



Sociodemographic and health disparities among students screening positive for food insecurity: Findings from a large college health surveillance system

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ABSTRACT

Food insecurity among college students has begun to be recognized as a pressing social issue. However, much of the research in this area to date is limited by factors like small sample sizes and convenience sampling. The objective of this study was to assess sociodemographic and health disparities among two- and four-year post-secondary students screening positive for food insecurity, using one of the largest relevant health surveillance databases available. This study included analyses of pooled annual data (2015–2018; $n = 13,720$) from students participating in state-based surveillance of 27 two- and four-year Minnesota post-secondary institutions. Food security was determined using a validated two-item screener. Disparities were examined across numerous factors including: sociodemographic, economic, academic, institutional, nutrition and weight-related health risk and resiliency. In total, 24% of students experienced food insecurity. Findings highlighted stark disparities, with notably high positive screening rates of food insecurity among non-Hispanic Black (43%), transgender/non-binary (42%) and first-generation (33%) students. Food insecurity was significantly associated with nearly every adverse health factor examined, despite controlling for demographics ($p < 0.0001$). Overall, these findings represent one of the largest peer-reviewed studies of college food insecurity to date and underscore robust differences between who experiences food insecurity and who does not. They also highlight troubling health risks that accompany food insecurity. Importantly, the COVID-19 pandemic has worsened these realities. To inform prevention efforts, additional research is urgently needed, including cohort studies, controlled trials, and quasi-experimental research based on rigorous evaluation of policy initiatives now being considered at institutional, state and federal levels.

1. Introduction

Successful completion of higher education is a key social determinant of health.(Case and Deaton, 2017; Sasson and Hayward, 2019) Individuals with college degrees earn 75% more money and experience half the unemployment of non-graduates, resulting in long-term benefits that include lower mortality rates.(Case and Deaton, 2017; Sasson and Hayward, 2019) Unfortunately, many of the 20 million Americans pursuing higher education today also experience food insecurity (FI). The COVID-19 pandemic, which resulted in university shut-downs and substantial unemployment for hourly and low-wage workers, has likely

exacerbated this issue.(Lowe, 2020) Furthermore, most college students are excluded from federal food assistance programs, such as the Supplemental Nutrition Assistance Program, which presents additional concerns.(U. S. Government Accountability Office, 2018) Some may be eligible, for example, if they are the primary caregiver for a young child, receive public assistance under a Title IV-A program, and/or work at least 20 h per week. However, work requirements are one factor that is particularly challenging for students during times of high unemployment, such as the pandemic. Numerous states requested federal waivers to temporarily loosen SNAP work requirements for students during the pandemic, and these were all denied.(Shahin, 2020)

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Food insecurity is defined as lack of consistent access to enough food for an active, healthy lifestyle.(USDA, 2021) Results from numerous cross-sectional studies suggest college FI is correlated with poor diet quality, low self-reported health, depression, difficulty concentrating, lower grades, and possible academic delays.(Bruening et al., 2017; Nikolaus et al., 2020) However, many studies on college student FI have limitations, including lack of statistical analyses, small sample sizes, convenience sampling, singular institutional foci and lack of comprehensive health-related data.

As institutions that reach most young adult Americans – more than any other institution – colleges can be key platforms for health promotion. Importantly, effective public health strategies are needed for 4-year colleges, as well as 2-year community colleges that are often under-resourced and serve students in need. Despite this, 2-year colleges are often not well represented in research as platforms for health promotion.

To better understand college FI, including the extent to which a range of factors is associated with FI, we examined one of the largest and most comprehensive college health surveillance systems, the Minnesota College Student Health Survey (CSHS). The CSHS is unparalleled in its representation of comprehensive health factors for both 4-year university and 2-year college students. In this study, we assessed FI screening rates and correlates of positive FI screening results including demographic, family, economic, institutional and academic factors, as well as leading health risk and resiliency factors. This study marks one of the largest investigations of college FI in the peer-reviewed literature to date.

