

Characteristics associated with changes in food security status among college students during the COVID-19 pandemic

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Abstract

The prevalence of food insecurity in the USA has increased since the start of the COVID-19 pandemic; however, past studies have not examined how the food security status of college students has been impacted. The purpose of this study was to examine changes in the prevalence of food insecurity; determine the proportion of students experiencing a change in food security status; and identify characteristics associated with changes in food security status from before to during the COVID-19 pandemic among a sample of college students. We administered a cross-sectional online survey to students from a large public university in the Southeastern USA. The 10-item U.S. Adult Food Security Module was used to assess food security status during the spring 2020 semester both before and during the COVID-19 pandemic, and students self-reported a variety of individual characteristics. The overall prevalence of food insecurity increased by approximately one-third during the spring 2020 semester from before to during the COVID-19 pandemic. When examining the types of changes in food security status experienced by students, 12% improved, 68% stayed the same, and 20% worsened. A variety of characteristics were associated with an improvement or worsening of food security status category from before to during the pandemic. Similar to what is seen in other reports, we found that the overall proportion of college students in our sample experiencing food insecurity increased during the COVID-19 pandemic; however, some students showed improvements in food security status. Approaches for addressing food insecurity during and beyond the pandemic are needed.

Keywords

Food insecurity, COVID-19, Coronavirus, College students, Universities, Surveys and questionnaires

BACKGROUND

Food insecurity is a serious public health problem associated with higher rates of a variety of chronic health conditions, mental health problems, and poor dietary intake [1]. In 2019, 10.5% of U.S. households experienced food insecurity [2]. The U.S. Department of Agriculture (USDA) describes four categories of food security: high (no limitations or problems accessing food), marginal (one or two indications, such as anxiety related to accessing food), low (reduction in the variety, quality, or desirability of diet), and very low (reduced food intake and

Implications

Practice: With overall rates of food insecurity among college students increasing during the COVID-19 pandemic, new approaches for addressing this issue are needed as the strategies promoted in the past, such as campus food pantries and meal swipe programs, may be of limited value with the need for social distancing and use of remote learning.

Policy: Policies that include long-term sustainable approaches for helping college students to meet their food needs both throughout and after the COVID-19 pandemic are needed.

Research: Future research looking at changes in food security status should be conducted with students from other universities, as well as explore strategies for addressing food insecurity among college students during the COVID-19 pandemic.

disrupted eating patterns) [3]. Individuals reporting high or marginal food security are often referred to as being food secure and individuals reporting low or very low food security are often referred to as being food insecure [3].

Few studies have been published on food insecurity in the USA during the COVID-19 pandemic [4–8]. Studies assessing food security status both before and during the pandemic have found higher proportions of study participants experiencing food insecurity during compared with before the pandemic [4–6]. National estimates of the prevalence of food insecurity have been higher during the pandemic compared with the 10.5% prevalence rate found in 2019 [2, 9, 10]. Data from the U.S. Census Bureau's Household Pulse Survey estimates that 25.2% of respondents experienced food insecurity between April 23 and June 30, 2020 [9], and a report from the Urban Institute found the proportion of adults living in food-insecure households to be 20.9% in March and April of 2020 and 17.7% in May 2020 [10].

High rates of food insecurity have also been found in the limited research focused on college students during the COVID-19 pandemic. The Hope Center for College, Community, and Justice conducted a survey of undergraduate students at 54 U.S. colleges and universities (15 four year and 39 two year institutions) during the COVID-19 pandemic from April 20 to May 15, 2020 [11]. They found that 38% of students from 4 year institutions and 44% of students from 2 year institutions reported being food insecure in the past 30 days, which is higher than found in their survey conducted in the fall of 2019 that found rates of food insecurity to be 33% for 4 year institutions and 42% for 2 year institutions [11]. To date, only one peer-reviewed study looking at the prevalence of and characteristics associated with food insecurity among college student populations during the COVID-19 pandemic has been published. This study was conducted in May and June of 2020 and found that, among a sample of 502 college students from three state-funded universities in Texas, 20.2% experienced low and 14.3% experienced very low food security [8]. A limitation of this study was the focus on only one time point and inability to assess changes in food security status over time.

Although the issue of food insecurity among college students had been receiving a growing amount of interest in both research and practice prior to the COVID-19 pandemic, there are no national estimates of food insecurity in this population. In December 2018, the U.S. Government Accountability Office released a report that reviewed 31 studies with estimates of food insecurity on college campuses ranging from 9% to over 50% [12]. A weighted estimate of the prevalence of food insecurity was reported as 41% in a recent review article, with estimates being higher for students attending community colleges [13].

To better understand the increasing rates of food insecurity seen in a variety of surveys, it is important to explore how college students are being impacted during the COVID-19 pandemic. When colleges transitioned to remote learning, many students experienced changes in their living and financial situations. Some students may have been in circumstances where their food security status worsened, while others may have been in situations where their food security status improved, such as moving home to families who were able to provide them with financial support and access to food. Given the potential long-term nature of the COVID-19 pandemic, it is imperative to fully understand the ways in which students' food security statuses are impacted. The objective of this study was to examine changes in the prevalence of each of the four food security status categories; determine the proportion of students experiencing a change in food security status; and identify characteristics associated with changes in food security status during the spring 2020 semester

from before to during the COVID-19 pandemic among a sample of college students from a university in the Southeastern USA.

