

ORIGINAL ARTICLE

Food Allergy & Anaphylaxis

Impact of food allergy on food insecurity and health literacy in a tertiary care pediatric allergy population

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Abstract

Background: Food insecurity (FI), limited availability of or access to nutritional foods, is linked to poor child/caregiver health. We examined FI in food-allergic and non-food-allergic children to determine whether dietary limitations associated with food allergy increases risk of FI.

Methods: Food-allergic and non-food-allergic children (1-17 years) were recruited from Arkansas Children's Hospital allergy/asthma clinics. The USDA Food Security Survey, the Newest Vital Sign Health Literacy (HL) questionnaire, and the Food Allergy Impact Scale QOL survey were administered. Logistic regression and analysis of covariance models were utilized for data analysis.

Results: Subjects (n = 650) included 325 food-allergic and 325 non-food-allergic children. Overall rate of FI was 21.5% (food allergic 22.2% and non-food allergic 20.9%) with no significant difference in the prevalence of FI between groups (OR = 1.30; 95% CI 0.86-1.96; *P* = 0.21). FI was increased in households of children with both milk and egg allergy when compared to those without food allergy and those with single food allergy (OR = 2.5; 95% CI 1.4-4.6; *P* = 0.003). Mean HL rates were higher in the food-secure vs food-insecure groups (mean diff = 0.31; 95% CI 0.03-0.59; *P* = 0.03). Among food-allergic children, QOL was better in the food-secure vs food-insecure group (mean diff = 0.61; 95% CI 0.002-1.23; *P* = 0.049).

Conclusion: Food allergy to milk and egg was associated with increased risk of household FI. Food-insecure participants had lower HL than their food-secure counterparts. Further work is needed to define risks associated with FI among food-allergic children to improve screening and management strategies.

KEYWORDS

food allergy, food insecurity, health literacy, pediatric allergy, quality of life

1 | INTRODUCTION

Food allergy is an adverse health effect arising from a specific immune response that occurs reproducibly on exposure to a given food.¹ Food allergy affects approximately 4% of US children under 18 years of age.²⁻⁴ A diagnosis of food allergy necessitates dietary elimination of food allergens and dietary substitutions,¹ which may be costly and difficult to accomplish. Food restriction diets impact daily life, causing hardship within families and psychosocial stressors.⁵ Additionally, in a study examining access to health care, food-allergic subjects reported significant difficulty in accessing food and medical care.⁶

Food security (FS) is defined as consistent and dependable access to food that supports a healthy lifestyle,⁷ while food insecurity (FI) is defined as limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire food in socially acceptable ways.^{8,9} In 2016, 12.3% of all US households and 8% of households with children were food insecure.⁷ Households with very low food security are those lacking food or have disrupted eating patterns at times during the year due to low resources. The rate of very low food security was 4.9% in 2016 in the United States. Additionally, FS households spend 29% more on food than FI households. In 2016, Arkansas was second in the nation household FI with a rate of 17.5%.⁷

Children living in low-income households have less variety of foods consumed regardless of food security.⁷ FI is also linked to poor health and nutrition outcomes, developmental and psychosocial issues, and poor emotional health.¹⁰⁻¹⁴ For example, FI increases the risk of childhood overweight status¹⁵⁻¹⁷ which may lead to other health comorbidities. Investigators have demonstrated that FI adds caregiver stress in low-income families and poorer quality of life (QOL) than those in FS households.^{18,19}

According to Healthy People 2010, health literacy (HL) is the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions.²⁰ HL is shaped by education and socioeconomic status and impacts health outcomes.²¹ Limited HL is linked to decreased understanding of health problems, increased hospitalizations, and poor self-reported health status.²¹⁻²³ A study of US parents found that nearly one in four, an estimated 21 million people, had limited HL.²⁴ While physicians may understand the potential repercussions of limited HL, barriers to addressing limited HL include difficulty in identifying those with limited literacy and constraints of time and resources required to address and teach these families.²⁵

To our knowledge, FI has not been examined among food-allergic children and their families. Additionally, the role of HL has not been fully evaluated among food-allergic patients. The primary aim of this study was to measure FI in food-allergic children compared to allergic children without food allergy in a tertiary care pediatric allergy population. We hypothesized that dietary restrictions required for food allergy management will contribute to increased risk for FI in households with food-allergic children

when compared to households without food-allergic children. Specifically, families of food-allergic children with FI may have additional barriers to obtaining safe foods for their children due to a variety of factors such as the ability to afford alternate foods, limited resources (eg, transportation, education), and other cofactors (eg, other atopic disease, competing medication access). The secondary aims were to examine HL and quality of life in association with food insecurity.

