



# Household food insecurity and school readiness among preschool-aged children in the USA

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## Abstract

**Objective:** The present study examines the association between mild and moderate-to-severe household food insecurity and school readiness among a nationally representative sample of preschool-aged children.

**Design:** Cross-sectional data pertaining to household food availability as well as four domains of school readiness – early learning skills, self-regulation, social-emotional development and physical health & motor development – were employed.

**Setting:** The USA.

**Participants:** 15 402 children aged 3–5 years from the 2016–2018 National Survey of Children's Health.

**Results:** Both mild and moderate-to-severe food insecurity are associated with an increase in needing support or being at-risk in each of the four school readiness domains, particularly *Self-Regulation* (IRR = 4.31; CI 2.68, 6.95) and *Social-Emotional Development* (IRR = 3.43; CI 2.16, 5.45). Furthermore, while nearly half of the children in food-secure households are on-track across all four school readiness domains (47.49%), only one in four children experiencing moderate-to-severe household food insecurity is on-track across all domains (25.26%).

**Conclusions:** Household food insecurity is associated with reductions in school readiness among preschool-aged children.

## Keywords

Household food insecurity  
School readiness  
Children  
Preschool

Household food insecurity – the limited or uncertain ability to acquire nutritionally adequate foods in socially acceptable ways – is a national public health concern that affects more than 15 million children each year<sup>(1,2)</sup>. Importantly, this public health issue does not bypass families with particularly young children, given that more than 16% of households with children under the age of 6 years experienced food insecurity in 2017<sup>(3)</sup>. Research to date has linked household food insecurity to myriad deleterious health outcomes among young children, including elevated BMI/obesity<sup>(4,5)</sup>, asthma<sup>(6)</sup> and dental caries<sup>(7)</sup>. The impact of household food insecurity, however, extends beyond these physical health challenges to diverse psychological, academic and behavioural challenges, including among very young children<sup>(8–12)</sup>. These findings buttress a recent statement from the Children's HealthWatch – a non-partisan paediatric research centre based in the USA – suggesting that the deleterious repercussions of household food insecurity for children's health and

development can emerge quite early in the life course – even in the 'years before they enter a classroom' – placing these children 'cognitively, emotionally, and physically behind their food-secure peers'<sup>(13)</sup>. Despite the clear relevance of food insecurity for health and development during early childhood, scholars have largely overlooked the potential association between household food insecurity and a multidimensional indicator of school readiness among preschool-aged children.

School readiness is a multifaceted construct that encompasses interrelated skills across early learning domains for children including academic, physical health and motor, executive functioning, language, social-emotional and behavioural components<sup>(14,15)</sup>. Research has indicated that future school adjustment and success, behavioural outcomes, health and well-being, and the ability to flourish across the life course are all significantly impacted by school readiness<sup>(14,16–18)</sup>. In this sense, school readiness sets the stage for favourable developmental outcome years

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into the future and can even 'reduce a host of lifestyle risks from childhood through adulthood'<sup>(17)</sup>. A comprehensive understanding of the origins of school readiness is therefore important, not only to identify when children are best poised to be successful upon starting school but also to detect vulnerable children who may require additional support and resources to enter school successfully<sup>(19)</sup>.

