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Andrea D. Brown

Hilary Seligman

Sarah Silwa

Ellen Barnidge

Kathryn L. Krupsky

See next page for additional authors

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Author(s)

Andrea D. Brown, Hilary Seligman, Sarah Silwa, Ellen Barnidge, Kathryn L. Krupsky, Zewiditu Demissie, and Angela D. Liese

RESEARCH ARTICLE

Food Insecurity and Suicidal Behaviors Among US High School Students*

ANDREA D. BROWN, MPH^a  HILARY SELIGMAN, MD, MAS^b SARAH SLIWA, MS, PhD^c ELLEN BARNIDGE, MPH, PhD^d KATHRYN L. KRUPSKY, PhD, MPH^e ZEWDITU DEMISSIE, PhD, MPH^f ANGELA D. LIESE, PhD^g

ABSTRACT

BACKGROUND: Food insecurity (FI) rates in the United States are particularly high among households with children. This research set aims to analyze if high school students experiencing FI had higher risk for mental health and suicidal behaviors.

METHODS: Using combined data from 11 states that conducted the 2017 Youth Risk Behavior Survey, a total of 26,962 and 24,051 high school students were used to estimate race/ethnicity and sex-stratified prevalence ratios (PRs) from Poisson regression models. A single-question was used to measure the exposure of FI and outcomes of mental health and suicidal behaviors.

RESULTS: Overall, 10.8% of students reported FI. Students experiencing FI had increased risk for all mental health and suicide behavior outcomes, regardless of their race/ethnicity or sex. PRs ranged from 1.9 (95% confidence interval [CI]:1.8, 2.0) to 3.1 (CI: 2.7, 3.6). Among males, PRs for the association between FI and all outcomes were highest among non-Hispanic black students (PRs ranged from 2.4 [CI: 1.7, 3.2] to 5.5 [CI: 2.3, 13.3]). Among females, PRs were highest among non-Hispanic white students (PRs ranged from 1.9 [CI:1.7, 2.1] to 3.6 [CI:2.9, 4.5]).

CONCLUSIONS: FI is consistently associated with mental health and suicidal behaviors among different subgroups of students.

Keywords: nutrition; mental health; adolescents; high school; suicide.

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In 2018, approximately 11.1% of all US households and 13.9% of US households with children under age 18 reported food insecurity (FI).¹ Household FI is characterized by the inability to reliably attain enough food for an active and healthy lifestyle due to lack

of financial, social, and other resources.¹ The USDA defines households experiencing “low food security” as those which report frequent barriers to acquiring food and maintaining a quality diet, in comparison households defined as experiencing “very low food

^aGraduate Student, (andreab@email.sc.edu), Department of Epidemiology and Biostatistics, Arnold School of Public Health, University of South Carolina, 915 Greene Street, Columbia, SC 29208.

^bProfessor, (hilary.seligman@uscf.edu), Departments of Medicine and of Epidemiology and Biostatistics, University of California San Francisco, San Francisco, CA.

^cHealth Scientist, (xxh8@cdc.gov), Division of Population Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, GA.

^dAssociate Professor and Interim Dean, (ellen.barnidge@slu.edu), Saint Louis University College of Public Health and Social Justice, Saint Louis, MO.

^eResearch Associate, (krupsky.kathryn@gmail.com), The Ohio State University Division of Epidemiology, Columbus, OH.

^fSupervisory Epidemiologist, (tjz5@cdc.gov), Division of Adolescent and School Health, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention, Centers for Disease Control and Prevention, Atlanta, GA; US Public Health Service Commissioned Corps, Rockville, MD.

^gProfessor, (liese@mailbox.sc.edu), Department of Epidemiology and Biostatistics, Arnold School of Public Health, University of South Carolina, 915 Greene Street, Columbia, SC, 29208.

Address correspondence to: Andrea D. Brown, Graduate Student, (andreab@email.sc.edu), Department of Epidemiology and Biostatistics, Arnold School of Public Health, University of South Carolina, 915 Greene Street, Columbia, SC 29208.

