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Authors
Zheng, Siwen
Ngo, Amanda L
Forman, Michele R
et al.

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Associations of household food insufficiency with childhood depression and anxiety: a nationwide cross-sectional study in the USA

Siwen Zheng,[1] Amanda L Ngo,[2] Michele R Forman,[3] Anna L Barcellos,[1] Lauren Liao,[1] Assiamira Ferrara,[2] Yeyi Zhu [2,4]

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[1]School of Public Health, University of California Berkeley, Berkeley, California, USA
[2]Division of Research, Kaiser Permanente Northern California, Oakland, California, USA
[3]Department of Nutrition Science, Purdue University, West Lafayette, Indiana, USA
[4]Department of Epidemiology and Biostatistics, University of California San Francisco, San Francisco, California, USA

Correspondence to
Dr Yeyi Zhu; Yeyi.Zhu@kp.org

ABSTRACT

Objective Household food insufficiency (HFIS) is a major public health threat to children. Children may be particularly vulnerable to HFIS as a psychological stressor due to their rapid growth and accelerated behavioural and cognitive states, whereas data focusing on HFIS and childhood mental disorders are as-yet sparse. We aimed to examine the associations of HFIS with depression and anxiety in US children.

Design Cross-sectional study.

Setting The 2016–2018 National Survey of Children's Health, a nationally-representative study.

Participants Primary caregivers of 102 341 children in the USA.

Primary and secondary outcome measures Physician diagnosed depression and anxiety were assessed by questionnaires administered to primary caregivers of 102 341 children. Multivariable logistic regression models estimated adjusted OR (aOR) for current depression or anxiety associated with HFIS measured through a validated single-item instrument.

Results Among children aged 3–17 years, 3.2% and 7.4% had parent-reported physician-diagnosed current depression and anxiety, respectively. Compared with children without HFIS, children with HFIS had approximately twofold higher weighted prevalence of anxiety or depression. After adjusting for covariates, children with versus without HFIS had a 1.53-fold (95% CI 1.15 to 2.03) and 1.48-fold (95% CI 1.20 to 1.82) increased odds of current depression and anxiety, respectively. Associations were slightly more pronounced among girls (aOR (95% CI): depression 1.69 (1.16 to 2.48); anxiety 1.78 (1.33 to 2.38)) than boys (1.42 (0.98 to 2.08); 1.32 (1.00 to 1.73); both P-for-interaction <0.01). The associations did not vary by children's age or race/ethnicity.

Conclusions HFIS was independently associated with depression and anxiety among US children. Girls presented slightly greater vulnerability to HFIS in terms of impaired mental health. Children identified as food-insufficient may warrant mental health assessment and possible intervention. Assessment of HFIS among children with impaired mental health is also warranted. Our findings also highlight the importance of promptly addressing HFIS with referral to appropriate resources and inform its potential to alleviate childhood mental health issues.

Strengths and limitations of this study

- Our study is among the first large-scale investigation of household food insufficiency and childhood depression or anxiety using a contemporary nationwide, multiracial/multiethnic sample of children aged 3–17 years in the USA.
- The National Survey of Children's Health sampling weights allow us to account for complex survey design and potential non-response bias.
- Our study includes robust data on a comprehensive set of covariates to minimise potential residual confounding.
- Our study was based on a cross-sectional nationwide survey, without the ability to differentiate antecedents from endpoints and thereby infer causality between household food insufficiency and childhood depression or anxiety.

INTRODUCTION

Household food insecurity, defined as limited access or availability to nutritionally adequate food, is a major public health burden to children. In 2018, 15.2% (11.2 million) of US children lived in food-insecure households.[1] Mental disorders are another critical threat to children and are the leading condition for healthcare expenditure in children, totalling $13.9 billion for treatment of mental disorders in US children in 2012.[2] In the past decade, there has been an upward trend in the prevalence of depression and anxiety especially in adolescents.[3–5] Indeed, childhood depression and anxiety are of particular public health concern due to the adverse and long-lasting impact by interfering with children's cognitive, emotional and social development, which may even lead to substance abuse and suicide.[6–8] Finally, children may be particularly vulnerable to food insecurity as a psychosocial stressor during this dynamic life stage of rapid growth and development.

Previous research has primarily focused on the impact of household food insecurity on child physical health,[9–11] with relatively fewer data on cognitive development.[12] Prior studies have linked household food insecurity to an array of childhood cognitive development issues ranging from poor school performance to suicide ideation,[13–20] with limited data on depression or anxiety as primary mental disorder outcomes.[17–20] Importantly, inferences from these studies have been largely hampered by restricted geographical and racial/ethnic variations, inconsistent definitions of mental health status and residual confounding due to missing covariates including child's health insurance, household factors and parental mental health. Contemporary data on food insecurity in relation to depression or anxiety among children of diverse geographical and racial/ethnic groups with comprehensive assessment of important risk factors in the US are lacking.

