

Food Allergy & Anxiety: Lessons Learned from the 2021 National Health Interview Survey

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Research Questions

1. What is the prevalence of self-diagnosed childhood and adult food allergy (FA) in the US in 2021 using the National Health Interview Survey (NHIS), a population-based cross-sectional household interview survey?
2. Is self-diagnosed FA associated with anxiety, depression, and neurodivergent conditions in the 2021 NHIS? Which factors influence this association?

Hypotheses

1. Prevalence of self-reported FA is similar to recent prevalence rates from national surveys
2. FA is associated with anxiety, depression, and neurodivergent conditions
 - a. This association with anxiety and depression may be explained by bullying or by T2 pathways affecting the brain

Background

Food Allergy (FA) prevalence in 2015 – 2016

- US Children: 7.6% out of ~38,000 children (1)
- US Adults: 10.8% out of ~40,000 adults (2)

FA and Anxiety/Depression

- Self-diagnosed FA significantly associated with anxiety and depression after adjusting for age and sex

FA and Neurodivergent Conditions

- Self-diagnosed FA significantly associated with autism spectrum disorder and ADHD after adjusting for various potential confounders using NHIS 1997 – 2018

1. Gupta RS et al. Pediatrics. 2018

2. Gupta RS et al. JAMA Netw Open. 2019

Background - Why FA May Contribute to Anxiety

- Risk of an accidental ingestion and potential life-threatening reaction
- Constant need to carry medications and be vigilant in case of a reaction
- Parenting practices - overprotective and non-autonomy granting
- Potential avoidance of certain social activities
- Bullying
- T2 inflammation affecting the brain

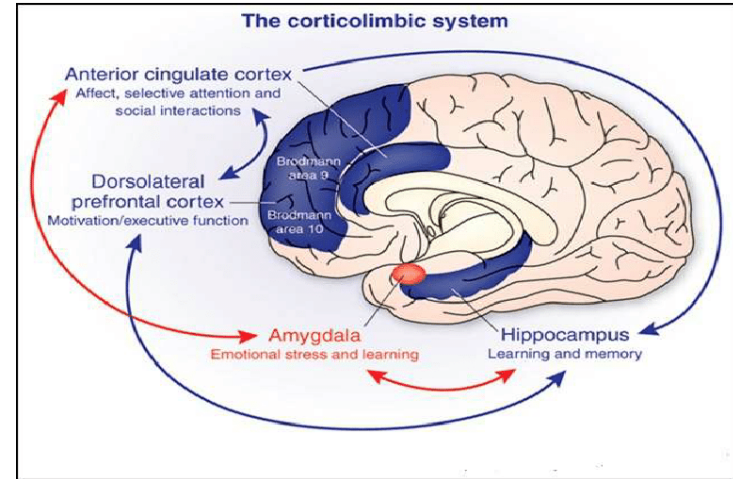
Background – Why FA May Contribute to Anxiety

FA and Bullying

- 20% - 35% of children and young adults reported FA related bullying (1-3)

T2 Inflammation and the Brain

- Murine models sensitized and exposed to allergen (4,5)
- Increased anxiety-like behavior and reduced social interaction
- TH2 cytokines and corticotropin-release hormone induced in olfactory bulbs and prefrontal cortex
- Enhanced neuronal activities and functional connectivity in anterior cingulate cortex and basolateral amygdala – correlated with level of anxiety



1. Brown D et al. Ann Allergy Asthma Immunol. 2021
2. Shemesh E et al. Pediatrics. 2013
3. Lieberman JA et al. Ann Allergy Asthma Immunol. 2010
4. Tonelli LH et al. Brain Behav Immun. 2009
5. Gholami-Mahtaj et al. Sci Rep. 2022

Background - National Health Interview Survey (NHIS)

- Cross-sectional household interview survey of US - 50 states and DC
- Monitor health of civilian noninstitutionalized population
- Yearly since 1957 - updated about every 15-20 years
- Face-to-face interview format with census workers
- Data collection continuous - Jan to Dec



NHIS

National Center for Health Statistics



Background - National Health Interview Survey (NHIS)

- Geographically clustered sampling of dwelling units
- Each month's sample is nationally representative
 - Weight samples to produce nationally representative estimates
- 30,000 adults and 9,000 children
- Last time food allergy questions in survey - 2018



SAMPLE CHILD QUESTIONNAIRE

Administered to a parent or guardian of one randomly selected child in each household

