % for other estimates [17]. As in other large health surveys, there was no information on reported allergies to specific foods. However, this is the only source of nationally representative data with an indicator of food allergy severity. In addition, the NSCH contains a diverse array of variables which allowed an examination of food allergy severity by characteristics from many domains (e.g., demographic, healthcare use, etc.). Finally, the NSCH provides the largest nationally representative data set of US children on which to examine conditions like food allergy.

This analysis of food allergy severity among US children provides some insight into how food allergy severity and use of health-related services may vary among US children with food allergy. Children with moderate/severe food allergy were more likely than those with mild food allergy to report using an IEP. In general, older children are more likely to have moderate/severe food allergy than younger children, but the association between moderate/severe allergy and both greater use of medical and educational services and having seen a specialist in the last 12 months is stronger for younger than older children. Other than age, we found no differences in severity of food allergy among food-allergic children by key sociodemographic characteristics, despite previously noted differences in biological markers

of food allergy by race/ethnicity. In addition, we found that associations between allergy severity and use of health related services did not differ significantly by race/ethnicity or poverty status. Given the importance of food allergy as an emerging public health issue, further research to confirm these findings would be useful.

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## Table 1

Unweighted frequencies and weighted percentages of sociodemographic and healthcare use characteristics by food allergy severity among children 0–17 years with food allergy: NSCH, 2007

| Characteristics | Food allergy severity | | | |
|---|---|---|---|---|
| | Mild | | Moderate/severe | |
| | n (unweighted) | % (weighted) | n (unweighted) | % (weighted) |
| All | 2,333 | | 2,285 | |
| Sociodemographic | | | | |
| Gender | | | | |
| Male | 1,195 | 48.7 (43.6, 53.8) | 1,262 | 54.1 (49.0, 59.3) |
| Female | 1,136 | 51.3 (46.2, 56.4) | 1,021 | 45.9 (40.7, 51.0) |
| Race | | | | |
| NH white | 1,518 | 58.6 (53.5, 63.8) | 1,506 | 55.5 (50.0, 60.9) |
| NH black | 251 | 15.2 (12.0, 18.4) | 258 | 18.8 (15.0, 22.7) |
| NH multiracial/other | 256 | 11.4 (7.3, 15.6) | 258 | 9.9 (7.2, 12.6) |
| Hispanic | 276 | 14.8 (11.0, 18.6) | 228 | 15.8 (10.0, 21.6) |
| Age group[1] | | | | |
| 0–5 years | 876 | 46.3 (41.2, 51.5) | 839 | 35.7 (30.7, 40.6) |
| 6–11 years | 661 | 28.6 (23.8, 33.4) | 700 | 31.6 (27.0, 36.1) |
| 12–17 years | 796 | 25.1 (21.7, 28.5) | 746 | 32.7 (27.5, 38.0) |
| Sibling status[1] | | | | |
| Only child | 1,081 | 32.8 (28.1, 37.6) | 958 | 24.0 (20.6, 27.4) |
| Sibling child | 1,252 | 67.2 (62.4, 71.9) | 1,327 | 76.0 (72.6, 79.4) |
| Family structure | | | | |
| 2 parents | 1,753 | 70.4 (65.6, 75.3) | 1,713 | 73.6 (69.6, 77.6) |
| Single mother/other | 567 | 29.6 (24.7, 34.4) | 561 | 26.4 (22.4, 30.4) |
| Mother’s education | | | | |
| ≤ High school | 530 | 31.3 (25.9, 36.7) | 464 | 29.5 (24.3, 34.7) |
| > High school | 1,658 | 68.7 (63.3, 74.1) | 1,685 | 70.5 (65.3, 75.7) |
| Mother US born | | | | |
| No | 239 | 12.8 (9.1, 16.5) | 222 | 12.7 (9.3, 16.2) |
| Poor status | | | | |
| Poor | 252 | 15.6 (11.9, 19.2) | 261 | 17.8 (13.9, 21.6) |
| Near poor | 358 | 21.1 (16.9, 25.3) | 353 | 20.8 (16.7, 24.9) |
| Not poor | 1,540 | 63.3 (58.4, 68.3) | 1,519 | 61.4 (56.4, 66.4) |
| Healthcare | | | | |
| Health insurance coverage | | | | |
| Uninsured | 47 | 2.5 (1.3, 4.9) | 55 | 1.8 (0.8, 2.8) |
| Insured consistently[a] | 2,057 | 86.6 (82.9, 90.3) | 2,035 | 86.8 (83.6, 90.1) |
| Insured inconsistently[b] | 205 | 9.7 (6.7, 12.7) | 178 | 10.8 (7.7, 13.9) |