Further, more women than men were susceptible to food insecurity related depression and anxiety due in part to sex differences in biological, cultural and experiential factors,[21 22] whereas sex-specific associations of food insecurity with depression and anxiety among children remain elusive. Moreover, given the previously reported age and racial/ethnic differences in risk of childhood depression and anxiety[23–25] and that food insecurity tends to disproportionally impact more racial/ethnic minorities,[26 27] examination of potential effect modification by child's age and race/ethnicity may inform risk-based preventive or intervention strategies.

The ongoing coronavirus disease 2019 (COVID-19) pandemic has the potential of posing a dual-threat of increased food insecurity and depression or anxiety in children. Since the pandemic, the number of children who experience household food insecurity has rapidly increased, with an unprecedented 18 million in 2020.[28] Simultaneously, depression and anxiety rates have increased among various populations including children.[29–31] Therefore, investigation of the association of food insecurity with childhood depression and anxiety is warranted to determine whether there is an association and if so, to inform timely preventive and intervention efforts to mitigate children's psychosocial stress.

While household food insecurity indicates limited access or availability to nutritionally adequate food, household food insufficiency (HFIS) suggests an inadequate amount of food intake due to a lack of money or resources.[32] The latter has been used as a synonym for hunger and is a more severe form of the former, which has been understudied.[33] Therefore, to address the above-mentioned gaps in the literature, in a nationally representative sample of children aged 3–17 years in the US, we examined these association of HFIS with current depression and anxiety and examined whether these associations may vary by children's age, sex or race/ethnicity.

METHODS

Study sample and design

Data were drawn from the 2016–2018 National Survey of Children's Health (NSCH), a nationally representative, parent/caregiver-completed cross-sectional survey among US children under 18 years old. Detailed methodology of the survey was previously described elsewhere.[34 35] In brief, households were selected based on child-presence flags provided by the Census Master Address File, with 60% addresses from Stratum 1 (flagged as households with children) and 40% from Stratum 2a (not flagged but has a higher probability of child presence than Stratum 2b), in order to improve sampling efficiency.[36] The selected households were contacted by mail to identify those with at least one child under 18 years old, among whom one child was randomly selected per household for parental/caregiver's response to the survey.[37] The household adult who was most familiar with the child's health status completed the survey via web or paper in English or Spanish. In total, 102 341 responses were collected in 2016–2018, of which 50 212, 21 599 and 30 530 were completed in these 3 years, respectively.

Among 102 341 children, we first excluded children less than 3 years old given the low prevalence of infant depression and anxiety (n=13 829). We further excluded children with missing or invalid data on HFIS (n=1694) or parent-reported physician-diagnosed outcomes of interest (n=391 for depression and n=526 for anxiety). The final analytical sample comprised 86 427 children for depression and 86 292 children for anxiety (see study flowchart in figure 1). Children in the analytical sample, compared with those excluded due to missing or invalid data on HFIS and depression or anxiety, did not differ by sex but were slightly more likely to be non-Hispanic white, enrol in private health insurance, have less severe household poverty status, live in a family with two married parents and have a parent/caregiver with good mental/emotional health status (online supplemental table 1).

HFIS measurement

The 2016–2018 NSCH employed a single-item instrument to assess HFIS as used previously.[38–40] The primary caregiver was asked, 'Which of these statements best describes the food situation in your household IN THE PAST 12 MONTHS?', with four choices: '1=We could always afford to eat good nutritious meals; 2=We could always afford enough to eat but not always the kinds of food we should eat; 3=Sometimes; and 4=Often we could not afford enough to eat'. A positive answer to 3 or 4 was deemed HFIS as done previously.[41] Single-item instrument for HFIS have been previously validated and used as a proxy for household food insecurity in the National Health and Nutrition Examination Survey.[42–44]

Outcome measure

The respondents were asked, 'Has a doctor or other health care provider EVER told you that this child has depression or anxiety problems?', 'If yes, does this child