2. Methods

Data were drawn from the 2015–2018 CSHS, an annual statewide surveillance system of 2- and 4-year Minnesota colleges and universities. During these years, 27 unique institutions participated (13 two-year public, 9 four-year public, 5 four-year private). For most institutions, students were randomly selected through registrars' enrollment lists. For smaller schools, all students were invited to participate to have sufficient samples for school-specific reports; at larger schools not all students were invited (sampling range: 12.5–100% of students). Eligible participants received postcard and email invitations to the anonymous online survey. Survey completers were entered into raffles for prizes like iPads® and gift cards. Overall response rate was 36.1%. Details on CSHS are available online and in previously published work.(Laska et al., 2015, 2011; Przedworski et al., 2015; Velazquez et al., 2011; VanKim et al., 2020, 2014)

Nineteen of 27 colleges participated more than once during 2015–2018. To minimize the chance students participated twice, we only used data from the most recent year. Study procedures were approved by the University of Minnesota Institutional Review Board.

2.1. Measures

Food insecurity was assessed via a two-item validated screener often used for preliminary screening for FI in clinical settings.(Hager et al., 2010) Participants responded to statements: “*Within the past 12 months*”... “*I worried whether my food would run out before I got money to buy more*” and “*The food I bought just didn't last and I didn't have money to get more*.” Response options were *often true*; *sometimes true*, *never true*, and *don't know*. If *often* or *sometimes true* was selected for either item, students were classified as FI. All others were classified as not experiencing FI. Validation findings have yielded 97% sensitivity and 83% specificity compared to other USDA assessment measures and demonstrate good construct validity.(Hager et al., 2010) However, unlike more comprehensive FI assessment tools, this screener cannot differentiate levels of food insecurity, such as very low versus low food security.

Nutrition/weight-related factors. Body mass index (BMI), calculated using self-reported height/weight, was categorized (<18.5, 18.5–24.99,

25.0–29.9, ≥30.0 kg/m²). Participants reported dietary behaviors using Youth Risk Behavior Surveillance System (YRBS) items, including 6 items assessing daily fruit/vegetable intake.(Centers for Disease, 2021) We used one YRBS item for soda consumption and an analogous item for sweetened coffee drinks. Overall SSB (sugar sweetened beverage) consumption was calculated by adding regular soda and sweetened coffee drinks. Respondents answered, “*In the past 7 days, how many days did you eat breakfast?*”; this was dichotomized using four days as a cut-point. Fast food frequency was collapsed into: less than several times/week or ≥ several times/week. YRBS-adapted items assessed strenuous (time engaging in activities “*that made you breathe hard (e.g. running, swimming laps, fast bicycling ...)*”) and moderate-intensity activity (activities “*that did not make you breathe hard (e.g., walking, slow bicycling ...)*”).(Amir-eault and Godin, 2015) Data were combined and categorized (≥75 or < 75 min/week).

Risk and resiliency factors:

- Substance use. Smoking tobacco in the past 30 days was categorized as any versus none. Binge drinking (≥5 alcohol drinks/sitting) in the past 2 weeks and past 30 day marijuana use were similarly dichotomized.

- Physical/mental health. Receiving a routine medical exam - was dichotomized as within vs. not within 12 months and depression was dichotomized as ever diagnosed (yes. vs. no). Frequent mental distress was assessed by asking, “*how many days during the past 30 days was your mental health not good?*” and dichotomized (≥14, <14 days).(Zahran et al., 2004)

- Stress. Items measured (a) perceived stress (scale: 1–10, 1 = low, 10 = high) and (b) ability to effectively manage stress in the past month (scales: 1–10, 1 = ineffective, 10 = very effective); poor stress management was identified when a students' self-reported stress rating was greater than their stress management rating.(Nelson et al., 2008) Respondents reported yes/no to 19 past year stressful events. Responses were summed and categorized (0, 1–2, ≥3 events).

- Sleep. Students were asked how many days in the past week “*[you] got enough sleep so that [you] feel rested when you wake up in the morning?*” Data were dichotomized (≥5, <5).

- Supportiveness of relationships was assessed for (a) friends, (b) family, (c) college/university faculty, and (d) college/university staff (1–10 scale, 1: very unsupportive, 10: very supportive). Friends and family were combined (using mean scores), as were faculty and staff; measures were dichotomized (supportive: 8–10, less supportive: <8).