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security” often report diminished food intake and eating patterns in addition to not being able to obtain stable resources for food. Awareness of household FI among children can lead to emotional feelings such as worry, sadness, or anger due to there not being enough food or other strategies used to manage FI, such as asking neighbors and family members to borrow food to make it through food shortages.² Even though parents tend to shield their children from FI, the USDA estimates that in 2018, 2.7 million households experienced FI severe enough to impact the quality and quantity of food available to both household children and adults. Moreover, an estimated 220,000 households with children experienced instances of very low food insecurity.¹

The experience of FI in childhood and adolescence can have lifelong impacts.^{3,4} Adolescents with FI are more likely to have adverse academic outcomes, behavioral problems, fewer friends, substance abuse, and chronic illnesses.⁵⁻⁷ FI is also associated with increased likelihood of mental health problems such as anxiety and depression among adolescents,⁷⁻⁹ and with increased mortality and suicide ideation in adults.^{10,11} However, what is known about FI and suicidal behaviors among adolescents is largely informed by studies conducted outside the United States^{12,13} or by extrapolating from studies conducted among adults.^{11,14-16} Resulting inferences may be biased by higher rates of suicide being reported among adults and differences in suicide rates found among adolescents outside the United States.^{17,18} To the best of our knowledge, only a single study examining associations between FI and suicidal behaviors using a national sample of US adolescents exists, reflecting data collected from 1988 to 1994. This study found that FI reported by a household caregiver was related to suicide ideation and suicide attempt among 15- and 16-year-old adolescents.¹⁹

Since that time, suicidal behaviors among youth have increased substantially. From 2000 to 2017, the rate of suicide has increased more than 45%, from 8 to 11.8 suicides per 100,000, among US adolescents ages 15 to 19 years old.²⁰ Suicide is the second leading cause of death among youth and young adults ages 15 to 24.²¹ Thus, it is paramount to identify potentially modifiable risk factors for suicidal behaviors.

The Youth Risk Behavior Survey (YRBS) is conducted biennially among local, state, and nationally representative samples of US high school students in grades 9-12. The 2017 YRBS has survey data for several health-related variables, including measures for FI, mental health, and suicide. This study examines how FI is related to measures of poor mental health, considering or planning suicide, and suicide attempt among high school students using 2017 YRBS data from states with FI data available.

METHODS

The 2017 YRBS were used to evaluate associations between FI and mental health and suicidal behaviors among US high school students. The YRBS is a cross-sectional, school-based survey that monitors key health behaviors among youth. Although the YRBS has a standard questionnaire that is used as a basis for all national and state administered surveys, individual states can customize their questionnaire by including a small number of different questions.²² For this research, we pooled state-level YRBS data from the 11 states that included YRBS’ optional FI question, obtained a sufficiently high response rate to have weighted data ($\geq 60\%$), and made their data publicly available ($n = 28,702$; see Table A2): Delaware, Hawaii, Idaho, North Carolina, North Dakota, Nebraska, Nevada, Pennsylvania, Rhode Island, Utah, and Virginia. All analyses were conducted in 2020.

Participants

This analytic sample included students with completed data on the exposure of interest (FI) and demographic covariates (age, sex, race/ethnicity, state, and grade level). In addition, due to greater missing data on suicide attempt as compared to the other outcomes, data were analyzed using two separate subsets. In phase 1 of the analyses, the sample only included participants who had complete data for 3 measures: poor mental health, considering suicide, or planning suicide ($N = 26,962$, 94.5% of total possible sample of participants with FI data [$n = 28,702$]). In phase 2 of the analyses, the sample included participants who had complete data for all 4 outcome variables, including an additional question on suicide attempt ($N = 24,051$ participants, 83.7% of the total possible sample of participants with FI data).

Instrumentation

Food insecurity. The YRBS uses a single item to measure the experience of hunger over the past month: “During the past 30 days, how often did you go hungry because there was not enough food in your home?” The item includes 5 response categories: “always,” “most of the time,” “sometimes,” “rarely,” and “never.” For this analysis, participants were considered food insecure if they answered “always,” “most of the time,” or “sometimes” and food secure if they reported “rarely” or “never” going hungry because there was not enough food in their home. We conducted a sensitivity analysis in which FI was considered a 5-level variable based on the 5 response categories.

Mental health. The YRBS asks students “During the past 12 months, did you ever feel so sad or hopeless almost every day for two weeks or more in a row that you stopped doing some usual activities?” Participants

could either respond “yes” or “no” to this question, with those responding yes considered to be in poor mental health relative to those who responded no.

Considered/planned suicide. The YRBS question of “During the past 12 months, did you ever seriously consider attempting suicide?” was used to measure having considered suicide over the past year. The YRBS question of “During the past 12 months, did you make a plan about how you would attempt suicide?” was used to measure having planned a suicide attempt over the past year. Participants could respond “yes” or “no” to each question.