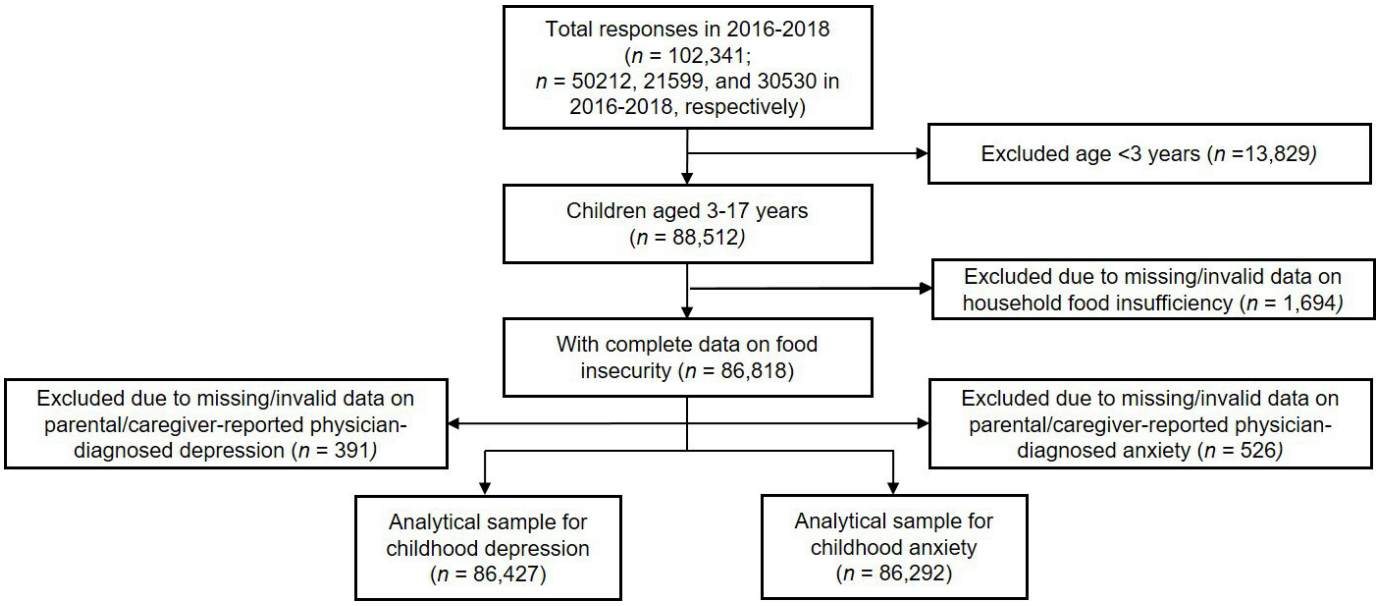

Figure 1 Study flowchart with unweighted survey sample sizes for children aged 3–17 years, National Survey of Children's Health, 2016–2018.

CURRENTLY have the condition?'. The child was considered to have physician diagnosis of current depression or anxiety if the respondent reported 'Yes' to both the first and second questions and have no current depression or anxiety if the respondent reported 'No' to the second question.

Covariates

Potential covariates were selected based on biological plausibility, prior knowledge and statistical considerations, including: child's age (3–5, 6–11, 12–17 years), sex (boys, girls), race/ethnicity (Hispanic, non-Hispanic white, non-Hispanic black, other), health insurance type (any public, private only, missing/uninsured), household poverty status (0–99, 100–199, 200–399, ≥400 per cent of federal poverty level, an economic measure used to decide whether a household would be eligible to receive welfare benefits,[45] with a lower percentage meaning more likely to live in poverty), family structure (two parents, married; two parents, unmarried; single parent or other (ie, grandparent or other relation)), parental/primary caregiver's mental/emotional health status (fair or poor, good, very good or excellent), and geographical region (Midwest, Northeast, South, West). Further, given the potential role of obesity in childhood depression and anxiety,[46] we additionally adjusted for child's body mass index (BMI) in a secondary analysis. Data on BMI were only available among children aged 10–17 years in the NSCH given the reasonably high classification rate (97.5%) of obesity status based on parent-reported weight and height among older school-aged children but not preschool or elementary school-aged children.[47 48] A covariate was included in the final model if the coefficient of exposure of interest changes by 10% or more.[49]

Statistical analysis

The NSCH sampling weights were applied to all analyses, accounting for the complex survey design and potential non-response bias.[50] The sampling weights were developed from base sampling weights which were the inverse of the probability of the selection of the address, and further adjusted for non-response, within-household subsampling factors.[51] Unweighted number and weighted prevalence of current depression or anxiety were calculated. The Rao-Scott χ^2 test was used to obtain p values for group comparisons of categorical variables.[52]

Univariable and multivariable logistic regressions assessed the associations of HFIS with parent-reported physician diagnosis of childhood depression or anxiety, respectively. Of note, two multivariable logistic regression models (Models 1 and 2) were performed, one adjusting for child's and household covariates, and the other additionally adjusting for parental or primary caregiver's mental and emotional health status. This was based on the fact that many previous studies did not adjust for or have data on parental or primary caregiver's mental and emotional health status and we would like to examine how this covariate could potentially affect the associations of HFIS with parent-reported physician diagnosis of childhood depression or anxiety. Given the relatively low prevalence of depression or anxiety in children aged 3–5 years, we conducted a sensitivity analysis restricted to children aged 6–17 years. Given the potential role of child's obesity in risk of depression and anxiety,[46 53–56] we performed another sensitivity analysis additionally adjusting for child's BMI among children aged 10–17 years to test the robustness of findings. Notably, child's BMI data were only available among this elder age group in the NSCH. Further, due to the potentially bi-directional association between childhood obesity and mental

disorders and the cross-sectional nature of this study, we acknowledge that this is simply an exploratory analysis.