- Resiliency was assessed using the 6-item Brief Resiliency Scale. Participants responded to statements like “*I tend to bounce back quickly after hard times*” and “*I have a hard time making it through stressful events*” (5 response options: strongly disagree to strongly agree). Three items were reverse coded. Means scores were calculated.(Smith et al., 2008)

- Academics. Students self-reported Grade Point Average (GPA) and were asked if specific factors influenced past year academic performance, including FI, stress and financial difficulties (yes/no).

Demographic, personal and economic factors. Survey items included questions assessing gender (male, female, transmale/transman, trans-female/transwoman, genderqueer, other), racial categorization (American Indian/Alaskan Native, Asian, Black/African-American, Native Hawaiian/Pacific Islander, white, or alternative), and ethnicity (Hispanic/Latinx, Hmong, Somali, none of these). Categorizations were recoded to Hispanic/Latinx and five non-Hispanic/Latinx categories: white exclusively, Black/African-American exclusively, Asian exclusively, American Indian/Alaskan Native exclusively, and multi-racial. (Hawaiian/Pacific Islander [n = 12] and other [n = 5] were too small for inclusion.) Respondents indicating Hmong (n = 291) or Somali (n = 118) were assigned to the race category indicated. Additional demographics included level in school (from 1st year undergraduate to doctoral/professional degree student), age, relationship, living

arrangement, highest parental education, parental income, credit card debt, and student loans. Respondents reported being full-time vs. part-time, fraternity/sorority members, international students and/or U.S. Armed Forces veteran. All CSHS items and response options are online.

Institutional factors were categorized: 2-year vs. 4-year, public vs. private. Campus locations were categorized as city, suburb, town or rural using federal designations. (College Navigator, 2010)

2.2. Analysis

The analytic sample included students with non-missing FI data ($n = 13,720$). We examined how students with vs. without FI data varied by demographics (chi-square tests; $p < 0.05$); racial/ethnic categorization was the only one significant. Respondents identifying as Black/African-American, Asian or multi-racial were more likely to have missing FI compared to others.

Following descriptive analyses, we ran models examining how FI varied by institutional and student factors. All models accounted for clustering within schools. We first examined how student demographic, academic, economic and institutional factors correlated with FI using chi-square tests. Next, we examined how nutrition and weight-related behaviors (6 separate models), risk behaviors, stress and resiliency (12 separate models) were associated with FI using logistic regression (FI = independent variable). We computed models with and without demographic covariates (gender, race/ethnicity, relationship status, parent income). We used SAS 9.4 (SAS Institute Inc.; Cary, NC) and Stata 15.1 (Stata Corp LLC; College Station, Texas).

The University of Minnesota Institutional Review Board (IRB) approved all data collection procedures. The secondary data analyses conducted through this study were deemed exempt from review by the IRB due to the anonymous nature of the data.

3. Results

3.1. Demographic, personal, economic and institutional correlates

Overall, 23.6% of respondents screened positive for FI using the two-item screening tool. We observed disparities in positive FI screens by gender, racial/ethnic categorization, parent education, and level in school ($p < 0.05$, Fig. 1). Highest rates were among: transgender/non-binary/other gendered (42%), Non-Hispanic Asian (35%), Hispanic/

Latinx (34%), Non-Hispanic Native American/Alaskan Native (36%), Non-Hispanic Black (43%), Non-Hispanic multi-racial (33%) and students whose parents' highest education was high school or less (33%). Personal, economic and other factors differed by FI status (Table 1). At the personal level, age and part-time student status did not vary by FI, but relationship status and living arrangements did. Students identified as food secure were more likely than those who identified as experiencing FI to be married/partnered and/or living in a residence hall, fraternity/sorority, parents' home or their own home; in contrast, students who screened positive for FI were more likely than those who were food secure to be single and renting housing.

Students with parents earning $< \$40$ k/year and those with student loans had higher positive FI screening rates. Students screening positive were less likely than those screening as food secure to have a credit card compared to those screening negative, but were also more likely to have debt in all but the highest category ($\geq \$5,000$).