The paucity of research regarding whether household food insecurity is associated with multiple, intersecting domains of school readiness is notable, in light of the connection between hunger, impaired learning and diminished school productivity<sup>(20)</sup>. Furthermore, food insecurity among children is associated with many constructs that are closely tied to school readiness, including childhood self-regulation<sup>(21)</sup> and social-emotional skills<sup>(9)</sup>. A recent meta-analysis, moreover, demonstrated that household food insecurity is associated with poor early childhood development in children under 5 years old<sup>(22)</sup>. Thus, to the extent that food insecurity interferes with diverse components of development during infancy and early childhood, it may be particularly deleterious for school readiness. Household food insecurity, moreover, is associated with increased parental conflict and use of harsh discipline in families with young children<sup>(23,24)</sup>. Given the extant body of research linking these forms of family disruption to diminished school readiness<sup>(25,26)</sup>, it is possible that household food insecurity may also correspond to reduced school readiness among preschool-aged children. Ultimately, children preparing to enter school with diverse family and health risks are vulnerable to poor performance across school readiness indicators<sup>(19)</sup>. Given the clear importance of optimal health for proper school readiness<sup>(27)</sup>, it follows that food insecurity may be especially harmful to school readiness outcomes, due to its multiple adverse health sequelae. Understanding the connection between food insecurity and school readiness is critical to inform how government programmes and public policy initiatives (i.e. Supplemental Nutrition Assistance Program (SNAP)) can be oriented to both alleviate food insecurity and improve children's school readiness skills<sup>(28)</sup>.

The present study examines the association between household food insecurity and a multidimensional measure of school readiness using a recent, nationally representative US sample of children aged 3–5 years old. We examine the following four domains of school readiness – early learning skills, self-regulation, social-emotional development and physical health & motor development. Specifically, we assess the association between food insecurity and being at risk in each of these four domains. Second, we assess whether food insecurity is associated with an accumulation of risk across multiple different domains of school readiness. In other words, we assess food insecurity as it relates to simultaneous risk in all school readiness domains. Therefore, we pose the following two research questions:

Is mild and/or moderate-to-severe household food insecurity associated with increased risk *within* individual school readiness domains (i.e. *Early*

*Learning Skills, Self-Regulation, Social-Emotional Development and Physical Health & Motor Development*)?

Is mild and/or moderate-to-severe household food insecurity associated with reductions in school readiness *across* school readiness domains?

## Materials and methods

### Participants

In the present study, data from the three most recent available cohorts (2016–2018) of the National Survey of Children's Health (NSCH) were analysed in 2020. The NSCH is a survey of a cross-sectional weighted probability sample of US children, ranging in age from 0 to 17 years. The survey is funded by HRSA's MCHB and conducted by the U.S. Census Bureau. Although a previous version of the NSCH was conducted three times between 2003 and 2012, a revised mail and web-based survey has been conducted each year since 2016, with 2018 being the most recent year available. The sample was taken from the Census Bureau's Master Address File, which contains a complete listing of all known residences in the USA and the District of Columbia and includes an administrative flag to identify households that are most likely to have children. The survey assessed multiple, intersecting components of children's lives and includes items that ask primary caregivers about the health and well-being of focal children as well as their development across a variety of domains (i.e. behavioural, social, cognitive, etc.). Caregivers are also asked about household food insecurity during the 12 months prior to the survey. Given these features of the data, they are well-suited to the present inquiry.

Importantly, items pertaining to school readiness were only asked of caregivers in reference to focal children who were 3, 4 or 5 years old. Among the 102 341 questionnaires that were completed from 2016 to 2018 for all focal children aged 0–17 years (2016, *n* 50 212; 2017, *n* 21 599; 2018, *n* 30 530), only 15 402 were completed on behalf of 3–5-year-old children (2016, *n* 7565; 2017, *n* 3219; 2018, *n* 4618). Thus, the final sample size for the current study is 15 402 children.

### Dependent variable: school readiness

In 2019, Ghandour and colleagues<sup>(14)</sup> noted that, prior to the 2016 cohort of the NSCH, 'no single U.S. data source support[ed] a multidimensional, population-based assessment of young children's readiness to start school.' Following this declaration, they laid out a comprehensive measurement strategy supported by the NSCH from 2016 onward as a means of assessing school readiness among 3–5-year-old children. Their goal was to provide a 'national portrait' of young children's progress towards becoming 'healthy and ready to learn'<sup>(14)</sup>.