Further, we tested for an interaction between HFIS and child's sex, age and race/ethnicity by including a cross product term and conducted stratified analysis by these factors, respectively. The P-for-interaction was calculated using the likelihood ratio test. All analyses were performed using SAS V.9.4 (SAS Institute) and the statistically significant level was set at a two-tailed value <0.05.

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination of this research.

RESULTS

Among US children aged 3–17 years from the 2016–2018 NSCH, 3.2% (weighted estimate 1.9 million) and 7.4% (4.4 million) had parent-reported physician-diagnosed current depression and anxiety, respectively (table 1). The weighted prevalence of depression was 8.2% in children exposed to HFIS versus 2.9% in children non-exposed to HFIS (p<0.001). The weighted prevalence of anxiety was 13.9% in children exposed to HFIS versus 7.0% in children non-exposed to HFIS (p<0.001). Overall, the weighted prevalence of depression was higher among children who were: aged ≥12 years, girls, non-Hispanic black and non-Hispanic white, in single-parent households or households with other than two parents, in poverty, enrolled in public insurance, with a parent or primary caregiver that had impaired mental and emotional health (all p<0.001); and those resided in the Midwest of USA (both p<0.005). The weighted prevalence of anxiety was higher among children who were: aged ≥12 years, non-Hispanic white, in single-parent households or households with other than two parents, enrolled in public insurance, with a parent or primary caregiver that had impaired mental and emotional health, resided in the Midwest of USA (all p<0.001); and girls (p<0.05).

After adjustment for child's and household covariates, children exposed to HFIS compared with food-sufficient counterparts had a 2.12-fold (95% CI 1.63 to 2.75) and 2.01-fold (95% CI 1.64 to 2.46) higher odds of depression and anxiety, respectively (Model 1, table 2). After additional adjusting for parental or primary caregiver's mental and emotional health status, the associations were attenuated but remained significant; HFIS was associated with a 1.53-fold (95% CI 1.15 to 2.03) and 1.48-fold (95% CI 1.20 to 1.82) higher odds of depression and anxiety, respectively (Model 2, table 2). To test the robustness of findings, we conducted a sensitivity analysis excluding younger children aged 3–5 years who only contributed to 0.6% of depression and 3.4% of anxiety cases to the analytical sample; results were materially unchanged (online supplemental table 2). In another sensitivity analysis among children aged 10–17 years who had data available on BMI, results were slightly attenuated but remained significant between HFIS and childhood depression (adjusted OR (aOR): 1.44; 95% CI 1.09 to 1.91) and anxiety (aOR: 1.38; 95% CI 1.09 to 1.76; online supplemental table 3), after additionally adjusting for child's obesity status.

Sex differences in the association of HFIS with childhood depression or anxiety appeared, with positive associations among girls (aOR (95% CI): depression 1.69 (1.16 to 2.48); anxiety 1.78 (1.33 to 2.38)) but not boys (1.42 (0.98 to 2.08); 1.32 (1.00 to 1.73); both P-for-interaction <0.01; figure 2). In age-stratified analysis, the association of HFIS with childhood depression did not vary between children aged 3–11 years (aOR 1.78; 95% CI 1.02 to 3.11) compared with those aged 12–17 years (aOR 1.47; 95% CI 1.09 to 1.98; P-for-interaction >0.15). The association of HFIS with childhood anxiety were similar between children aged 3–11 years (aOR 1.53; 95% CI 1.13 to 2.06) and 12–17 years (aOR 1.56; 95% Ci 1.19 to 2.02; P-for-interaction >0.15; online supplemental table 4). No racial/ethnic differences were observed in the associations of HFIS with depression or anxiety (P-for-interaction >0.15; data not shown).

DISCUSSION

In this analysis of the 2016–2018 NSCH data, HFIS was independently associated with parent-reported physician-diagnosed current depression and anxiety among children aged 3–17 years in the USA, even after adjusting for important covariates. Sex-specific analysis provides suggestive evidence that girls compared with boys exhibited slightly greater vulnerability to adverse mental health issues (ie, depression and anxiety) associated with HFIS. With the American Academy of Pediatrics recommendation for routine screening for HFIS in primary care settings,[57] our findings suggest that children identified with HFIS may warrant monitoring and evaluation of mental health and possible intervention. On the other hand, children with anxiety or depression may warrant screening for HFIS to better understand the potential underpinnings to their impaired mental health.