Students who screened positive for FI were also more likely than food secure students to report experiencing 18 of the 19 past year stressful life events. Of note, despite statistical differences, overall prevalence of some stressful events was low, and thus the absolute differences by FI status was also low (e.g., 0.9 versus 0.4% arrested in the past year, comparing FI versus non-FI groups). However, events with the lowest prevalence rates were also the most severe and included potentially life-changing factors like arrest, bankruptcy, and attempted suicide.

We observed no significant differences in FI results by institution characteristics (data not in tables), including by (a) 2-year public, 4-year public and 4-year private institutions among undergraduates (26%, 27%, 22%, respectively), (b) 4-year public and 4-year private institutions among graduate students (13%, 13%, respectively), or (c) campuses in city, suburban, town and rural settings (24%, 26%, 21%, 27%, respectively).

3.2. Nutrition and weight-related correlates

Results from six separate models with FI as the independent variable are presented in table 2. Students identified as experiencing FI were more likely than food secure students to have BMI ≥ 30 , less physical activity, and more SSBs, breakfast skipping and fast food, compared to food secure students ($p < 0.001$). All these relationships, except for physical activity, were also significant in fully adjusted models. We detected no difference in fruit/vegetable intake by FI status.

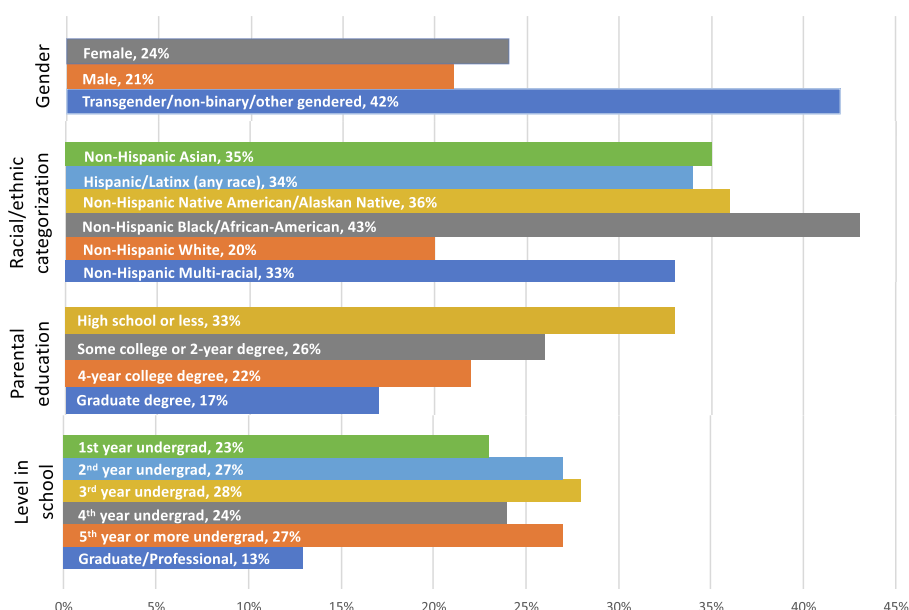


Fig. 1. Prevalence of food insecurity (FI) by gender, racial/ethnic categorization, parental education and level in school (Minnesota College Student Health Survey Surveillance System, 2015–2018). Footnote: Prevalence of FI differed across factors (gender: $p = 0.009$, race/ethnicity: $p < 0.0001$, parental education: $p < 0.0001$, level in school: $p = 0.05$). Factors account for the following percent of analytic sample: Gender: 66% female, 33% male, 2% transgender/other; Race/Ethnicity: 9% Non-Hispanic Asian; 5% Hispanic/Latinx (any race); 1% Non-Hispanic Native American/Alaskan Native; 5% Non-Hispanic Black/African American; 77% Non-Hispanic White; 4% Non-Hispanic Multi-racial; Parental education: 5% high school or less; 28% some college/2-year degree; 30% 4-year degree; 27% graduate degree; Level in school: 23% 1st year undergrad; 21% 2nd year; 19% 3rd year; 17% 4th year; 4% 5th+ year; 13% graduate/professional; 3% other.

Table 1

Personal, economic and other student correlates of food insecurity (Minnesota College Student Health Survey Surveillance System, 2015–2018).