In creating their measure of school readiness, Ghandour and colleagues utilised items included in the NSCH that are rooted in an established framework by the National Educational Goals Panel and has been employed by the U.S. Department of Education<sup>(14)</sup>. Furthermore, Ghandour and colleagues performed numerous analyses to validate their pilot measure of school readiness<sup>(14)</sup>. First, item-level analyses were performed to identify gaps, weaknesses and strengths of each of the survey items. This involved assessment of data quality, the calculation of descriptive analyses and a determination of concurrent validity by examining patterns between items by child age and caregiver education. Second, confirmatory factor analyses were conducted to assess the validity of the hypothesised school readiness domains. This resulted in the identification of four distinct domains of school readiness within the NSCH: *Early Learning Skills*, *Self-Regulation*, *Social-Emotional Development* and *Physical Health & Motor Development*. Building upon the information obtained from the confirmatory factor analysis process, Ghandour *et al.* addressed variability in item response categories, variation in the number of items across domains and anticipated age differences in mastery of skills reflected in the survey items<sup>(14)</sup>. After developing their coding scheme, Ghandour *et al.* performed additional tests of concurrent validity to distinguish between groups who were expected to be theoretically different on the basis of parent confidence that their child was ready for school and highest level of parent education<sup>(14)</sup>. More recently, these school readiness domains were examined using NSCH data from 2016 to 2018 and an adapted form of Ghandour and colleagues coding scheme<sup>(14,29–31)</sup>. This coding scheme is also employed in the current study and is further outlined in Appendix A.

In total, eighteen items were employed to measure school readiness: seven items pertaining to Early Learning Skills (*Beginning Sounds, Letters, Rhyming, Verbal Expression, Writing, Counting and Shapes*), four items pertaining to Self-Regulation (*Attention, Sitting Still, Task Persistence and Following Instructions*), four items pertaining to Social-Emotional Development (*Peer Interactions, Peer Relationships, Emotional Resilience and Empathy*) and three items pertaining to Physical Health & Motor Development (*General Health, General Oral Health and Fine Motor Skills*). For each of these items, children in different age groups were identified as At-Risk (0), Needs Support (1) or On-Track (2) on the basis of diverse response options (for more details, see Appendix B).

#### *Domain-specific composite measures*

Following the categorisation of children as At-Risk, Needs Support or On-Track on the basis of responses to individual items within each of the four domains, two domain-specific composite measures were constructed for each domain: a *Needs Support/At-Risk Index* and an *At-Risk Index*. The *Needs Support/At-Risk Index* is simply the sum of the number of items in a given domain on which the child was

categorised as needs support or at-risk. The *At-Risk Index* is simply the sum of the number of items in a given domain on which the child was categorised as at-risk.

#### *Number of on-track domains*

Finally, we followed Ghandour *et al.* as well as several other recent studies and categorised children as At-Risk (0), Needs Support (1) or On-Track (2) on a given domain (for more details on the coding scheme, see Appendix B)<sup>(14,29–31)</sup>. After placing children in these categories for each domain, a count measure of the number of on-track domains was created by summing up the number of domains on which a child was categorised as on-track (0–4). As was the case with Ghandour *et al.*, children who were on-track in none of the domains or only one domain were collapsed into a single group, given the small proportion of the sample who were on-track in zero domains (~2%)<sup>(14)</sup>.

#### **Independent variable: household food insecurity**

The 2016–2018 NSCH includes one item that asks primary caregivers, ‘Which of these statements best describes the food situation in your household in the past 12 months?’. Response options included (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 we could not afford enough to eat* and (4) *Often we could not afford enough to eat*. In accordance with recent studies<sup>(32–34)</sup>, respondents who reported that they could sometimes or often not afford enough to eat were designated as experiencing *moderate-to-severe food insecurity* (2), respondents who reported that they could always afford enough to eat, but could not always afford to purchase nutritious foods, were designated as experiencing *mild food insecurity* (1) and respondents who reported being consistently able to afford good, nutritious meals were designated as being *food secure* (0).