We found that HFIS was positively associated with odds of depression and anxiety among children aged 3–17 in the USA, after adjusting for covariates. Our findings of positive associations between HFIS and childhood depression and anxiety were consistent with some[13–17 19 20] but not all[18] of previous studies on HFIS and child mental health outcomes. Several cross-sectional, prospective cohort and case–control studies in the USA and Canada echoed that HFIS was positively associated with childhood mental health problems including psychosocial function, conduct problems, hyperactivity and aggression,[13–17 20] but few studies focused on childhood depression or anxiety.[17–20] In a prospective Canadian cohort study, children from food-insecure families were more likely to experience depression or anxiety and hyperactivity or inattention;[18] however, after controlling for covariates including immigrant status and parental depression, HFIS only remained to be associated with hyperactivity

Table 1 Unweighted number and weighted prevalence of depression and anxiety among US children aged 3–17 years, National Survey of Children's Health (2016–2018)

Characteristic	Depression (n=82 372)*				Anxiety (n=82 239)*			
	Unweighted No., all	Unweighted No., depression	Weighted % (95% CI) of depression†	P value‡	Unweighted No., all	Unweighted No., anxiety	Weighted % (95% CI) of anxiety†	P value‡
Overall	86 427	3591	3.2 (3.0 to 3.4)		86 292	8116	7.4 (7.1 to 7.7)	
Household food insufficiency				<0.001				<0.001
No	82 819	3166	2.9 (2.7 to 3.1)		82 686	7415	7.0 (6.7 to 7.3)	
Yes	3608	425	8.2 (6.7 to 9.8)		3606	701	13.9 (11.8 to 16.0)	
Child's age, year				<0.001				<0.001
3–5	15 057	22	0.2 (0.0 to 0.3)		15 059	267	1.7 (1.4 to 2.1)	
6–11	30 216	577	1.8 (1.5 to 2.1)		30 174	2481	6.9 (6.3 to 7.5)	
12–17	41 154	2992	6.2 (5.8 to 6.7)		41 059	5368	10.6 (10.1 to 11.2)	
Child's sex				0.005				0.044
Boys	44 579	1570	2.9 (2.6 to 3.2)		44 523	3824	7.1 (6.6 to 7.5)	
Girls	41 848	2021	3.6 (3.2 to 3.9)		41 769	4292	7.8 (7.3 to 8.3)	
Child's race/ethnicity				<0.001				<0.001
Non-Hispanic white	60 347	2604	3.7 (3.4 to 4.0)		60 223	6264	9.3 (8.9 to 9.8)	
Hispanic	9753	384	2.3 (1.8 to 2.7)		9746	797	5.6 (4.8 to 6.5)	
Non-Hispanic black	5304	227	3.8 (3.0 to 4.6)		5304	315	5.0 (4.1 to 5.8)	
Other	11 023	376	2.8 (2.2 to 3.4)		11 019	740	5.4 (4.6 to 6.2)	
Geographical region				<0.01				<0.001
Northeast	15 821	629	3.1 (2.5 to 3.7)		15 788	1743	7.8 (7.1 to 8.6)	
Midwest	21 552	967	4.1 (3.6 to 4.5)		21 511	2050	8.8 (8.1 to 9.4)	
South	27 328	1081	3.2 (2.9 to 3.6)		27 291	2425	7.2 (6.6 to 7.8)	
West	21 726	914	2.7 (2.2 to 3.1)		21 702	1898	6.3 (5.6 to 7.0)	
Child's health insurance				<0.001				<0.001
Any public	19 507	1450	5.0 (4.4 to 5.5)		19 462	2688	9.1 (8.3 to 9.8)	
Private only	62 865	1980	2.3 (2.1 to 2.5)		62 777	5113	6.6 (6.3 to 7.0)	
Missing/uninsured	4055	161	2.6 (1.8 to 3.3)		4053	315	6.0 (4.6 to 7.5)	
Household poverty status, % of federal poverty level				<0.001				0.088
0–99	7647	530	4.8 (4.1 to 5.6)		7634	903	7.5 (6.6 to 8.5)	
100–199	14 236	774	3.5 (3.0 to 3.9)		14 217	1483	7.3 (6.6 to 8.1)	
200–399	31 372	1169	2.6 (2.3 to 2.9)		31 321	2801	7.3 (6.8 to 7.9)	
≥400	33 172	1118	2.8 (2.4 to 3.1)		33 120	2929	7.5 (7.0 to 8.0)	

Continued

Table 1 Continued

Characteristic	Depression (n=82 372)*				Anxiety (n=82 239)*			
	Unweighted No., all	Unweighted No., depression	Weighted % (95% CI) of depression†	P value‡	Unweighted No., all	Unweighted No., anxiety	Weighted % (95% CI) of anxiety†	P value‡
Family structure				<0.001				<0.001
Two parents, married	62 086	1965	2.3 (2.1 to 2.6)		61 977	5150	6.7 (6.3 to 7.1)	
Two parents, unmarried	5341	261	4.1 (3.0 to 5.2)		5340	514	7.7 (6.2 to 9.1)	
Single or other	17 087	1346	5.3 (4.8 to 5.9)		18 406	2410	9.3 (8.6 to 10.1)	
Parental/primary caregiver's mental and emotional health status				<0.001				<0.001
Fair or poor	3564	588	12.0 (10.1 to 13.9)		3555	936	21.8 (18.9 to 24.7)	
Good	14 908	1164	6.4 (5.6 to 7.2)		14 865	2344	12.4 (11.4 to 13.5)	
Excellent or very good	67 033	1811	2.0 (1.8 to 2.2)		66 948	4759	5.4 (5.1 to 5.7)	