		% of analytic sample	% food secure	% food insecure	p-value ^a
OVERALL SAMPLE		100	76	24	
PERSONAL FACTORS					
Age	18-24 years	71	70	74	0.25
	25+ years	29	30	26	
Relationship status	Single	47	46	49	0.04
	Engaged/committed	36	35	38	
	Married/domestic partner	16	17	11	
	Separated/widowed/divorced	2	2	2	
Living arrangements	Rent	40	36	51	<.0001
	Residence hall or Fraternity/Sorority	27	28	24	
	Parent's home	16	18	12	
	Own a house	14	16	8	
	Public/Subsidized housing	0.5	0.3	1	
	Homeless	0.1	0.1	0.3	
	Other	2	2	2	
Student status	Part-time	16	17	13	0.12
	Full-time	84	83	87	
ECONOMIC FACTORS					
Parents/caretaker yearly income	<\$40K	25	12	25	0.0007
	\$40-99K	33	32	33	
	≥\$100K	24	26	16	
	Don't know/prefer not to answer	28	29	25	
Credit card debt	No credit card	40	38	44	0.0006
	No debt (pay off every month)	32	36	18	
	\$1-\$999	12	10	19	
	\$1000-2999	7	6	10	
	\$3000-4999	3	3	4	
	\$5000+	6	6	6	
Student loan debt	\$0	31	34	19	0.0003
	\$1-15K	25	24	28	
	\$15,001-45K	23	21	29	
	>\$45K	11	11	14	
	Don't know/prefer not to answer	10	10	10	
STRESSFUL LIFE EVENTS IN THE PAST YEAR					
Roommate/Housemate conflict		20	17	29	<.0001
Death of someone close to you		19	18	23	<.0001
Serious physical illness of someone close to you		17	16	23	<.0001
Parental conflict		15	13	24	<.0001
Termination of a personal relationship (not marriage)		15	13	21	0.0001
Excessive debt other than credit card		12	9	22	<.0001
Failing a class		9	7	17	<.0001
Excessive credit card debt		9	7	16	<.0001
Diagnosed as having a mental illness		8	6	12	0.0003
Spouse/Partner conflict (including divorce/separation)		7	6	11	<.0001
Lack of health care coverage		6	4	11	<.0001
Being put on academic probation		5	4	8	<.0001
Issues related to sexual orientation		4	3	6	0.003
Diagnosed with serious physical illness		4	3	5	0.0005
Being fired or laid off from a job		3	2	5	<.0001
Getting married		2	2	2	0.84
I attempted suicide		1	1	2	0.0005
Bankruptcy		0.6	0.3	1	<.0001
Being arrested		0.5	0.4	1	0.004
SUMMARY SCORE: Number of stressful life events					<.0001
0 events in the past year		35	39	20	
1-2 events		42	42	40	
≥3 events		24	19	41	
OTHER FACTORS					
Member of fraternity or sorority		6	6	5	0.37
International student		5	4	7	0.05
Serving/served in U.S. Armed Forces		3	3	3	0.32

Note: CSHS 2015-2018 includes data from respondents attending 27 Minnesota post-secondary institutions, including 13 two-year public, 9 four-year public and 5 four-year private institutions.

^a Wald chi-square test (adjusted for clustering within school).

Table 2

Nutrition, activity and weight-related correlates of food insecurity among college students (Minnesota College Student Health Survey Surveillance System, 2015–2018)

	Minimally adjusted ^b		Fully adjusted ^c		p-value
	Food secure % of students	Food insecure % of students	Food secure % of students	Food insecure % of students	
BMI (kg/m²)^a					<0.0001
<18.5	3	3	3	3	<0.0001
18.5–24.9	54	48	52	47	
24.9–29.9	26	26	25	25	
≥30	17	23	20	25	
Moderate/vigorous physical activity					0.13
≥75 mins per week	53	49	54	52	0.41
<75 mins per week	47	51	46	48	
Fruits/vegetables					
≥5 times per day	16	16	16	15	
<5 times per day	84	84	84	85	0.52
Sugar sweetened beverages					<0.0001
≥1 per day	30	35	29	35	<0.0001
<1 per day	70	65	71	65	
Breakfast frequency					
≥4 days per week	61	46	60	48	
<4 days per week	39	54	40	52	<0.0001
Fast food frequency					<0.0001
≥several times per week	11	16	11	16	<0.0001
<several times per week	89	84	89	84	

^a BMI set to missing if self-reported weight < 70 lb (n = 19) or BMI < 14 (n = 29)

^b predicted probabilities from logistic regression; adjusted for clustering within school. Results from 6 models presented (Independent variable: food insecurity; Dependent variable: weight-related factor).