#### **Covariates**

The following covariates were included in adjusted multivariate models to minimise the likelihood of spurious results: child age, child sex, child race (black, Hispanic, other, with white as reference category), child firstborn (including only children), child schooling status (child currently enrolled in school), household poverty ratio (federal poverty level 100–199%, 200–399%, 400+ %, with below the poverty line (federal poverty level < 100 %) as the reference category), nutrition assistance (receipt of food stamps/SNAP benefits during the past 12 months), English as primary household language (binary item in which households whose primary language was designated as English were assigned a value of 1; otherwise, households were assigned a value of 0), maternal age at birth, parent education (from less than high school (1) to college degree or higher (4)), parent marital status, parent immigrant status and parent primary caregiver status.

### Analytical plan

First, we calculated descriptive statistics for all variables included in the present study. Second, given outcomes that were negatively skewed, zero-inflated and over-dispersed, we employed negative binomial regression to examine the association between our household food insecurity measures, the needs support/at-risk index and the at-risk index for each of the four school readiness domains (i.e. *Early Learning Skills*, *Self-Regulation*, *Social-Emotional Development* and *Physical Health & Motor Development*), adjusted for covariates. Third, we constructed a figure to plot the percentage of children who were on-track across school readiness domains, stratified by household food insecurity. Finally, in line with prior research<sup>(29,20)</sup>, we re-examined these patterns across school readiness domains in a multivariate model employing multinomial logistic regression. This model examined the unadjusted and adjusted associations between household food insecurity (both mild and moderate-to-severe) and the relative risk of being on-track on one or none of the school readiness domains, two of the school readiness domains and three of the school readiness domains (relative to all four), adjusted for covariates.

We conducted all analyses in STATA 15.1 using multiply imputed data (chained equations, twenty imputations). Multiple imputation began by first generating a determined number of data sets where imputed values are derived from all predictors relevant to imputed variables. This process uses an expectation maximisation algorithm<sup>(35)</sup>. Subsequently, multiple imputation performs the statistical analyses specified on all individual imputed data sets and then pools the results from each data set into a single set of results using standard formulas<sup>(36)</sup>. Multiple imputation was performed using all analytical variables after restricting the sample to children between the ages of 3 and 5 years ( $n = 15\,402$ ). Ultimately, 14\,140 participants possessed valid (non-missing) data on all study variables. Furthermore, in a similar fashion to Jacobsen<sup>(37)</sup>, all individual variables are missing <10% of observations. Missing data were multiply imputed in Stata 15.1 using *mi* commands for all study variables in an effort to retain all cases for present analyses. Multiple imputation was chosen given that it has a number of advantages compared with other approaches to handling missing data (i.e. listwise deletion, pairwise deletion or single imputation methods), as it resolves issues related to wastefulness as well as biased covariances, *P*-values and CI<sup>(38)</sup>. All models also adjust for survey year (i.e. 2016, 2017 or 2018) and include sample weights that adjust for nonresponse, probability of selection and the demographic distribution of the target population.

### Results

First, we calculated descriptive statistics for all study variables. The descriptive statistics are shown in Table 1. As shown in the table, most children are not classified as needing support or being at-risk across most or all items within a

given domain, given the low average scores on the indices and the relative large standard deviations. Additionally, the bulk of the sample is on-track on most or all school readiness domains, with 77% of the sample being on-track in three or more domains. Even so, 8.71% are on-track on only one or none of the domains. In terms of household food insecurity, approximately three in four children come from food-secure homes and the majority of children in food-insecure homes experience mild food insecurity. Even so, 3.73% of the sample experience moderate-to-severe household food insecurity. Furthermore, the sample is majority white (68.65%) with a slight male majority (51.99%). Most children are first-born (54.47%) and had begun some form of schooling (66.58%). Furthermore, 12.12% receive nutrition assistance and 11.20% are below the poverty line. The majority of children have a parent as their primary caregiver (91.97%), married parents (76.11%) and speak English as the primary household language (92.18%).