*The sample sizes for the analytical data set for depression (n=82 372) and anxiety (n=82 239) were slightly different due to different levels of missing data in depression and anxiety.
†All percentages were calculated with weighted data to reflect the national representative prevalence in the target US population.
‡Obtained by Rao-Scott X^2 test.

or inattention but not depression or anxiety.[18] Of note, inferences from these studies have been largely limited by restricted geographical and racial/ethnic variation, measurement of composite mental health outcomes including depression or anxiety but not focusing on these two conditions separately, and residual confounding due to missing data on covariates (eg, child's health insurance and parental mental and emotional health status). Our findings extend the literature by providing contemporary, racially/ethnically and socioeconomically diverse data on HFIS in relation to parent-reported physician-diagnosed current depression and anxiety among US children at a national level.

The mechanisms underlying the association between HFIS and childhood depression or anxiety remain to be elucidated. An experimental study in non-human primates revealed that nursing mothers exposed to unpredictable access to food had impaired interaction with their offspring, thus leading to a sense of insecurity characterised by anxiety and depression symptoms in their offspring.[15] In human studies, children living in food-insecure/insufficient households may be conscious of the unstable food supply and even have to manage and allocate food resources.[38] The experience of HFIS could be inherently destabilising and emotionally taxing for children, which could in turn develop into a toxic stress and escalate into mental health difficulties.[38] Further, psychosocial stressors including HFIS early in life can influence mental health status by altering brain neurochemistry and morphology through brain neural circuits involving corticotropin-releasing factor, which has been hypothesised as a distinct biological subtype of adult depression.[15] Moreover, living in a food-insecure/insufficient household may lead to nutritional deprivation in children,[58–60] while nutrient deficiencies and poor dietary quality can potentially impair children's mental health.[58 59 61] Also importantly, psychosocial beyond biological factors such as parental mental health, parenting practices and bonding, social isolation, immigration status, inadequate child-care arrangements and lack of social support for the children may play important roles in the association between HFIS and childhood mental health.[62]

We observed significant sex differences, with associations between HFIS and current depression or anxiety being slightly more pronounced among girls compared with boys. Although the mechanisms underlying the sex-specific HFIS-depression association in children remain elusive, previous research in adults has illustrated plausible explanations. Biologically, compared with men, women are subject to greater fluctuations in reproductive hormones across lifespan,[21 22] and the changes in the hormones can alter brain structure and function and disproportionally induce anxiety and depression in women.[21] Notably, these previous data are limited to adults and data on children are scant. Future investigations into the exact mechanisms underlying the sex disparities in the association of HFIS with childhood depression and anxiety are warranted.

Table 2 Crude and adjusted OR (95% CI) of depression and anxiety by household food insufficiency and other risk factors among US children aged 3–17 years, National Survey of Children's Health (2016–2018)