	2019	2020	2021	2022	2023	2024	2025	2026	2027
ANNUAL CORE	Health Status: Asthma, Diabetes, Developmental and learning disabilities, Social and emotional screening for very young children Functioning and Disability: Vision, Hearing, Mobility, Self-care, Communication and comprehension, Learning, Emotions, Behaviors Health Insurance: Coverage status, Sources of coverage, Characteristics of coverage, Continuity of coverage, Reasons for no health insurance Health Care Access and Use: Primary and urgent care, Financial barriers to care, Prescription medication, Flu immunization Demographics: Race and Hispanic origin of child, Marital status of parent(s), Activity, Schooling, Employment of family members, Family income, Food-related program participation, Housing, Telephone use								
ROTATING CORE	Service Utilization: Dental care, Mental health care, Other services		Allergies and Other Conditions	Service Utilization: Dental care, Mental health care, Other services		Allergies and Other Conditions	Service Utilization: Dental care, Mental health care, Other services		Allergies and Other Conditions
	Mental Health Assessment¹	Injuries		Mental Health Assessment¹	Injuries		Mental Health Assessment¹	Injuries	
	Stressful Life Events	Health-related Behaviors: Physical activity, Neighborhood characteristics, Sleep, Height and weight, Screen time	Stressful Life Events	Health-related Behaviors	Stressful Life Events	Health-related Behaviors: Physical activity, Neighborhood characteristics, Sleep, Height and weight, Screen time	Stressful Life Events	Health-related Behaviors: Physical activity, Neighborhood characteristics, Sleep, Height and weight, Screen time	Stressful Life Events
SPONSORED CONTENT	Sustaining sponsors* add content every year. Annual sponsored content includes household food security (USDA) and disorders of sensory systems and communication (NIDCD).								
	Other sponsors* add content for selected years. Sponsorships include asthma in 2020 (NCEH, NHLBI), additional stressful life events in 2021–2022 (NCIPC), life satisfaction in 2021–2022 (NCCDPHP and NIH/ODP), voice, swallowing, speech and language in 2022 (NIDCD), and complementary and integrative health in 2022 (NCCIH).								
EMERGING TOPICS	New topics of growing interest may be added by the National Center for Health Statistics, generally for one year. Emerging topics include coronavirus-related content in 2020 (July)–2022, telehealth in 2020 (July)–2022, concussions in 2020–2022, bullying in 2021–2022, and interaction with health care providers in 2021.								

* As of February 2022, sponsors include the United States Department of Agriculture (USDA), National Institute on Deafness and Other Communication Disorders (NIDCD), National Center for Environmental Health (NCEH), National Heart, Lung, and Blood Institute (NHLBI), National Center for Injury Prevention and Control (NCIPC), National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP), National Institutes of Health Office of Disease Prevention (NIH/ODP), and National Center for Complementary and Integrative Health (NCCIH). NCEH, NCIPC, and NCCDPHP are part of the Centers for Disease Control and Prevention. NIDCD, NHLBI, ODP, and NCCIH are part of the National Institutes of Health.

¹Questions come from the Strengths and Difficulties Questionnaire.

Background – Publication with 2021 NHIS and FA

Zablotsky et al. 2023. National Center for Health Statistics Data Brief

- Reported on percentage of children with a physician-diagnosed FA from 2021 NHIS survey and the varying rates based on race and ethnicity
- Did not evaluate for any associations or adjust for confounders

Methods - 2021 NHIS Survey Analysis

- Stata statistical software
 - Simple and multivariable logistic regression models were created using data from 2021 NHIS for children and adults
 - Sampling survey weights were used for all analyses

Methods - 2021 NHIS Survey Questions

2021 NHIS Self-Diagnosed FA:

- The next question is about food allergies. People with food allergies have reactions such as hives, vomiting, trouble breathing, or throat tightening that occur within two hours of eating a specific food. Do you have an allergy to one or more foods?

1997 – 2018 NHIS Self-Diagnosed FA:

- During the past 12 months, has sample child had any of the following conditions...Any kind of food/digestive allergy?