Suicide attempt. To measure suicide attempt the YRBS asks students to report the number of times that they attempted suicide during the year before the survey; response options for this question included “0 times,” “1 time,” “2 or 3 times,” “4 or 5 times,” and “6 or more times.” For this analysis, this question was reclassified as a binary variable to indicate “no” for youth who reported attempting suicide “0 times,” and to indicate “yes” for youth who reported attempting suicide 1 or more times.

Covariates and additional variables. The YRBS collects several demographic variables within its questionnaire. For this analysis, sex (female, male), race/ethnicity (non-Hispanic black [NHB], Hispanic/Latino, non-Hispanic white [NHW], or non-Hispanic other race/ethnicity [NHO]), and grade (9th, 10th, 11th, or 12th) were included as covariate variables.

Statistical Analysis

The statistical analyses were conducted considering the complex survey design of YRBS and utilizing STATA statistical software²³ and a 5% significance level ($p < 0.05$). Sample nonresponse and oversampling were accounted for in all analyses using YRBS survey weights. Descriptive statistics for categorical demographic variables by FI status and by outcomes were computed using weighted percentages and Pearson’s chi-square test.

Poisson regressions were used due to the high prevalence of some study outcomes.²⁴ In phase 1 of the analysis, Poisson regressions were used to analyze the unadjusted and adjusted association between the binary FI measure and individual binary outcome measures for poor mental health, having considered suicide, and having planned suicide. For analysis phase 2, Poisson regression was used to analyze the unadjusted and adjusted association between the binary FI measure and the binary outcome measure for suicide attempt. Taylor Series Linearization were applied to Poisson models to estimate variance. Interaction between FI status and sex, and FI status and race/ethnicity were found to be significant for poor mental health using Wald tests and a 5% significance level (see Table A1). Results from phase

1 and phase 2 of analysis were stratified by both sex and race/ethnicity.

RESULTS

Among the 26,962 students included in phase 1 analyses, 10.8% reported FI (Table 1). About half (49.9%) of the sample were female, 60.6% were NHW, and there were approximately equal proportions of students in 9th, 10th, 11th, and 12th grade. Overall significant differences in FI status were found across sex ($p = 0.0185$) and race/ethnicity ($p < 0.0001$). The subset sample of 24,051 students that were used in phase 2 of data analysis was not statistically different by demographics from the sample of 26,962 students used in phase 1 (data not shown).

Among the phase 1 sample, 30.0% of students reported feeling sad or hopeless for 2 weeks or more in the past 12 months, 16.2% had seriously considered suicide, and 13.5% had made a suicide plan (Table 2). Approximately 7.4% of students from the phase 2 sample reported having attempted suicide at least once over the past year (Table 2). Compared to male students, female students were significantly more likely to report poor mental health and all measured outcomes of suicidal behaviors ($p < .0001$ for all outcomes). Significant differences in reported poor mental health and suicidal behaviors were also found across race/ethnicity, with Hispanic and other race/ethnicity students having the highest prevalence of all reported outcomes (Table 2).

Overall, FI was associated with increased risk for all mental health and suicide behavior outcomes among students—prevalence ratios [PRs] ranged from 1.9 (95% confidence interval [CI]: 1.8, 2.0) to 3.1 (CI: 2.7, 3.6). Across race/ethnicity and sex, students experiencing FI were significantly more likely to report feeling sad or hopeless for more than 2 weeks in a row, seriously considering suicide, and making a suicide plan compared to food secure students (Table 3). Specifically, the adjusted PR for the association between experiencing FI and feeling sad or hopeless ranged from 1.8 for Hispanic male students to 2.4 for NHB male students and from 1.6 for Hispanic female students to 1.9 for NHW female students. The adjusted PR for the association between experiencing FI and seriously considering suicide ranged from 2.1 for Hispanic male students to 3.6 for NHB male students and from 1.9 for NHB female students to 2.4 for NHW female students. NHB male students experiencing FI had the highest PR among male students for seriously considering suicide (PR = 3.6, 95% confidence interval [CI]: 1.9-6.9), and making a suicide plan (PR = 3.0, CI: 1.5-5.9) (Table 3). Among female students, NHW students experiencing FI had the highest PR for seriously considering suicide (PR = 2.4, CI: 2.1-2.7), and making a suicide plan (PR = 2.7, CI: 2.3-3.1) (Table 3).