Second, we explored the unadjusted and adjusted associations between household food insecurity and the rate of needs supports/at-risk items within each of the four school readiness domains using negative binomial regression. The results are displayed in Table 2. The unadjusted results indicate that both mild and moderate-to-severe food insecurity are consistently associated with an increased rate of needs support/at-risk items within all four domains (i.e. *Early Learning Skills*, *Self-Regulation*, *Social-Emotional Development* and *Physical Health & Motor Development*). Increases in the rate of needs support/at-risk items associated with mild food insecurity range from 35 to 68%, contingent on the domain being examined. Furthermore, increases in the rate of needs support/at-risk items associated with moderate-to-severe food insecurity range from 55 to 113%, contingent on the domain being examined. Ancillary analyses indicated that these findings largely held across groups distinguished by schooling status and age, with especially robust associations in the case of moderate-to-severe food insecurity and the at-risk index regardless of schooling status or age group (see Appendix C). As shown in Table 2, associations remained statistically significant after adjustment for covariates. Similar, though typically stronger patterns emerged in the case of the at-risk index. For children in households experiencing moderate-to-severe food insecurity, the rate of at-risk items is especially high in the case of *Self-Regulation* (IRR = 2.78; CI 1.70, 4.54) and *Social-Emotional Development* (IRR = 2.66; CI 1.61, 4.39). Robustness checks confirmed that these results held across racial/ethnic groups. For more details on the percentage of children designated as needing support or being at-risk on individual school readiness items by level of household food insecurity, see Appendix D.

Third, we constructed a figure to plot the percentage of children who were on-track across school readiness domains, stratified by household food insecurity. The pattern of results is illustrated in Fig. 1. The figure reveals that, while just over 6.48% of children in food-secure households are on-track in only one or none of the domains, more than three times as many children in households

**Table 1** Descriptive statistics

	Percentage	Mean	SD	Range
School readiness measures				
Early learning skills				
Needs support/at-risk index		2.19	1.91	0–7
At-risk index		0.63	1.24	0–7
Self-regulation				
Needs support/at-risk index		0.86	1.10	0–4
At-risk index		0.07	0.34	0–4
Social-emotional development				
Needs support/at-risk index		0.75	0.94	0–4
At-risk index		0.06	0.28	0–4
Physical health & motor development				
Needs support/at-risk index		0.41	0.65	0–3
At-risk index		0.08	0.30	0–3
Number of on-track domains				
One or none	8.71		–	0–1
Two	14.29		–	0–1
Three	33.90		–	0–1
Four	43.10		–	0–1
Household food insecurity				
None	75.40		–	0–1
Mild	20.87		–	0–1
Moderate-to-severe	3.73		–	0–1
Covariates				
Age		3.99	0.82	3–5
Male	51.99		–	0–1
White	68.65		–	0–1
Black	5.86		–	0–1
Hispanic	11.23		–	0–1
Other race/ethnicity	14.26		–	0–1
Child firstborn	54.47		–	0–1
Child schooling status	66.58		–	0–1
FPL below 100 %	11.20		–	0–1
FPL 100–199 %	16.38		–	0–1
FPL 200–399 %	32.22		–	0–1
FPL 400 %+	40.20		–	0–1
Nutrition assistance	12.12		–	0–1
English as primary household language	92.18		–	0–1
Maternal age at birth		30.00	5.57	18–45
Parent education		3.50	0.76	1–4
Parent marital status	76.11		–	0–1
Parent immigrant status	12.43		–	0–1
Parent primary caregiver status	91.97		–	0–1

experiencing moderate-to-severe food insecurity are on-track in only one or none of the domains (22.82%). Conversely, while nearly half of the children in food-secure households are on-track across all four school readiness domains (47.49%), only one in four children experiencing moderate-to-severe household food insecurity are on-track across all domains (25.26%).