2 | METHODS

2.1 | Study population

We prospectively recruited 650 families with children, 1-17 years, from the allergy and asthma clinics at Arkansas Children's Hospital. We enrolled 325 in the food-allergic group and 325 in the non-food-allergic group. Institutional Review Board approval was obtained, and informed consent and assent were implemented. Enrolled participants included those with atopic diseases including allergic rhinitis, physician-diagnosed food allergy (IgE-mediated and non-IgE-mediated), atopic dermatitis, and asthma. Non-English-speaking participants were not included in this study. Demographic data and medical history were collected including age, gender, ethnicity, concomitant atopic diseases, diet restrictions, and growth parameters. Participation in WIC (Special Supplemental Nutrition Program for Women, Infants, and Children) and/or SNAP (Supplemental Nutrition Assistance Program) was identified in study participants.

2.2 | Food security survey

The US Household Food Security Scale, an 18-item questionnaire considered the gold standard for assessing FS, was used to identify households with FI.²⁶ An example question from the survey includes the following: "We worried whether our food would run out before we got money to buy more (Answer: often true, sometimes true, never true, don't know/refused)." The scale was designed to identify FI in households in which low financial resources limit the ability to purchase food. The questionnaire was administered via face-to-face interview to the caregivers of the study participants. Households were further divided into the following FS groups based on positive questionnaire responses: high (0 responses), marginal (1-2 responses), low (3-7 responses), or very low (8-18 responses). The presence of FI was defined by the presence of low or very low FS. Any family identified with FI was referred to a social worker for further assistance.

2.3 | Health literacy assessment

The Newest Vital Sign is a validated HL questionnaire that enables practitioners to assess HL.²⁷ In this questionnaire, caregivers reviewed a nutrition label from an ice cream carton with six questions (scored as one point/question) about this label. An example question includes the following: "If you eat the entire container, how many

calories will you eat? (Answer: 1000 calories).” Scoring of questions provided the following ratings: 0-1 suggests high likelihood (50% or more) for limited HL, 2-3 possibility of limited HL, and 4-6 almost always indicates adequate HL. The outcome variable of interest was the proportion who had limited (score 0-3).

2.4 | Quality of life (QOL) measurement

The Food Allergy Impact Scale is a 32-item scale used to identify the impact of food allergy on various aspects of QOL in families with food-allergic children.⁵ We used a 6-item subset of the Food Allergy Impact Scale to address the impact of food allergy on QOL related to meal preparation.⁵ Caregivers of food-allergic children were asked to rate the degree to which the child's food allergy affects various aspects of meal preparation on a 7-point Likert scale (1 = not at all and 7 = very much).

2.5 | Statistical methods

We estimated that a sample size of 325 people in each of the two groups would yield at least 80% power to detect a difference of 10% in proportion of FI between the two groups assuming a 10% R-squared of the independent variable with other covariates. The sample size calculation was computed using the PASS software assuming a two-sided significance level of 5%.²⁸

Summary statistics such as mean and standard deviation for continuous measures (median and quartiles in case of skewed data) and frequency and percent for categorical measures are presented