| Characteristics | Food allergy severity | | | |
|---|---|---|---|---|
| | Mild | | Moderate/severe | |
| | n (unweighted) | % (weighted) | n (unweighted) | % (weighted) |
| Does child have a usual place of care? | | | | |
| No | 91 | 4.4 (2.7, 6.2) | 91 | 6.4 (2.3, 10.5) |
| Does child have regular doctor? | | | | |
| No | 117 | 5.3 (3.8, 7.5) | 92 | 3.5 (2.2, 5.5) |
| Has child seen a specialist in the last 12 mos?[1] | | | | |
| Yes | 975 | 35.1 (30.9, 39.5) | 1,286 | 51.0 (45.7, 56.2) |
| Number of preventive visits in last year | | | | |
| None | 156 | 6.1 (3.4, 8.8) | 145 | 7.5 (3.3, 11.6) |
| One | 902 | 36.1 (31.4, 40.7) | 907 | 40.3 (35.0, 45.5) |
| Two or more | 1,259 | 57.8 (52.9, 62.8) | 1,213 | 52.3 (46.9, 57.6) |
| Use of IEP?[1] | | | | |
| Yes | 293 | 10.8 (8.5, 13.1) | 368 | 20.1 (15.6, 24.6) |
| Does child require more services than is usual?[1] | | | | |
| Yes | 506 | 22.5 (18.3, 27.2) | 773 | 35.3 (30.6, 40.3) |

[1] Pearson Chi-square comparing mild and moderate/severe food allergy, $p < 0.01$

[a] Reported having no health insurance at anytime in the previous 12 months

[b] Reported having no health insurance at some time in the previous 12 months

**Table 2**

Odds of moderate/severe food allergy among children with food allergy, by sociodemographic characteristics

| Characteristics | Food allergy severity | |
|---|---|---|
| | Crude | Adjusted |
| Sociodemographic | n = 4,610 | n = 4,543 |
| Gender | | |
| Male | Ref | Ref |
| Female | 0.80 (0.60, 1.08) | 0.77 (0.58, 1.01) |
| Race/ethnicity | | |
| non-Hispanic white | Ref | Ref |
| non-Hispanic black | 1.31 (0.92, 1.88) | 1.43 (0.98, 2.09) |
| Hispanic | 0.92 (0.55, 1.54) | 1.08 (0.69, 1.70) |
| non-Hispanic multiracial/other | 1.13 (0.66, 1.94) | 0.90 (0.54, 1.51) |
| Age group | | |
| 0–5 years | Ref | Ref |
| 6–11 years | 1.43 (1.01, 2.04)† | 1.51 (1.06, 2.14)† |
| 12–17 years | 1.70 (1.21, 2.38)† | 1.90 (1.37, 2.62)† |
| Sibling status | | |
| Only child | Ref | |
| Sibling child | 1.55 (1.16, 2.06)† | 1.39 (1.06, 1.81)† |
| Family structure | | |
| 2 parents | Ref | |
| Single mother/other | 0.85 (0.63, 1.17) | 0.75 (0.52, 1.06) |
| Mother’s education | | |
| ≤ High school | Ref | |
| > High school | 1.09 (0.77, 1.55) | 1.12 (0.78, 1.59) |
| Mother US born | | |
| Yes | Ref | |
| No | 1.01 (0.64, 1.59) | 0.98 (0.61, 1.58) |
| Household poverty status | | |
| Poor | Ref | |
| Near poor | 0.86 (0.54, 1.38) | 0.72 (0.43, 1.23) |
| Not poor | 0.85 (0.57, 1.26) | 0.71 (0.43, 1.18) |

† $p < 0.05$

## Table 3

Odds of healthcare use characteristics by food allergy severity among children with food allergy

| | Health care use characteristic | |
|---|---|---|
| | **Crude** | **Adjusted[a]** |
| Healthcare | n = 4,610 | n = 4,543 |
| Has usual source of care | | |
| Mild | Ref | |
| Mod/severe | 0.68 (0.31, 1.52) | 0.65 (0.34, 1.25) |
| Has a regular doctor | | |
| Mild | Ref | |
| Mod/severe | 1.56 (0.86, 2.85) | 1.48 (0.84, 2.62) |
| Receipt of preventive visits in last year | | |
| Mild | Ref | |
| Mod/severe | 0.80 (0.37, 1.73) | 0.92 (0.48, 1.78) |
| Uses IEP | | |
| Mild | Ref | |
| Mod/severe | 2.07 (1.43, 2.99)† | 1.88 (1.31, 2.70)† |
| Requires more services than is usual | | |
| 0–5 years | | |
| Mild | Ref | Ref |
| Mod/severe | 2.79 (1.68, 4.65)† | 2.67 (1.61, 4.43)† |
| 6–17 years | | |
| Mild | Ref | Ref |
| Mod/severe | 1.42 (0.94, 2.15) | 1.39 (0.76, 2.53) |
| Has seen a specialist in the last 12 mos | | |
| 0–5 years | | |
| Mild | Ref | Ref |
| Mod/severe | 2.84 (1.76, 4.59)† | 2.83 (1.76, 4.57)† |
| 6–17 years | | |
| Mild | Ref | Ref |
| Mod/severe | 1.45 (1.02, 2.06)† | 1.45 (1.02, 2.06)† |

† $p < 0.05$

[a] Adjusted for health insurance coverage, race/ethnicity, and age (for variables with no significant age interaction)