Finally, we examined the unadjusted and adjusted associations between household food insecurity (both mild and moderate-to-severe) and the relative risk of being on-track on one or none of the school readiness domains, two of the school readiness domains and three of the school readiness domains (relative to all four) using multinomial logistic regression. The findings, which are displayed in Table 3, reveal that children in food-insecure households are at significantly greater risk of failing to attain on-track status on most or all school readiness domains. Specifically, in the unadjusted models, children in households reporting mild food insecurity incur a 182% increase in the risk of being

on-track on one or none of the domains (relative to all four), whereas children in households reporting moderate-to-severe food insecurity incur a 379% increase in the risk of being on-track on one or none of the domains (relative to all four). The pattern of significant results also held across groups distinguished by schooling status and/or age, particularly as the number of on-track domains decreases (relative to all four) (see Appendix E). Effects are somewhat attenuated as the number of on-track domains increases (relative to all four) and following adjustment for covariates.

## Discussion

Our findings reveal that household food insecurity is associated with increased rates of needing support/being at-risk on all four domains of school readiness and that this relationship is somewhat stronger in the case of moderate-to-severe household food insecurity. In particular, the risk of failing to

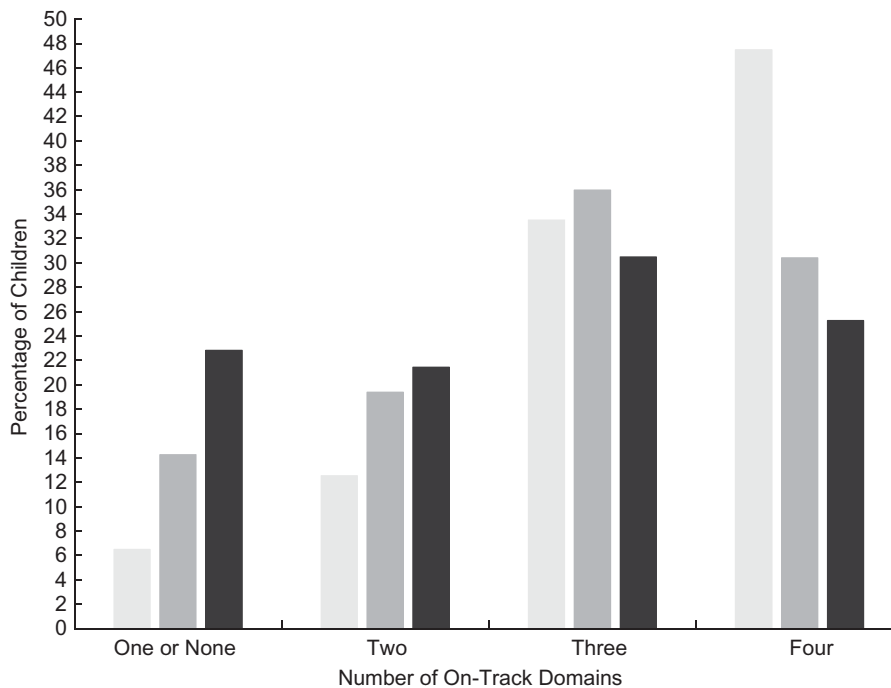
**Table 2** Household food insecurity and school readiness: analysis of the healthy and ready-to-learn domains