for all predictors, demographics, and outcome variables of interest. All demographics were compared between the food-allergic and non-food-allergic groups to check for potential confounding variables. Continuous variables were compared between two independent groups using a two-sided, two-sample *t* test, while categorical variables were compared using a chi-squared test or Fisher's exact test for association for small size variables. A logistic regression analysis was used to test the effect of food allergy on the presence of FI after adjusting for confounding variables. A separate logistic regression analysis was performed to check for differences in FI rates among different subgroups of food allergy participants (allergic to both milk and egg, milk only, egg only, and “other” foods due to low prevalence of other allergens). An analysis of covariance model was used to test for the effect of food allergy and FI on HL rates, mean overall QOL scores, and the mean QOL scores for the individual questions after adjusting for confounding variables. All multivariable models included age, gender, race, asthma (Yes/No), allergic rhinitis (Yes/No), and atopic dermatitis (Yes/No) in addition to the primary variables of interest. Effects from a logistic regression model were presented as odds ratios (OR) and 95% confidence intervals (CI), while effects from a linear model were expressed as estimated mean differences and corresponding 95% confidence intervals. All tests conducted were two-sided, assuming a significance level of 5%. All statistical analysis was performed using the statistical software R Development Core Team and JMP Pro (Version 13, SAS® Institute Inc, Cary, NC, USA).²⁹ The forest plot of odds ratios was done using the *forestplot* package in R.³⁰

TABLE 1 Characteristics of the participants in the food allergy and non-food-allergic groups

Characteristic	N	Food allergy (n = 325)	No food allergy (n = 325)	Overall (N = 650)	P
Gender—n (%)					
Male	650	211 (64.9%)	192 (59.1%)	403 (62.0%)	0.13
Female		114 (35.1%)	133 (40.9%)	247 (38.0%)	
Age, mean (SD)	650	7.2 (4.4)	8.7 (4.4)	8.0 (4.5)	<0.001
Race—n (%)					
Caucasian	650	206 (63.4%)	180 (55.4%)	386 (59.4%)	0.06
African American		102 (31.4%)	131 (40.3%)	233 (35.9%)	
Other		17 (5.2%)	14 (4.3%)	31 (4.7%)	
BMI—mean (SD)	633	18.8 (4.8)	20.1 (5.1)	19.4 (4.9)	0.0004
Participation in WIC	640	66 (20.7%)	47 (14.6%)	113 (17.7%)	0.04
Participation in SNAP	644	77 (23.9%)	89 (27.6%)	166 (25.8%)	0.28
Atopic history					
Asthma	650	141 (43.4%)	221 (68.0%)	362 (55.7%)	<0.001
Allergic rhinitis	650	105 (32.3%)	141 (43.4%)	246 (37.9%)	0.004
Atopic dermatitis	650	149 (45.9%)	89 (27.4%)	238 (36.6%)	<0.001
Environmental allergy	650	136 (41.9%)	135 (41.5%)	271 (41.7%)	0.94
Number of foods avoiding	650	3.3 (2.6)	0 (0)	1.7 (2.5)	NA