Table 1. Demographic Characteristics Overall and According to Food Insecurity Status (Phase 1 Sample)*

Characteristic	Overall N (%) [§]	Food Security Status [†]		p-Value [‡]
		Food Insecure [†] (n = 3849) % [§] (95% CI)	Food Secure [†] (n = 23,113) % [§] (95% CI)	
Overall	26,962	10.8 (9.9, 11.6)	89.2 (88.3, 90.1)	0.0185 [¶]
Sex				
Female	14,066 (49.9)	11.4 (10.4, 12.5)	88.6 (87.5, 89.6)	
Male	12,896 (50.1)	10.1 (9.1, 11.1)	89.9 (88.9, 90.9)	0.6725
Grade level				
9th	7070 (26.3)	10.7 (8.9, 12.5)	89.3 (87.5, 91.1)	
10th	7168 (25.8)	10.4 (9.1, 11.7)	89.6 (88.3, 90.9)	
11th	7643 (24.6)	11.5 (10.2, 12.8)	88.5 (87.2, 89.8)	
12th	5081 (23.4)	10.4 (9.1, 11.8)	89.6 (88.2, 90.9)	<.0001 [¶]
Race/Ethnicity				
Black	2631 (15.0)	14.3 (12.0, 16.6)	85.7 (83.4, 88.0)	
Hispanic	5303 (14.8)	15.0 (13.5, 16.4)	85.0 (83.6, 86.5)	
White	12,731 (60.6)	8.1 (7.4, 8.9)	91.9 (91.1, 92.6)	
Other	6297 (9.6)	15.4 (13.7, 17.1)	84.6 (82.9, 86.3)	

*Used 2017 Youth Risk Behavior Survey data and 11 states that included the food security question. Eleven states included are as follows: Delaware, Hawaii, Idaho, North Carolina, North Dakota, Nebraska, Nevada, Pennsylvania, Rhode Island, Utah, and Virginia.

[†] Food insecure includes responses of always, most of the time, sometimes to the question "During the past 30 days, how often did you go hungry because there was not enough food in your home?"

[‡] P-values summarize results from the Rao-Scott chi-square test comparing food insecurity status groups.

[§] Sample n is unweighted; Percentage is weighted.

^{||} All Hispanic students are included in the Hispanic category. All other races are non-Hispanic.

[¶] Indicates statistical significance of $p < 0.05$ from Rao-Scott chi-square test.

Table 2. Demographic characteristics overall and by mental health and suicide outcomes*

Characteristic	Overall (%) [‡]	Outcomes for Suicide Ideation and Attempt [†]									Attempted Suicide ^{†,¶}		
		Felt Sad/Hopeless [†]			Considered Suicide [†]			Made a Suicide Plan [†]					
		% [‡]	(95% CI)	p-Value [§]	% [‡]	(95% CI)	p-Value [§]	% [‡]	(95% CI)	p-Value [§]	% [‡]	(95% CI)	p-Value [§]
Overall	-	30.0	(29.2, 30.9)		16.2	(15.4, 16.9)		13.5	(12.8, 14.3)		7.4	(6.8, 8.0)	
Sex				<.0001 [#]			<.0001 [#]			<.0001 [#]			<.0001 [#]
Female	(49.9)	39.6	(38.3, 40.9)		21.7	(20.6, 22.8)		17.2	(16.2, 18.3)		9.9	(9.0, 10.8)	
Male	(50.1)	20.6	(19.5, 21.7)		10.6	(9.8, 11.4)		9.8	(9.0, 10.7)		4.8	(4.2, 5.4)	
Grade				0.1352			0.096			0.0046 [#]			0.0120 [#]
9th	(26.3)	29.7	(27.9, 31.5)		16.6	(15.4, 17.9)		14.4	(13.0, 15.8)		8.7	(7.6, 9.8)	
10th	(25.8)	28.9	(27.2, 30.6)		15.8	(14.3, 17.2)		12.6	(11.3, 13.8)		6.9	(5.9, 7.9)	
11th	(24.6)	31.8	(30.1, 33.6)		17.3	(16.0, 18.6)		14.9	(13.7, 16.0)		7.6	(6.6, 8.6)	
12th	(23.4)	29.9	(27.9, 31.9)		14.9	(13.3, 16.5)		12.2	(10.9, 13.5)		6.3	(5.1, 7.6)	
Race/Ethnicity				<.0001 [#]			0.0003 [#]			0.0015 [#]			<.0001 [#]
Black	(15.0)	27.4	(25.2, 29.6)		14.2	(12.6, 15.8)		13.5	(11.7, 15.3)		8.5	(6.7, 10.3)	
Hispanic	(14.8)	34.6	(32.6, 36.6)		17.6	(16.0, 19.3)		15.2	(13.6, 16.7)		10.2	(8.8, 11.7)	
White	(60.6)	29.2	(28.0, 30.4)		15.8	(14.8, 16.9)		12.7	(11.7, 13.7)		6.2	(5.4, 6.9)	
Other	(9.6)	32.6	(30.3, 34.9)		19.3	(17.5, 21.1)		16.4	(14.5, 18.2)		9.6	(8.2, 11.1)	

*Used 2017 Youth Risk Behavior Survey data and 11 states that included the food security question. Eleven states included are as follows: Delaware, Hawaii, Idaho, North Carolina, North Dakota, Nebraska, Nevada, Pennsylvania, Rhode Island, Utah, and Virginia.