	Unadjusted IRR		Unadjusted IRR		Adjusted IRR		Adjusted IRR	
	IRR	CI	IRR	CI	IRR	CI	IRR	CI
Household food insecurity	Needs support/At-risk index		At-risk index		Needs support/At-risk index		At-risk index	
Mild	1.39**	1.28, 1.52	1.65**	1.40, 1.93	1.25**	1.15, 1.36	1.41**	1.21, 1.64
Moderate-to-severe	1.55**	1.32, 1.82	2.01**	1.55, 2.61	1.24**	1.07, 1.43	1.40**	1.10, 1.77
	Needs support/At-risk index		At-risk items		Needs support/At-risk index		At-risk items	
Mild	1.50**	1.32, 1.70	2.11**	1.26, 3.53	1.29**	1.16, 1.44	1.49**	1.08, 2.06
Moderate-to-severe	2.13**	1.76, 2.57	4.31**	2.68, 6.95	1.64**	1.34, 2.00	2.78**	1.70, 4.54
	Needs support/At-risk index		At-risk items		Needs support/At-risk index		At-risk items	
Mild	1.35**	1.17, 1.54	2.26**	1.28, 3.99	1.25**	1.12, 1.41	1.72**	1.24, 2.38
Moderate-to-severe	1.77**	1.48, 2.11	3.43**	2.16, 5.45	1.51**	1.25, 1.81	2.66**	1.61, 4.39
	Needs support/At-risk index		At-risk items		Needs support/At-risk index		At-risk items	
Mild	1.68**	1.44, 1.97	1.93**	1.33, 2.80	1.43**	1.23, 1.65	1.60**	1.15, 2.22
Moderate-to-severe	2.04**	1.64, 2.54	2.15**	1.35, 3.42	1.52**	1.18, 1.95	1.58***	0.97, 2.59

IRR, incidence rate ratio.

Reference category is On-Track. \* $P < 0.05$ ; \*\* $P < 0.01$ ; \*\*\* $P < 0.10$ .

In adjusted models, covariates are suppressed to conserve space. Covariates include child age, child sex, child race (black, Hispanic, other, with white as reference category), child firstborn, child schooling status, household poverty ratio (100–199 %, 200–399 %, 400+ %, with below the poverty line as the reference category), nutrition assistance, English as primary household language, maternal age, parent education, parent marital status, parent immigrant status and parent primary caregiver status. Estimates are weighted to represent the US population of 3-to-5-year-old children, and models are adjusted for survey year to account for year-specific fixed effects.



**Fig. 1** Percentage of children who are on-track across school readiness domains, stratified by household food insecurity. ■, None; ■, mild; ■, moderate-to-severe

attain on-track status on most or all of the domains was elevated among children residing in food-insecure homes, and the magnitude of these associations was generally strongest for children experiencing moderate-to-severe food

insecurity. Thus, our findings suggest that, while mild food insecurity is certainly associated with deleterious school readiness outcomes, moderate-to-severe food insecurity may be particularly harmful for school readiness.

**Table 3** Household food insecurity and school readiness across healthy and ready-to-learn domains: on-track?

School readiness		Number of on-track domains						
		Four	Three		Two		One or None	
Household food insecurity			RRR	CI	RRR	CI	RRR	CI
Mild	Unadjusted RRR	Ref	1.55**	1.26, 1.90	2.05**	1.60, 2.61	2.82**	2.08, 3.81
Moderate-to-Severe	Unadjusted RRR	Ref	1.67*	1.02, 2.75	2.56**	1.43, 4.58	4.79**	3.06, 7.50
Mild	Adjusted RRR	Ref	1.40**	1.11, 1.76	1.70**	1.29, 2.24	1.95**	1.41, 2.70
Moderate-to-Severe	Adjusted RRR	Ref	1.40	0.85, 2.26	1.69***	0.92, 3.11	2.36**	1.40, 3.99

RRR, relative risk ratio.

\* $P < 0.05$ ; \*\* $P < 0.01$ ; \*\*\* $P < 0.10$ .

In adjusted models, covariates are suppressed to conserve space. Covariates include child age, child sex, child race (black, Hispanic, other, with white as reference category), child firstborn, child schooling status, household poverty ratio (100–199 %, 200–399 %, 400+ %, with below the poverty line as the reference category), nutrition assistance, English as primary household language, maternal age, parent education, parent marital status, parent immigrant status and parent primary caregiver status. All models are weighted to represent the US population of 3-to-5-year-old children and adjust for survey year to account for year-specific fixed effects.