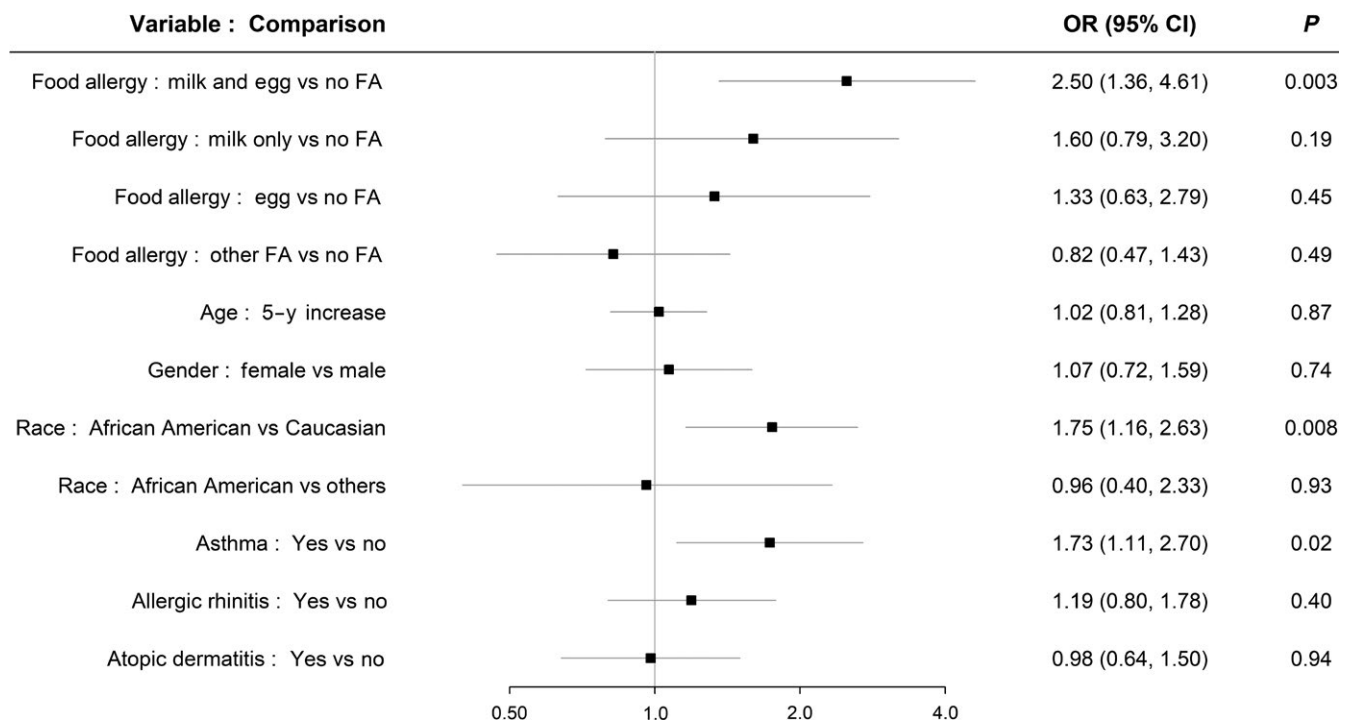


FIGURE 1 Odds ratios (OR) and 95% confidence intervals (CI) from logistic regression analysis showing the effect of different subgroups of food allergy (FA) on food insecurity rates after adjusting for other factors. Odds ratios >1 indicate increased risk of FI relative to the comparison group while odds ratios below 1 indicate lower risk of FI

3 | RESULTS

3.1 | Study population

The study population included 325 subjects in the food-allergic group and 325 subjects in the non-food-allergic group; 33 people refused participation in the study. Risk factors and outcomes were summarized and compared between the two groups (Table 1). The number of dietary restrictions was expectedly different between groups ($P < 0.001$). Younger age ($P < 0.001$) and differences in growth parameters were noted in the food-allergic group with significantly lower height ($P < 0.001$), weight ($P < 0.001$), weight Z-score ($P = 0.007$), BMI ($P = 0.001$), and BMI Z-score ($P = 0.02$). The most common atopic comorbidities included asthma, allergic rhinitis, and atopic dermatitis, with asthma ($P < 0.001$) and allergic rhinitis ($P = 0.005$) higher in the non-food-allergic group and atopic dermatitis ($P < 0.001$) higher in the food-allergic group.

3.2 | Food insecurity rates among children with food allergy compared to allergic children without food allergy

The overall rate of FI for the study population was 21.5% (140/650); the rate of very low FI was 6.8% (44/650). The incidence of FI (unadjusted) was not significantly different between the food-allergic (22.2%) and non-food-allergic groups (20.9%, $P = 0.70$). After adjusting for age, gender, race, asthma, allergic rhinitis, and atopic dermatitis, there was still no significant difference in the prevalence of FI

rates between groups (OR = 1.30; 95% CI 0.86-1.96; $P = 0.21$). A majority of study food allergy participants (184/325 or 57%) were allergic to milk and/or egg; the remaining 141 participants had other food allergies. When subgroup analysis was performed, the presence of milk and egg allergy was associated with increased FI (OR = 2.5; 95% CI 1.4-4.6; $P = 0.003$), whereas milk or egg allergy alone had no significant impact on FI rates (Figure 1). None of the other food allergens being avoided (soy, wheat, peanuts, tree nuts, fish, shellfish, sesame, beef, pork, chicken, turkey, oat, barley, rye, rice, potato, corn) were associated with FI when grouped as "other" foods due to low prevalence of individual allergens. Additionally, we did not find a significant difference in weight between the FI and FS groups; mean weight (SD) in the FI group was 35.3 (22.4) kg and 33.3 (20.5) kg in the FS group ($P = 0.35$).