^c predicted probabilities from logistic regression; adjusted for: student gender, race/ethnicity, and relationship status; parent education and income; and clustering within school. Results from 6 models presented (Independent variable: food insecurity; Dependent variable: weight-related factor).

3.3. Additional risk/resiliency correlates

Results from twelve models are presented in table 3. Risk and resiliency factors varied by FI in both minimally and fully adjusted models ($p < 0.0001$). Students identified as experiencing FI were more likely than food secure students to use tobacco and marijuana and to binge drink. They were less likely to have had a recent routine medical exam and more likely to have diagnosed depression, poor mental health, more stress and insufficient sleep. They also reported having less supportive relationships and lower perceived resiliency than food secure students.

Students who screened positive for FI also reported lower GPAs. Among those experiencing FI, only 7% reported that FI affected their past year academics (data not shown). However, 49% of students identified as FI reported stress had affected past year academics (vs. 29%

among those without FI, $p < 0.001$) and 27% of those identified as FI reported financial difficulties had affected their academics (vs. 6% without FI, $p < 0.001$).

4. Discussion

Our findings underscore robust differences between students who screen positive for FI and those who do not. Consistent with previous literature, (Bruening et al., 2017) we found Black/African-American and first-generation college students (i.e., whose parents did not have 4-year degrees) had nearly twice the rates of positive FI screenings compared to other counterparts. Students identifying as Hispanic/Latinx, Asian, Native American/ Alaskan Native or multi-racial also had notably high rates of FI. In addition, students identifying as transgender, non-binary or other gender, groups already burdened with health vulnerabilities, (VanKim et al., 2014; Kidd et al., 2020) also appeared to experience unacceptably high FI rates. These student groups] need prioritization and require additional safety nets to meet basic needs while moving through higher education.

In 2018, 11% of US households experienced FI.(United States Department of Agriculture, 2020) Based on our data and that of others, (Bruening et al., 2017; Nikolaus et al., 2020) prevalence of FI among undergraduate students may be higher, though research findings have been mixed. Even among first year students(Bruening et al., 2018) – often assumed to be “immune” to FI due to presumed campus resources and meal plans – 23% screened positive for FI in our sample. Previous research on college student FI has identified prevalence rates that vary widely, with an average often cited as 35%.(Bruening et al., 2017) Nationally representative CPS (Current Population Survey) data also has been used to assess FI among households that include an undergraduate college student in their first through fourth year; results indicate these households exhibit FI rates similar to national household averages. (Blagg et al., 2017; C G., 2020) Another recent population-based study also found similar results.(Larson et al., 2020) The reasons for these discrepancies in prevalence rates are not fully understood; they could be due in part to differences in study and sampling designs and/or lack of valid FI measurement for college students. However, regardless of whether FI is more common among college students than in the general population and/or non-college students, the US has a history of intentionally excluding students from food assistance programs, and there are notable policy opportunities to help bring much-needed assistance to students experiencing FI. Despite these issues, however, our research on college FI is not intended to diminish and should not be seen as a threat to on-going efforts focused on meeting the needs of non-student populations.

Despite this, the common misconception of today's college student being supported by parents, living in dormitories and eating in abundantly sourced dining halls is far from reality for many, especially students from low-resource families.(U. S. Department of Education. Digest of Education Statistics; 2018) Importantly, a myriad of opportunities over the past decade have allowed students from resource-limited backgrounds to enroll in 2- and 4- year colleges(King, 2017) Today nearly half of students seeking Bachelor's degrees are students of color and half are first-generation.(Hunt-White, 2018) These students may be more likely to come from families experiencing FI, though they previously had some protection against hunger due to youth food assistance programs like US national school meal programs.(United States Department of Agriculture, 2021) Upon entering college, however, food assistance virtually disappears.Thus, while opportunities are available for young people to enter higher education, they lack support to cover basic needs. Furthermore, first generation college students may lack sufficient guidance in estimating the true cost of college and challenges ahead. Our findings showed students experiencing FI reported less supportive relationships compared to food secure students, which could further limit the critical guidance, social capitol and safety nets needed to stay afloat.