Self-Diagnosed FA Prevalence and Demographic Characteristics in US Children

- 8,245 US children sampled
- 684 had self-diagnosed FA – prevalence of **7.9%**
- Factors associated with a significantly lower rate of self-diagnosed FA:
 - Hispanic race and ethnicity
 - Age 0 – 2 years
- Factors associated with a significantly greater rate of self-diagnosed FA:
 - Non-Hispanic Black race and ethnicity
 - Age 14 – 17 years
 - Higher parental education levels
 - Comorbid atopic conditions

Self-Diagnosed FA Prevalence and Demographic Characteristics in US Adults

- 29,439 US adults sampled
- 2,950 had self-diagnosed FA – prevalence of **9.8%**
- Factors associated with a significantly lower rate of self-diagnosed FA:
 - Hispanic race and ethnicity
 - Male sex
 - Age \geq 60
 - Midwest region
- Factors associated with a significantly greater rate of self-diagnosed FA:
 - Non-Hispanic Black race and ethnicity
 - Female sex
 - Age 40-49 years
 - Higher education levels
 - Northeast region
 - Comorbid atopic conditions

Table 1: Association between Self-Diagnosed FA and Anxiety/Depression in US Children and Adults

Condition	Model 1^a OR (95% CI)	Model 2^b OR (95% CI)	Model 3^c OR (95% CI)
Children			
Anxiety	1.53 (1.22 – 1.92)*	1.41 (1.11 – 1.79)*	1.44 (1.01 – 2.04)*
Depression	1.47 (1.12 – 1.93)*	1.29 (0.97 – 1.74)	1.16 (0.79 – 1.70)
Adults			
Anxiety	1.66 (1.51 – 1.83)*	1.51 (1.37 – 1.68)*	–
Depression	1.63 (1.46 – 1.82)*	1.52 (1.36 – 1.70)*	–

^aModel 1: Univariate logistic regression (unadjusted)

^bModel 2: Multivariable logistic regression model adjusted for age, sex, race, ethnicity, income, education, geographic region, urban/rural classification, and neurodivergent conditions (children only)

^cModel 3: Multivariable logistic regression model adjusted for bullying and the variables in Model 2

* Two-sided p <0.05

Table 2: Association between Self-Diagnosed FA and Neurodivergent Conditions in US Children

Condition	Unadjusted OR (95% CI)	Adjusted ¹ OR (95% CI)
ADHD	1.44 (1.08 – 1.93)*	1.25 (0.90 – 1.74)
ASD	1.22 (0.78 – 1.92)	1.16 (0.71 – 1.87)
Learning Disability	1.37 (0.99 – 1.87)	1.27 (0.91 – 1.80)
Intellectual Disability	2.53 (1.52 – 4.22)*	2.41 (1.40 – 4.13)*
Other Development Delay	1.67 (1.19 – 2.33)*	1.66 (1.17 – 2.36)*
Overall	1.50 (1.19 – 1.89)*	1.44 (1.12 – 1.85)*

¹Adjusted: Multivariable logistic regression model adjusted for age, sex, race, ethnicity, income, education, geographic region, and urban/rural classification

* Two-sided p <0.05

Conclusions

- Prevalence of self-diagnosed FA in 2021 is similar to 5-6 years prior
- Significant association between FA and anxiety in children and adults after adjusting for various confounders (including bullying in children)
 - T2 inflammation an underlying mechanism?
- Other potential contributors to anxiety not addressed:
 - Risk of an accidental ingestion and potential life-threatening reaction
 - Constant need to carry medication and vigilance in case of a reaction
 - Parenting practices – overprotective and non-autonomy granting
 - Potential avoidance of certain social activities

Conclusions

- Depression is not associated with FA in children after adjusting for various confounders, but it is in adults
- Intellectual disability and other developmental delay are associated with self-diagnosed FA after adjusting for various confounders, but ASD and ADHD are not, unlike prior data from previous NHIS surveys

Strengths

- Large population-based cross-sectional household interview survey
- Robust sampling methods to get a diverse, nationally representative sample
- Thorough questions for self-diagnosed FA
- More current snapshot of self-diagnosed FA prevalence and associations between with anxiety, depression, and neurodivergent conditions
- Accounted for multiple confounders when evaluating associations

Limitations

- Cross-sectional survey study
- No biomarkers or physician documentation to confirm FA
- Did not investigate prevalence of specific FA or severity of FAs
- Many potential additional confounders

Discussion

- Anxiety in patients with chronic illness decreases quality of life, decreases adherence to treatments, leads to fewer positive health behaviors, and increases medical costs
- Anxiety & FA – combination of environmental, societal, and biologic mechanisms = biopsychosocial model for FA and anxiety
- By better understanding this model we can develop better treatment approaches to help reduce anxiety in patients with FAs
 - Food challenges and oral immunotherapy
 - Education in schools
 - FA psychologist/counselor
 - Omalizumab?

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