African Americans had significantly higher FI rates when compared to Caucasians (OR = 1.75; 95% CI 1.16-2.63, $P = 0.008$; Figure 1). The FI rates were not significantly different between African Americans and other racial groups (OR = 0.96; 95% CI 0.40, 2.33). Participants with asthma had increased risk of FI (OR = 1.73; 95% CI 1.11-2.70, $P = 0.02$).

Participation in WIC was 27.2% in the FI group (37/136), while it was only 15.1% (76/504) in the FS group ($P = 0.001$). Similarly, participation in SNAP was 45.3% (62/137) in the FI group and only 20.5% (104/507) in the FS group ($P < 0.001$; data not shown). We further analyzed FI rates between food-allergic and non-food-allergic participants, after adjusting for WIC and SNAP, and there were no significant differences in FI rates ($P = 0.29$).

TABLE 2 Estimated means and 95% confidence intervals for various effects predicting mean health literacy in a linear regression model

Variable	Comparison	Difference (95% CI)	P
Food insecurity	Yes vs No	−0.31 (−0.59, −0.03)	0.03
Age	5 y older	0.06 (−0.07, 0.04)	0.36
Gender	Female vs Male	0.01 (−0.23, 0.24)	0.95
Food allergy	Yes vs No	0.12 (−0.12, 0.36)	0.33
Race			
Caucasian	Caucasian vs African American	1.57 (1.32, 1.82)	<0.001
Other	Other vs African American	0.68 (0.12, 1.23)	
Asthma	Yes vs No	−0.32 (−0.57, −0.07)	0.01
Allergic rhinitis	Yes vs No	0.14 (−0.09, 0.38)	0.24
Atopic dermatitis	Yes vs No	0.13 (0.12, 0.38)	0.31

Estimated mean and 95% CI are adjusted for no food allergy, food secure, age 7.3 y, male gender, Caucasian race, no asthma, no allergic rhinitis, and no atopic dermatitis.

3.3 | Health literacy among families with food insecurity

Mean HL rates were significantly higher in the FS group ($n = 510$) compared to the FI group ($n = 140$; mean difference = 0.31; 95% CI 0.03–0.59; $P = 0.03$; Table 2). However, HL rates were not significantly different between food-allergic and non-food-allergic groups ($P = 0.36$). HL rates were significantly associated with race ($P < 0.001$), with Caucasians demonstrating higher overall HL. Caucasians had on average 1.57 (95% CI 1.32–1.82) more correct responses compared to African Americans. Other racial groups had an average of 0.68 (95% CI 0.12–1.23) more correct responses when compared to African Americans. Additionally, Caucasians had on average 0.89 (95% CI 0.35–1.43) more correct responses when compared to other races. HL rates were significantly associated with asthma ($P = 0.01$), with non-asthma participants having higher HL rates than asthma participants (mean difference = 0.32, 95% CI 0.07–0.57).

3.4 | Quality of life among food-allergic children with food insecurity

Among food-allergic participants, overall QOL was 0.62 points better in the FS group than the FI group (95% CI 0.00–1.23; $P = 0.049$) after adjusting for age, gender, race, asthma, allergic rhinitis, and atopic dermatitis (Table 3). There was a significant association between race and mean QOL ($P = 0.003$). African American participants and families had lower QOL scores, indicating better QOL, when compared to both Caucasians (mean difference = 0.86; 95% CI 0.29–1.43) and other racial groups (mean difference = 1.55; 95% CI 0.39–2.72). When comparing individual QOL questions, FS participants with food allergy had significantly better scores than FI participants with food allergy on questions related to meal planning for the family ($P = 0.04$) and grocery shopping ($P = 0.01$).