[†] Proportion of adolescents who indicated 'yes' to this outcome.

[‡] Percentage is weighted.

[§] P-values summarize results from the Rao-Scott chi-square test comparing food insecurity status groups.

^{||} All Hispanic students are included in the Hispanic category. All other races are non-Hispanic.

[¶] Analyzed separately using data set with 24,051 adolescents who had no missing data for all 4 suicidal behavior outcomes.

[#] Indicates statistical significance of $p < 0.05$ from Rao-Scott chi-square test.

Table 3. The Association of Food Insecurity With Mental Health and Suicidal Behavior Measures Among Students

Characteristic	Overall (%) [†]	Felt Sad/Hopeless			Considered Suicide			Made a Suicide Plan			Attempted Suicide [§]		
		(%) [†]	aPR [‡]	95% CI	(%) [†]	aPR [‡]	95% CI	(%) [†]	aPR [‡]	95% CI	(%) [†]	aPR [‡]	95% CI
26,962													
All students													
Food insecure		(52.6)	1.9	(1.8, 2.0)**	(33.4)	2.3	(2.1, 2.5)**	(28.7)	2.4	(2.2, 2.6)**	(20.0)	3.1	(2.7, 3.6)**
Food secure		(27.3)			(14.1)			(11.7)			(6.0)		
White males	(30.9)												
Food insecure		(41.2)	2.2	(1.8, 2.6)**	(26.1)	2.6	(2.0, 3.4)**	(21.6)	2.4	(1.9, 3.2)**	(13.4)	3.7	(2.5, 5.5)**
Food secure		(18.6)	—	Ref	(9.7)	—	Ref	(8.7)	—	Ref	(3.5)	—	Ref
Black males	(7.2)												
Food insecure		(34.1)	2.4	(1.7, 3.2)**	(19.7)	3.6	(1.9, 6.9)**	(22.6)	3.0	(1.5, 5.9)*	(16.8)	5.5	(2.3, 13.3)**
Food secure		(15.3)	—	Ref	(6.4)	—	Ref	(7.7)	—	Ref	(3.3)	—	Ref
Hispanic males [¶]	(7.3)												
Food insecure		(37.3)	1.8	(1.5, 2.1)**	(20.4)	2.1	(1.5, 2.9)**	(16.4)	1.9	(1.4, 2.6)**	(13.4)	2.2	(1.3, 3.7)*
Food secure		(20.9)	—	Ref	(9.5)	—	Ref	(8.7)	—	Ref	(6.2)	—	Ref
All other race males	(4.8)												
Food insecure		(43.6)	2.4	(1.8, 3.1)**	(21.4)	2.2	(1.6, 3.1)**	(19.3)	2.0	(1.4, 3.0)*	(12.9)	2.9	(1.7, 5.1)**
Food secure		(18.7)	—	Ref	(10.4)	—	Ref	(9.9)	—	Ref	(4.5)	—	Ref
White females	(29.7)												
Food insecure		(68.4)	1.9	(1.7, 2.1)**	(46.3)	2.4	(2.1, 2.7)**	(38.5)	2.7	(2.3, 3.1)**	(24.9)	3.6	(2.9, 4.5)**
Food secure		(35.5)	—	Ref	(18.5)	—	Ref	(13.7)	—	Ref	(6.7)	—	Ref
Black females	(7.8)												
Food insecure		(54.5)	1.7	(1.4, 2.1)**	(33.2)	1.9	(1.4, 2.6)**	(28.2)	1.9	(1.4, 2.6)**	(22.2)	2.2	(1.4, 3.5)*
Food secure		(32.9)	—	Ref	(17.3)	—	Ref	(15.0)	—	Ref	(9.9)	—	Ref
Hispanic females [¶]	(7.5)												
Food insecure		(67.4)	1.6	(1.4, 1.8)**	(43.4)	2.1	(1.7, 2.5)**	(39.7)	2.3	(2.0, 2.8)**	(27.5)	2.6	(2.0, 3.4)**
Food secure		(41.6)	—	Ref	(20.5)	—	Ref	(16.8)	—	Ref	(10.4)	—	Ref
All other race females	(4.8)												
Food insecure		(61.3)	1.6	(1.5, 1.8)**	(43.4)	2.0	(1.6, 2.4)**	(34.5)	1.9	(1.4, 2.5)**	(25.3)	2.3	(1.7, 3.2)**
Food secure		(39.3)	—	Ref	(23.4)	—	Ref	(19.0)	—	Ref	(11.4)	—	Ref

* = <0.01.