Table 3

Risk and resiliency correlates of food security among college students (Minnesota College Student Health Survey Surveillance System, 2015–2018).

	Minimally adjusted ^a		p-value	Fully adjusted ^b		p-value
	Food secure % of students	Food insecure		Food secure % of students	Food insecure	
<i>Smoking tobacco in past 30 days</i>			<0.0001			<0.0001
Yes	15	23		15	24	
No	85	77		85	76	
<i>Marijuana use in past 30 days</i>			<0.0001			<0.0001
Yes	12	18		12	19	
No	88	82		88	81	
<i>Binge drinking in past 14 days</i>			<0.0001			<0.0001
Yes	30	37		31	37	
No	70	63		69	63	
<i>Last routine medical exam</i>			<0.0001			<0.0001
Within past 12 months	63	58		62	58	
Not within past 12 months	37	42		38	42	
<i>Ever diagnosed with depression</i>			<0.0001			<0.0001
Yes	27	41		28	42	
No	73	58		72	58	
<i>Mental distress in past month</i>			<0.0001			<0.0001
≥14 days mental health was “not good”	16	29		16	28	
<14 days mental health was “not good”	84	71		84	72	
<i>Stressful life events in past 12 months</i>			<0.0001			<0.0001
0 events	39	20		38	20	
1–2 events	42	39		43	41	
≥3 events	19	41		19	40	
<i>Self-rated stress management</i>			<0.0001			<0.0001
Stress level > stress management skill rating	33	52		34	51	
Stress management skill ≥ stress rating	67	48		66	49	
<i>Self-rated sleep sufficiency</i>			<0.0001			<0.0001
Sufficient sleep < 5 days per week	64	75		65	75	
Sufficient sleep ≥ 5 days per week	36	25		35	25	
<i>Supportiveness of relationships (1–10 scale)</i>			<0.0001			<0.0001
-Friends/Family						
Supportive (8–10)	77	64		78	66	
Less supportive (1–7)	23	36		22	34	
-College/University faculty/staff			<0.0001			<0.0001
Supportive (8–10)	52	42		52	43	
Less supportive (1–7)	48	58		48	57	
<i>Grade Point Average (GPA)</i>			<0.0001			<0.0001
< 3.0	19	34		24	36	
3.0–3.5	29	33		28	31	
>3.5	51	33		49	33	
	Mean	Mean	p-value^a	Mean	Mean	p-value^b
<i>Resilience (1–5 scale)</i>	3.5	3.2	<0.0001	3.5	3.3	<0.0001

^a predicted probabilities from logistic regression; adjusted for clustering within school. Results from 13 models presented (Independent variable: food insecurity; Dependent variable: weight-related factor).

^b predicted probabilities from logistic regression; adjusted for: student gender, race/ethnicity, and relationship status; parent education and income; and clustering within school. Results from 13 models presented (Independent variable: food insecurity; Dependent variable: weight-related factor).

Unexpectedly, our findings revealed that positive FI screening rates did not vary between 2-year vs. 4-year or private vs. public institutions. A priori, we hypothesized we would observe disparities by institution type. Compared to 4-year institutions, 2-year institutions serve a greater percent of first-generation students and students of color (U. S. Department of Education. Digest of Education Statistics, 2018; U.S. Department of Education. Web Tables. Profile of Undergraduate Students, 2020). Our past research has shown students at 2-year colleges are at greater risk for other health concerns (Laska et al., 2011). In addition, other research suggests FI is more prevalent at 2-year institutions (Blagg et al., 2017; Goldrick-Rab et al., 2018). Findings from CPS between 2008 and 2014 showed a higher prevalence of FI among households that included a 2-year student, compared to households with a 4-year student; however, this disparity was not evident in 2015 (Blagg et al., 2017). This finding is consistent with findings from our data, which was collected 2015–2018.