	Depression (n=82 372)			Anxiety (n=82 239)		
	Crude	Model 1*	Model 2†	Crude	Model 1*	Model 2†
Household food insufficiency						
No	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Yes	2.99 (2.41 to 3.71)	2.15 (1.68 to 2.75)	1.56 (1.19 to 2.04)	2.15 (1.80 to 2.57)	2.08 (1.71 to 2.53)	1.53 (1.25 to 1.87)
Child's age, year						
3–5	0.02 (0.01 to 0.05)	0.02 (0.01 to 0.05)	0.02 (0.01 to 0.05)	0.15 (0.12 to 0.18)	0.14 (0.12 to 0.18)	0.14 (0.11 to 0.18)
6–11	0.27 (0.23 to 0.33)	0.27 (0.22 to 0.32)	0.26 (0.22 to 0.32)	0.62 (0.56 to 0.69)	0.62 (0.56 to 0.69)	0.61 (0.55 to 0.68)
12–17	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Child's sex						
Boys	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Girls	1.23 (1.06 to 1.41)	1.24 (1.07 to 1.44)	1.22 (1.05 to 1.42)	1.10 (1.00 to 1.22)	1.12 (1.01 to 1.24)	1.11 (1.01 to 1.23)
Child's race/ethnicity						
Non-Hispanic white	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Hispanic	0.61 (0.49 to 0.76)	0.47 (0.37 to 0.59)	0.50 (0.40 to 0.62)	0.58 (0.49 to 0.68)	0.52 (0.44 to 0.61)	0.54 (0.46 to 0.64)
Non-Hispanic black	1.04 (0.82 to 1.31)	0.58 (0.45 to 0.76)	0.60 (0.46 to 0.78)	0.51 (0.42 to 0.61)	0.37 (0.30 to 0.45)	0.37 (0.30 to 0.45)
Other	0.75 (0.59 to 0.95)	0.71 (0.56 to 0.92)	0.70 (0.54 to 0.90)	0.56 (0.48 to 0.66)	0.55 (0.47 to 0.64)	0.53 (0.45 to 0.62)
Geographical region						
Northeast	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Midwest	1.33 (1.06 to 1.66)	1.20 (0.96 to 1.51)	1.18 (0.93 to 1.48)	1.13 (0.99 to 1.29)	1.06 (0.93 to 1.21)	1.03 (0.90 to 1.18)
South	1.05 (0.84 to 1.31)	0.98 (0.78 to 1.25)	0.99 (0.78 to 1.26)	0.91 (0.80 to 1.05)	0.94 (0.82 to 1.08)	0.94 (0.82 to 1.09)
West	0.86 (0.67 to 1.10)	0.95 (0.74 to 1.24)	0.96 (0.74 to 1.24)	0.79 (0.67 to 0.92)	0.85 (0.73 to 1.00)	0.84 (0.71 to 0.99)
Child's health insurance						
Any public	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Private only	0.45 (0.39 to 0.52)	0.43 (0.35 to 0.51)	0.45 (0.37 to 0.54)	0.71 (0.64 to 0.79)	0.54 (0.47 to 0.62)	0.56 (0.48 to 0.64)
Missing/uninsured	0.50 (0.36 to 0.69)	0.49 (0.35 to 0.69)	0.50 (0.36 to 0.71)	0.65 (0.49 to 0.84)	0.59 (0.45 to 0.78)	0.60 (0.46 to 0.79)
Household poverty status, % of federal poverty level						
0–99	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
100–199	0.70 (0.57 to 0.88)	0.85 (0.68 to 1.07)	0.93 (0.74 to 1.18)	0.97 (0.81 to 1.15)	1.08 (0.89 to 1.30)	1.17 (0.96 to 1.41)
200–399	0.53 (0.43 to 0.65)	0.91 (0.73 to 1.15)	1.05 (0.83 to 1.33)	0.97 (0.83 to 1.14)	1.34 (1.10 to 1.63)	1.52 (1.24 to 1.87)
≥400	0.56 (0.45 to 0.69)	1.17 (0.90 to 1.53)	1.44 (1.10 to 1.89)	0.99 (0.85 to 1.16)	1.50 (1.22 to 1.85)	1.81 (1.46 to 2.24)
Family structure						

Continued

Table 2 Continued

	Depression (n=82 372)			Anxiety (n=82 239)		
	Crude	Model 1*	Model 2†	Crude	Model 1*	Model 2†
Two parents, married	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Two parents, unmarried	1.77 (1.32 to 2.37)	1.63 (1.21 to 2.19)	1.41 (1.05 to 1.89)	1.16 (0.94 to 1.42)	1.21 (0.97 to 1.50)	1.07 (0.87 to 1.33)
Single or other	2.35 (2.03 to 2.72)	1.76 (1.47 to 2.09)	1.55 (1.30 to 1.85)	1.44 (1.30 to 1.60)	1.40 (1.24 to 1.58)	1.26 (1.11 to 1.43)
Parental/primary caregiver's mental and emotional health status						
Fair or poor	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Good	0.50 (0.40 to 0.62)		0.59 (0.46 to 0.75)	0.51 (0.42 to 0.62)		0.50 (0.41 to 0.62)
Excellent or very good	0.15 (0.12 to 0.18)		0.20 (0.16 to 0.25)	0.20 (0.17 to 0.24)		0.21 (0.17 to 0.26)

*Adjusted for all other variables listed under Model 1.
†Adjusted for all other variables listed under Model 2 (ie, those in Model 1 and parental/primary caregiver's mental and emotional health status).