** = <0.0001 for p-value that summarizes results from Poisson regression model.

[†] Sample n is unweighted; Percentage is weighted.[‡] aPR = Prevalence ratio; Prevalence ratios are adjusted for state and grade. Prevalence ratios among 'all students' are additionally adjusted for race/ethnicity and sex.[§] Analyzed separately using data set with 24,051 adolescents who had no missing data for all 4 suicidal behavior outcomes.^{||} Total sample of 26,962 includes males and females of all races.[¶] All Hispanic students are included in the Hispanic category. All other races are non-Hispanic.

Students reporting FI also had significantly increased risk of attempting suicide across all groups of race/ethnicity and sex. (Table 3). The adjusted PR for the association between FI and suicide attempt ranged from 2.2 to 5.5 for male students and from 2.2 to 3.6 for female students after adjusting for grade level and state. Particularly among NHB male students, FI was associated with more than 5 times the risk of suicide attempt ($p < 0.0001$) (Table 3). In addition, NHW male and female students experiencing FI were almost 4 times more likely to report suicide attempt compared to food secure NHW male and female students (Table 3). Sensitivity analyses also showed a gradient increase in PRs for outcome measures across categories of FI when it was considered as a 5-category exposure measure versus a binary measure (results not shown).

DISCUSSION

This study highlights associations between mental health and suicide thoughts and attempt with FI

and underscores the importance of addressing FI among high school students. We find that students experiencing FI had increased risk of feelings of sadness or hopelessness, considering suicide, having made a suicide plan, and attempting suicide, irrespective of their race/ethnicity or sex, when compared with food secure students, using data from 11 US states. Moreover, NHB male students experiencing FI had the highest risk among males on all outcomes and NHW female students experiencing FI had the highest risk among females for all outcomes.

Results found concur with the few other studies conducted on this topic.^{12,19} Particularly using a nationally representative sample of adolescents, Alaimo et al.¹⁹ found that food-insufficient adolescents were significantly more likely to have attempted suicide (odds ratio [OR] = 5.0, 95% CI: 1.7-14.6), to have thoughts of death (OR = 2.0, CI: 1.2-3.3), and to have a desire to die (OR = 3.4, CI: 1.5-7.5). Similarly, the current study found that students experiencing FI were significantly more likely to have

seriously considered attempting suicide and to have attempted suicide. However, when comparing current study results, it should be noted that Alaimo et al. only included adolescents age 15 and 16 in their analysis, whereas the current study included a sample of students who were 12 to 18 years old. In addition, Alaimo et al. did not stratify by demographic characteristics. In the present study, stratification was essential to more precisely assess associations between FI and suicidal behaviors among students and to determine the intersecting effects of race/ethnicity and sex. However, more research is needed to confirm if specific groups are at greater risk of suicidal behaviors.

The USDA reports that 13.9% of US households (5.2 million) with children under age 18 experienced FI in 2018; households with children that were headed by a single woman (27.8%) or single man (15.9%), households with an income below 185% of the federal poverty line (31.3%), and NHB (25.2%) or Hispanic (16.8%) households had disproportionate rates of FI.¹ Although the YRBS survey does not assess various household demographic measures, this study was able to examine the influence of student's race/ethnicity and sex. This study found that nearly 11% of sampled students experienced FI and students of minority race/ethnicity and those who were female were significantly more likely to experience FI. While several hypotheses have been tested as to how FI may differentially affect children in a household depending on their sex, past research supports that sex differences in FI may be due to females being more likely to report FI within a household as compared to males.^{1,25} This suggests that the reported prevalence of FI among males may be underestimated in the current study.