METHODS

Study design and sample

We emailed an invitation and link to a 94-item online questionnaire through Qualtrics online survey software six times during the data collection period of June 12–July 16, 2020, to students from a large public university in the Southeastern USA. Eligibility criteria for completing the survey were being at least 18 years of age and attending the university during the spring 2020 semester. The survey was open to students in all program types (i.e., undergraduate, graduate, and professional). The survey was developed specifically for this study; however, it included some questions used in past surveys of food insecurity at this campus conducted in the fall of 2016 [14] and the fall of 2019 (M. Olfert, DrPH, unpublished data, 2019). The study was reviewed and determined to be exempt by the institutional review board at the university where the study was conducted.

Measures

We assessed food security status using the 10-item U.S. Adult Food Security Module [16]. The questions typically reference the last 12 months or last 30 days; however, they were modified for this survey to reference the spring 2020 semester up to March 6 (pre-COVID-19) and during the spring 2020 semester after March 6 (during COVID-19). The spring 2020 semester lasted from January 8 to May 5, 2020, so each of these time periods represented approximately 2 months. March 6, 2020 was used as the reference period to define before and during the COVID-19 pandemic because this was the date when the university went on spring break and thereafter transitioned to remote learning. A similar approach of asking about before and during the COVID-19 pandemic has been used to assess changes in food security status in other studies [4, 6]. We used the USDA's scoring system to classify students as experiencing high food security (zero affirmative responses), marginal food security (one or two affirmative responses), low food security (three to five affirmative responses), or very low food security (six to ten affirmative responses) for both before and during the COVID-19 pandemic [15]. Change in food security status category was determined by comparing student food security status classifications before and during the COVID-19 pandemic. Students reporting a higher food security status category during compared with before were considered "improved," students reporting the same category during and before were considered "stayed the same," and students reporting a lower category

during compared with before were considered “worsened.” In order to get a more precise measure of the change in food security status, we also determined change in food security status based on the number of affirmative responses a student indicated on the 10-item U.S. Adult Food Security Module. Students reporting a higher number of affirmative responses during compared with before were considered “improved,” students reporting the same number of affirmative responses during and before were considered “stayed the same,” and students reporting fewer affirmative responses during compared with before were considered “worsened.” We chose to focus on this because a change in the number of affirmative responses could occur without a change in food security status category (i.e., a student could report three affirmative responses before the pandemic and five after but would be considered experiencing low food security at both time points).

Students also self-reported information on a variety of student characteristics, including age, gender, ethnicity, race, year in school, program type (residential vs. online), marital status, disability status, and whether they were an international student or first-generation college student, had dependent children, were affiliated with the military (active duty, veteran, retired, National Guard, or Reserves member), received financial aid, received Supplemental Nutrition Assistance Program (SNAP) benefits, and participated in free and reduced-price school meals while in high school. Students also reported where they lived (off-campus, on-campus residence hall, on-campus apartment, fraternity, or sorority), whether they had a meal plan, and their employment status during the spring 2020 semester. These characteristics were selected based on characteristics examined in past research on food insecurity among college students, including risk factors identified by the Government Accountability Office report [12] and past research on the campus where this study was conducted [14] (M. Olfert, DrPH, unpublished data, 2019). Students were also asked whether they moved in with family and if their or someone in their household’s employment status changed due to the COVID-19 pandemic. For changes in employment, being permanently laid off or fired, temporarily laid off or fired, quitting, having a decrease in work hours, an employer close, and/or being no longer able to work because of moving were considered as having a loss of employment. The questionnaire also asked whether students received financial support from family or provided financial support to family both before and during the COVID-19 pandemic.

Statistical analysis

Statistical analyses included students with information on all variables examined. We calculated the proportion of students reporting each of the four food security status categories before and during the

COVID-19 pandemic, as well as the proportion of students whose food security status improved, stayed the same, and worsened using both change in food security status category and the number of affirmative responses to the 10-item U.S. Adult Food Security Module. We reported descriptive statistics for each student characteristic (age, gender, ethnicity, race, program type, year in school, international student, first-generation college student, marital status, dependent children, disability status, military-affiliated, participation in free or reduced-price meals in high school, spring semester housing, spring semester meal plan, moved in with family, spring semester employment, loss of employment, loss of household employment, financial aid, received SNAP during the pandemic, received financial support from family, and provided financial support to family) by the change in food security status based on the change in the number of affirmative responses and assessed statistical significance using Pearson’s chi-square tests for categorical variables and analysis of variance for age, which was the only continuous variable. We used multinomial logistic regression to examine the association between the type of change in food security status during the COVID-19 pandemic (improved, stayed the same, or worsened) based on the change in the number of affirmative responses and all characteristics found to be significant in the bivariate models. We also used a multinomial logistic regression model that controlled for all significant characteristics and baseline number of affirmative responses. The reference group was students whose food security status stayed the same. All analyses were conducted using SAS version 9.4 [16] and statistical significance was considered $p < .05$.