Strikingly, we found students identified as experiencing FI were more likely to experience nearly every other health risk factor we examined. Consistent with previous research (Bruening et al., 2017; Nikolaus et al., 2020) students who screened positive for FI also reported lower GPAs than food secure students. Though the causal nature of this

relationship is unclear, relationships between FI and health or academic outcomes were not attributable to sociodemographics, as highlighted by our consistent results between minimally and fully adjusted models. Overall, there is an important need for longitudinal research, of which there is very little (Bruening et al., 2017, 2018). It is possible FI may not cause these adverse outcomes per se, but rather serve as a symptom of larger issues, like poverty. Rigorous trials and natural experiments to evaluate institutional, state, and federal efforts are needed to test direct causal effects of FI on student outcomes. Ultimately, however, regardless of causality, millions of students are experiencing FI, and this in and of itself represents an important social injustice.

FI is inextricably tied to economic factors, and students who screened positive for FI reported lower parental income, more student loans and more credit card debt than their counterparts. Although students carried significant debt, there appear to be interesting secular trends in students' credit card management and debt. Our previous findings from 2004 indicated nearly 80% of Minnesota college students had a credit card (Nelson et al., 2008). In contrast, these findings from 2015 to 2018 reveal only 56% of FI and 62% of food secure students had credit cards. This change may reflect federal restrictions on credit card marketing to students during this time (Maloney, 2021). Importantly, we must

continue protecting students from marketing that puts them at risk for excessive debt and high interest rates which could be crippling in the future. Other questionable practices – which appear to worsen during economic downturns – include those of for-profit colleges targeting non-traditional and marginalized students through aggressive recruiting and provision of misleading information.(Cotton, 2017; Gold, 2019) Research suggests students at for-profit colleges borrow more than other students and represent half of all student loan defaults. Although CSHS does not include for-profits, this is a notable area for future research.

Our research has limitations. Despite being one of the only datasets of its kind, data were drawn from surveillance in one state. Another notable limitation is use of the two-item FI screener.(Hager et al., 2010) Though it has been validated against other USDA measures and used throughout the field, it is often used in clinical settings as a screening tool. The screener is not the optimal tool for assessing food security, as it is not comprehensive and cannot differentiate levels of food security. Further, some literature has questioned the overall applicability of USDA FI measurement items for college students, and researchers have called for rigorous measurement development to address this unique population.(Nikolaus et al., 2019; Ames and Barnett, 2019) Despite these limitations, strengths of our work include use of a one-of-a-kind state surveillance system with strong representation of both 2-year and 4-year colleges, which is lacking from other large data sources on college health, like the National College Health Assessment (www.acha.org). The CSHS also utilizes probability sampling and includes health data spanning a wide range of domains relevant to FI.

Given the continuing COVID-19 pandemic, the situation for college students is expected to worsen, especially for those who are unemployed or under-employed. The challenge for higher education decision-makers now is to rapidly discern how best to address the growing needs of underserved students. Numerous state and federal bills addressing college FI are also under consideration.(Laska et al., 2020b; Laska and Fleischhacker, 2020) and public health professionals can play an important role in advocacy and dissemination of sound evidence. Policies and practices to reduce disparities in FI are particularly important, with the most critical being those directly benefitting students from underserved communities. Examples include recent legislation in Washington state to fund the *Homeless and Foster Care Students Pilot Program*, with the goal of providing students who are homeless and/or from the foster care system with reduced-price meals and other food resources, and also the recently introduced federal *Emergency Ensuring Access to SNAP Act of 2020*, which would better student access to SNAP during the pandemic (Laska et al., 2020a, b; Laska and Fleischhacker, 2020). In contrast, policies and practices addressing FI among the college population as a whole – like campus food pantries accessible to all students, regardless of need – could unintentionally worsen disparities, despite possibly reducing FI overall.

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CRediT authorship contribution statement

Melissa N. Laska: Conceptualization, Methodology, Resources, Writing - original draft, Visualization, Supervision, Funding acquisition. **Kathleen Lenk:** Methodology, Software, Formal analysis, Data curation, Writing - review & editing, Visualization. **Katherine Lust:** Methodology, Data curation, Writing - review & editing, Project administration. **Cydney M. McGuire:** Writing - review & editing. **Carolyn M. Porta:** Writing - review & editing. **Michael Stebleton:** Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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