Notably, this study found that NHB male students experiencing FI had the highest risk among males for suicidal behaviors. Although research is sparse on risk factors for suicide and suicide ideation among Black youth, studies indicate the compounding of other factors such as racism and complex issues related to childhood and adolescence may contribute to increased FI and suicide ideation found among NHB males.^{26,27} In general, studies suggest that FI may be linked to suicidal behaviors such as suicidal ideation and suicide attempt among adolescents due to mechanisms such as increased nutritional deficiency, stigma, stress, and social isolation.^{28,29} Research also supports that depression may play a major role in explaining the underlying association between FI and suicidal ideation and attempt, given that people who engage in suicidal behaviors often experience depression and given that risk of depression is known to be higher among people who are experiencing FI.³⁰

LIMITATIONS

Overall, results of this study can be used to better understand links between FI and suicidal behaviors

among US high school students. A strength of this study is that it is the only study published within the last 18 years to use a large sample of US high school students to analyze associations between FI and suicidal behaviors. However, because this study is cross-sectional the direction of the relationship between FI and suicidal behaviors is unclear, and causality cannot be determined. Still, it may be more plausible to hypothesize that FI would result in suicidal behaviors as compared to the alternative.

Residual confounding is an important limitation of this study. Because the YRBS did not include measures of household income, family structure, or parental education, these measures were not controlled for nor considered in addition to FI in analyses for potential clustering of effects in relation to suicidal behaviors. However, previous research findings strongly support that FI is linked to various poor health outcomes even after controlling for confounders related to socioeconomic status.^{4,30-33} Thus, although FI can be characterized by a lack of financial resources, it does not necessarily operate as a marker of poverty and has effects on health independent of poverty/income. FI can be the result of psychosocial factors which extend beyond poverty.^{31,34} Additionally, given the large magnitude and generally precise estimates of associations found between FI and outcomes of mental health and suicidal behaviors in this study it is likely that our results depict true associations despite potential overestimation due to residual confounding. Moreover, our study also adjusted for race/ethnicity which has been used as a proxy for socioeconomic status when representative data is unavailable.^{35,36} Notably Alaimo's et al.¹⁹ study reported estimates for associations of food insufficiency with depressive symptoms and suicidal behaviors using a national sample of adolescents that were comparable to the current study even after adjustment for multiple socioeconomic factors including family income, parental education, employment status, and marital status. Nevertheless, findings from the current study should be interpreted cautiously.

This analysis was also limited in that YRBS uses only a single item to assess FI among students, rather than the standard USDA Household Food Security Survey Module (HFSSM) which includes multiple questions related to the ability of a household to secure financial resources for food, and also measures frequency of skipping meals, eating balanced meals, and going hungry. Using a single item to assess food security status may not provide much context about the experience of FI. Specifically, the YRBS single-item measure of FI does not distinguish between the social problem of hunger and the physical sensation of hunger, experienced by most people, that is not related to lack of economic or social resources.³⁷ In addition the YRBS single-item measure of FI has not

been validated, so we do not know how it compares to established measures of FI such as the USDA HFSSM. The YRBS assessment differs from the USDA HFSSM assessment of FI among households with children in that the YRBS asks students to report on their own food security status, while the USDA asks a head of household to report on the food security status of the entire household. Previous studies show higher levels of FI when using adolescent-reported versus parent-reported assessments.^{2,38} This may explain why we observed a higher prevalence of FI among students than national estimates for FI in households with children that used parent-reported estimates. Adolescents might be affected by experiences of FI more than their parents realize, thus there is value in including adolescent-reported FI in a behavioral surveillance system such as the YRBS. In addition due to missing data across variables, particularly for the measure used for suicide attempt, there was a reduction in the overall analytic sample. However, there were no major demographic differences between the full and reduced samples. The sample included the 11 US states that had publicly available YRBS data related to FI; accordingly, our results are only generalizable to high school students living in those states.

IMPLICATIONS FOR SCHOOL HEALTH

This research highlights significant associations between experiencing FI and risk for suicide among high school students of all race/ethnicities and sexes. Results of this study are increasingly important given the heightened estimated FI rate that has occurred over recent months due to the Coronavirus pandemic for some types of households.³⁹ The severity of mental health concerns and their associations with FI found among US high school students may have poor implications for public health. Overall, across this sample of students, prevalence estimates for feeling sad or hopeless for 2 weeks or more, considering or having planned suicide, and attempting suicide at least once during the year before the survey were considerable. Associations found between reporting FI and risk for suicide in this study support the need for increased mental health services and prevention programs for high school students experiencing FI, particularly targeting schools which provide tiered support systems for a broad range of student behavioral health issues. One possible intervention to explore would be expanding and/or redesigning current US school-based breakfast and lunch programs and summer programs so that they better reach high school students. To this end, it is especially important that ongoing public health efforts work to address barriers to high school student participation in school meals given that participation rates among students eligible for free- and reduced-price school meals

are lowest among high school students.⁴⁰ Likewise, implementation of suicide prevention programs in schools that focus on the whole school population with regard to social-emotional learning programs, promoting connectedness, parenting programs, and the like are also recommended. Findings highlight a need for greater implementation of Whole School, Whole Community, Whole Child approaches⁴¹ in schools to holistically address the psychosocial, health, and academic needs of students. High schools provide a unique opportunity to facilitate referrals and multifaceted social support systems for students who may need access to services that can address both FI and risk of suicidal behaviors.