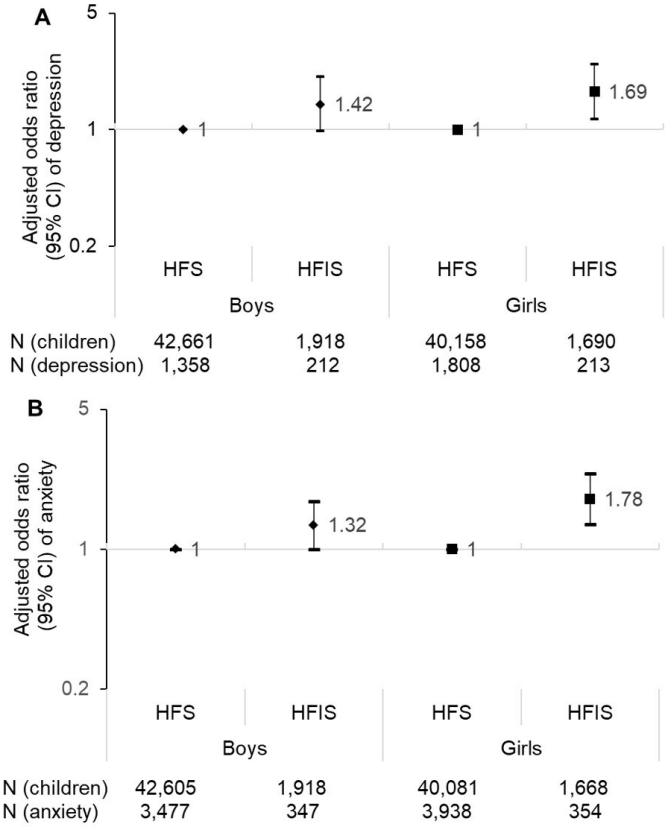

Figure 2 Sex-specific adjusted OR (95% CI) of depression (A) and anxiety (B) in association with household food insufficiency among US children aged 3–17 years, National Survey of Children's Health (2016–2018)*. *Adjusted for child's age, sex, race/ethnicity, geographical region, health insurance type, household poverty status, family structure and parental/primary caregiver's mental and emotional health status. HFS, household food sufficiency; HFIS, household food insufficiency.

Further, given that childhood obesity may contribute to elevated social stigma, peer problems and poor self-perception and thus lead to depression or anxiety,[63 64] we examined associations of HFIS with childhood depression and anxiety with further adjustment for child's obesity and found slightly attenuated but robust findings. However, due to the potentially bi-directional associations between childhood obesity and mental disorders[64 65] and the cross-sectional nature of this study, we acknowledge this is an exploratory analysis. Future prospective studies with capacities to establish temporal sequence are needed.

Strengths and limitations

Our study has some notable strengths. To the best of our knowledge, our study is among the first large-scale investigation of HFIS and childhood depression/anxiety using a contemporary nationwide, multiracial/multiethnic sample of children aged 3–17 years in the USA. In addition, the NSCH sampling weights allow us to account for complex survey design and potential non-response bias.[50] Further, our study includes robust data on a comprehensive set of covariates to minimise

potential residual confounding. In particular, parents and children may have shared patterns of and predisposition to mental health issues,[66 67] whereas limited previous studies accounted for parental mental health status. Our study served to address this issue and fill in the gap in the literature.

Our study has some limitations. The determination of childhood depression or anxiety status was based on parental report of physician diagnosis, which may be subject to potential recall and report bias. However, previous data suggest significant convergent and discriminant validity of parent-reported childhood depression and anxiety with child-report, teacher-report and peer-report measures.[68] Further, the weighted prevalence estimates of current depression (3.2%) and anxiety (7.4%) in this study were similar to the national prevalence (depression: 3.2% and anxiety: 7.1%) among children aged 3–17 years,[69] supporting the potential external validity of the outcome. Additionally, our study used a single-item indicator for HFIS measurement, not the 18-item United States Department of Agriculture (USDA) Core Food Security Module. However, single-item indicators of HFIS have been validated and widely used as proxies for HFIS.[42–44] Our study was based on a cross-sectional NSCH survey, without the ability to differentiate antecedents from endpoints and thereby infer causality between HFIS and childhood depression or anxiety, or rule out the possibility of reverse causation.[41] Nonetheless, we tried to reduce the potential impact of reverse causation by adjusting for parental or primary caregiver's mental and emotional health status because children and their parents may have shared predisposition to mental dysfunctions and parental mental issues may impair their ability to ensure HFIS. Our analytical samples (n=86 427 for depression and n=86 292 for anxiety) were drawn from the nationally representative NSCH study; however, those children who were excluded (n=2085 or n=2220) were slightly more likely to be non-Hispanic black, single-parented, uninsured, have lower socioeconomic status and have parent/caregiver with impaired mental/emotional health, which may have either underestimated or overestimated the true effect sizes.

In conclusion, we report positive associations of HFIS with parent-reported physician diagnosis of current depression and anxiety among US children aged 3–17 years, independent of multiple covariates. Girls compared with boys exhibited a slightly greater vulnerability to depression and anxiety associated with HFIS. Our findings suggest that children identified as being exposed to HFIS may benefit from mental health evaluation and monitoring and possible intervention. Our findings also highlight the importance of promptly addressing HFIS with appropriate referral to resources such as Supplemental Nutrition Assistance Program, public child nutrition programmes and philanthropic food resources, which may help to alleviate the HFIS-related mental health outcomes in children.[70 71] Meanwhile, children with anxiety or depression may be screened for HFIS to better contextualise their mental health issues. Further investigation is warranted in a prospective frame especially amid or post the COVID-19 pandemic as children may be more vulnerable than ever to a dual-threat of worsened HFIS and increased depression and anxiety. If our findings are confirmed in a prospective manner, efforts to reduce or eradicate HFIS targeting sociostructural causes are urgently warranted given its adverse impact on childhood mental health.

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Patient consent for publication Not required.

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ORCID iD

Yeyi Zhu http://orcid.org/0000-0002-7296-738X

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