The study findings highlight the need for policy interventions that can both alleviate food insecurity and improve school readiness of children. One option is restructuring nutrition assistance programmes to alleviate food insecurity and improve educational outcomes among children. For instance, recent work suggests that increasing weekly benefits by just \$42 for SNAP households could lead to a 62 % decline in household food insecurity<sup>(39)</sup>. Relatedly, because adverse impacts of food insecurity for school readiness also extend to households living above the poverty line, benefits such as SNAP may need to be expanded to a broader base of Americans to help children avoid food insecurity. Indeed, recent research demonstrates that SNAP is related to improved math and reading skills for vulnerable preschool-aged children, suggesting 'strong support for the role of SNAP, especially for the most economically disadvantaged families, in advancing key school readiness skills that are important to children's developmental outcomes'<sup>(28)</sup>. Another useful approach to help mitigate the impact of food insecurity is through the expansion of mobile feeding programmes. Generally, such programmes transport food to individuals, rather than require individuals to travel to access food<sup>(40)</sup>. For instance, the USDA summer meal programme sponsors mobile feeding to provide food to hungry children when access to food is limited elsewhere, such as in the home or in schools.

Aside from initiatives targeting food insecurity, improvements in school readiness among at-risk children can be achieved through targeted intervention efforts that focus on fostering early literacy, prosocial and self-regulatory skills before at-risk children enter school<sup>(41)</sup>. For example, expanding access to preschool education programmes such as Head Start – especially to food-insecure children – is a useful approach considering such programmes have demonstrated the ability to improve school readiness<sup>(42)</sup> and long-term educational outcomes among disadvantaged children<sup>(43)</sup>. In addition, home visiting programmes could yield benefits for improving school readiness. Such programmes typically provide nurses or other health care professionals to work with at-risk mothers during pregnancy and after birth, providing educational resources

about proper childcare and development, and assisting with access to tangible resources when needed<sup>(44)</sup>. A recent randomised clinical trial conducted by Bierman and colleagues revealed that home visiting programmes targeting the school readiness of preschool children can reduce the need for school services following school entry and produce lasting benefits that are evident for several years<sup>(45)</sup>.

### Limitations

Although the current study is the first to assess the association between food insecurity and school readiness using a large, nationally representative sample, it is not without its limitations. First, the study uses observational, cross-sectional data and therefore cannot definitively determine whether the association between food insecurity and school readiness is causal. Relatedly, future research using alternative, longitudinal data sources is needed in order to tease apart the causal order of these variables. Second, the measure of food insecurity is a single-item measure. While this item has been validated as a proxy for food insecurity in past research<sup>(46,47)</sup> and has been used in prior research using the NSCH<sup>(8,32)</sup>, it would be useful for future work to evaluate the link between food insecurity and school readiness using multiple items from the full USDA Household Food Insecurity Module. The use of more detailed data can be helpful in further disentangling subtle differences in the relationship between food insecurity and school readiness. Third, our measure of school readiness, while new and innovative, is a pilot measure<sup>(14)</sup>. Accordingly, future research should seek to validate this measure and explore the association between food insecurity and school readiness with additional sources of data and alternative measurement strategies. Finally, while we were able to account for whether children had begun any form of schooling, we were not able to account for whether some of the older children (e.g. 5-year-old children) may have already started kindergarten. Although our findings emerged for both the older and younger children in the sample, future research should employ samples that can better distinguish between children who have and have not entered kindergarten.

## Conclusions

The results of the current study show a robust association between household food insecurity and school readiness among children. This relationship appears to (1) hold both within and across school readiness domains and (2) be somewhat stronger among children living in households experiencing moderate-to-severe food insecurity (relative to those living in households experiencing mild food insecurity).

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## Supplementary material

For supplementary material accompanying this paper visit <https://doi.org/10.1017/S1368980021000550>

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