Human Subjects Approval Statement

Data used in this study were approved by the CDC as research not involving identifiable human subjects. YRBS data used for this analysis is publicly available at <https://www.cdc.gov/healthyyouth/data/yrb/data.htm>.

Author contributions

All authors contributed to conceptualization of the research question. A.D.B. analyzed the data, wrote, and edited the article; H.S., S.S., E.B., K.L.K., Z.D., A.D.L. reviewed and edited the article. All authors have approved this article for publication.

Conflict of Interest

No financial disclosures were reported by the authors of this paper.

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Appendix

Table A1. Results From Interaction Analysis of Food Insecurity With Mental Health and Suicide Ideation Indicators

Mental Health Indicators	Food Security Status x Sex p-Value*	Food Security Status x Race/Ethnicity p-Value*
Feel sad or hopeless for ≤ 2 weeks in a row that stopped you from doing some usual activities		
Yes	0.0028 [¶]	0.0371 [¶]
No		
Seriously considered attempting suicide		
Yes	0.2762	0.1267
No		
Made a plan about how they would attempt suicide		
Yes	0.7755	0.1550
No		
Attempted suicide		
Yes	0.2356	0.0577
No		

*p-values for models that were adjusted for age, state, grade, race sex, and interaction term.

[¶]Indicates statistical significance of $p < 0.05$ from Rao-Scott chi-square test.

Table A2. Demographic Characteristics for the Total Possible Sample of Youth Risk Behavior Survey Participants With Food Security Data (n = 28,702) and the Reduced Phase 2 Sample (n = 24,051)*

Characteristic	Total Possible Sample			Phase 2 Sample		
	Overall n (%) [§]	Food Insecure [†] (n = 4252) % [§] (95% CI)	p-Value [‡]	Overall n (%) [§]	Food Insecure [†] (n = 3289) % [§] (95% CI)	p-Value [‡]
Overall	28,702-	11.1 (10.2, 12.0)		24,051 -	10.1 (9.2, 11.0)	
Sex			0.1408			0.0099 [¶]
Female	14,688 (49.4)	11.4 (10.4-12.5)		12,729.0 (50.6)	10.9 (9.8, 12.0)	
Male	13,762 (50.6)	10.6 (9.6-11.6)		11,322.0 (49.4)	9.4 (8.4, 10.4)	
Grade level			0.6473			0.3345
9th	7490 (26.5)	10.9 (9.2, 12.7)		6255.0 (25.9)	10.1 (8.3, 11.9)	
10th	7522 (25.7)	10.6 (9.3, 11.9)		6461.0 (26.3)	9.9 (8.6, 11.3)	
11th	7987 (24.6)	11.8 (10.4, 13.1)		6828.0 (24.7)	11.1 (9.8, 12.5)	
12th	5328 (23.2)	10.8 (9.4, 12.3)		4507.0 (23.2)	9.3 (8.0, 10.7)	
Race/ethnicity			<.0001 [¶]			<.0001 [¶]
Black	2771 (15.4)	15.0 (12.6-17.3)		2190.0 (15.0)	13.9 (11.6, 16.3)	
Hispanic	5591 (15.0)	15.3 (14.0-16.7)		4504.0 (14.0)	14.7 (13.2, 16.2)	
White	13,010 (59.8)	8.3 (7.5-9.0)		11,753.0 (62.4)	7.6 (6.8, 8.3)	

*Used 2017 Youth Risk Behavior Survey data and 11 states that included the food security question. Eleven states included are as follows: Delaware, Hawaii, Idaho, North Carolina, North Dakota, Nebraska, Nevada, Pennsylvania, Rhode Island, Utah, and Virginia.

[†] Food insecure includes responses of always, most of the time, sometimes to the question "During the past 30 days, how often did you go hungry because there was not enough food in your home?"

[‡] P-values summarize results from the Rao-Scott chi-square test comparing food insecurity status groups.

[§] Sample n is unweighted; Percentage is weighted.

^{||} All Hispanic students are included in the Hispanic category. All other races are non-Hispanic.

[¶] Indicates statistical significance of $p < 0.05$ from Rao-Scott chi-square test.