TABLE 3 Quality of life of food allergy participants

Quality of life questions	Diff (95% CI)	P
Meal planning for my child	0.60 (−0.05, 1.25)	0.07
Meal planning for the family	0.71 (0.04, 1.38)	0.04
Grocery shopping	0.84 (0.17, 1.51)	0.01
Preparing meals for my child	0.59 (−0.10, 1.29)	0.09
Preparing meals for the family	0.50 (−0.19, 1.20)	0.15
Meals or snacks on the run	0.54 (−0.14, 1.21)	0.12
Overall QOL	0.62 (0.00, 1.23)	0.049

Estimated mean and 95% CI are adjusted for food secure, age, gender, race, asthma, allergic rhinitis, and atopic dermatitis. Lower QOL scores imply a better quality of life.

4 | DISCUSSION

We sought to examine the association of food allergy with FI in a population of allergic children in a tertiary care pediatric center. Food-allergic children face dietary limitations due to food-restricted diets, and food insecurity contributes further to potential nutritional inadequacies. Using the USDA Household Food Security Survey to identify FI, our data indicate that food allergy alone does not increase the risk of FI in a population of allergic children. However, families with children having combined milk and egg allergy had significantly more FI than those with only milk or egg allergy. The overall rate of FI in our tertiary care, subspecialty population was 21.5%, which is higher than the rate of food insecurity for the state of Arkansas (17.5%) and nation (12.3%) in the most recent USDA survey.⁷

Our data indicate that approximately one in five children from our center with food allergy have FI, rates higher than state averages,⁷ and those rates are increased more than twofold among families with children diagnosed with both milk and egg allergy. These results are important for clinicians who manage food-allergic patients. A family's ability to access safe, healthy, allergen-free alternatives in

the face of limited resources, and FI is an important consideration in dietary counseling, education, and management of food allergy.

In this study, FI was associated with lower HL, indicating a further barrier to assisting food-insecure children and families. Although there was not a significant association between food allergy and HL, both food-allergic and non-food-allergic participants with FI were found to have lower HL. This finding highlights the need for plain language educational materials and interventions for allergic patients, as well as improvements in allergen quantification in food manufacturing to better inform the allergic consumer and care providers about specific allergen content.⁴

Our results demonstrate that FI households with food-allergic children have more difficulty in day-to-day tasks (eg, grocery shopping, meal planning) and decreased QOL compared to FS families with food-allergic children. Interestingly, African American participants showed higher FI, lower HL, but better QOL among the food-allergic population. There may be other factors, such as social determinants of health, contributing to these findings among African Americans with food allergy in this study. The differences noted between African American and other races may also place African Americans at increased risk for health disparities or worse health outcomes.⁷ Findings further demonstrate the need for increased support for patients and families living with food allergy at risk for food insecurity, as well as an improved understanding of how food allergy impacts diverse populations.

There are potential limitations in this study. First, in this cross-sectional study in a single center, FI was measured only one time using the USDA Household Food Security Survey. While the survey asks participants to reflect over the past month in their household, there is still potential for recall bias and missed FI. Additionally, participation in WIC and SNAP programs may be filling a gap for FI for some participants leading to underestimation of FI in our study population. Further, FI may fluctuate over time due to personal economic drivers. A potential for response bias is also present, due to the sensitive nature of the information acquired with caregivers potentially altering answers and impacting FI rates. An important limitation of this study is the exclusion on non-English-speaking families due to limited interpreter resources. There is also a likely link between socioeconomic status, educational level, maternal income, and race, but this information was not collected in our study. We also did not include information about siblings (allergic or non-allergic) in the household which may also impact food insecurity. Finally, our relatively small subpopulation of milk- and egg-allergic children may provide sampling bias and highlight the need for larger populations to confirm the impact of combined milk and egg allergy on FI as reported. Specifically, our single-center study may not be widely generalizable but requires further investigation.

Future work should include standard implementation of validated food security screening tools,³¹ especially among allergy patients in a tertiary care referral center. The importance of educating families and children with food allergy is an integral component of treating food allergy, and those at risk for FI may warrant

additional education, instruction, and assistance in accessing resources. The potential for limited literacy among food-allergic populations should be considered when designing interventions. In a group of children that is already at risk for nutritional inadequacies and reduced quality of life, the potential impact of FI on the health and livelihood of patients with food allergy demands further attention.

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CONFLICT OF INTEREST

No conflicts are identified for any authors.

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