RESULTS

The survey was sent to a list of 29,745 email addresses obtained from the university’s directory information. Forty-three emails bounced, 3,195 students consented to participate, 83 students were excluded for not meeting the eligibility criteria, and 1,073 were not included in the analyses due to missing data on variables examined. The analytical sample included 2,039 students. The majority of students in the sample were female, non-Hispanic, White, single, and had no dependent children. Compared with the overall student population at the university where the study was conducted, our sample had a higher proportion of females (73% vs. 59%) and a lower proportion of undergraduate students (57% vs. 64%) [17]. The way the university reports race/ethnicity data are not directly comparable to our data; however, both our sample and overall student population were predominately white [17].

Table 1 shows the proportion of students in the sample reporting high, marginal, low, and very low food security in the spring semester before and during the COVID-19 pandemic. Overall, the

Table 1 | Food security status among students during the spring 2020 semester before and during the COVID-19 pandemic

	Before COVID-19 pandemic (January 8–March 6, 2020)	During COVID-19 pandemic (March 7–May 5, 2020)
	<i>n</i> (%)	<i>n</i> (%)
High food security	1,508 (74.0)	1,408 (69.1)
Marginal food security	311 (15.3)	337 (16.5)
Low food security	130 (6.4)	156 (7.7)
Very low food security	90 (4.4)	138 (6.8)

proportion of students reporting high food security decreased and the proportion of students reporting marginal, low, and very low food security increased. The direction of change in food security status category differed among students. We found that 10.5% of students reported a higher food security status category, 71.8% reported the same food security status category, and 17.7% reported a lower food security status category during the pandemic compared with before. When assessing change based on the number of affirmative responses, which is a more precise measure of the change in food security status compared with using food security status category, 12% improved, 68% stayed the same, and 20% worsened.

Table 2 shows student characteristics by the change in food security status category. Students whose food security status improved, stayed the same, or worsened during the COVID-19 differed from each other on a variety of characteristics. Characteristics significantly associated with the change in food security status category were age, gender, ethnicity, race, year in school, international student, first-generation college student, marital status, disability status, participation in free or reduced-price meals in high school, spring semester housing, spring semester meal plan, moved in with family, spring semester employment, loss of employment, loss of household employment, financial aid, received SNAP during the pandemic, received financial support from family, and provided financial support to family. Student characteristics not significantly associated with the change in food security status category were program type, dependent children, and military affiliated.

Table 3 shows the results of both the unadjusted and adjusted multinomial logistic regression models. While there were significant associations found between change in food security status and categories within each of the student characteristics examined in the unadjusted models, many of these associations were no longer significant in the adjusted models. Compared with White students, Asian students had a higher odds of reporting worsened food security status during the pandemic (adjusted odds ratio [AOR]: 1.60, 95% confidence interval [CI]: 1.10, 2.32). There was a higher odds of reporting worsened food security status during the pandemic for international students (AOR: 1.82, 95% CI: 1.04, 3.20), students with a disability (AOR:

2.01, 95% CI: 1.53, 2.64), students who participated in free or reduced-price school meals in high school (AOR: 2.15, 95% CI: 1.46, 3.15), students who lost employment during the pandemic (AOR: 2.24, 95% CI: 1.62, 3.10), and students who reported a loss of employment for another household member during the pandemic (AOR: 1.81, 95% CI: 1.38, 2.35). First-generation students had higher odds of reporting that their food security status improved during the pandemic (AOR: 1.58, 95% CI: 1.00, 2.49).

Students who moved in with family during the pandemic had a higher odds of reporting that their food security status improved (AOR: 2.36, 95% CI: 1.34, 4.15) and lower odds of reporting that their food security status worsened (AOR: 0.53, 95% CI: 0.38, 0.75). Students had a higher odds of reporting improved food security status if they received financial support from family before (AOR: 3.31, 95% CI: 1.07, 10.18), during (AOR: 1.84, 95% CI: 1.04, 3.27), or both before and during the pandemic (AOR: 2.22, 95% CI: 1.02, 4.83). Students who received financial support from family both before and during the pandemic also had a higher odds of reporting worsened food security status during the pandemic (AOR: 1.79, 95% CI: 1.11, 2.88). Students who provided financial support to family both before and during the pandemic had higher odds of reporting that their food security status worsened (AOR: 1.97, 95% CI: 1.08, 3.58).

DISCUSSION

Consistent with previous survey findings, we found that students in our sample reported higher rates of food insecurity during the COVID-19 pandemic compared with before [4–6]. In their study of adults in Vermont, Niles et al. found an increase of nearly one-third (18.8%–24.8%) in the prevalence of food insecurity among individuals in their sample from the year before to during the COVID-19 outbreak [6]. Although we found lower rates of food insecurity (low or very low food security), the prevalence also increased by approximately one-third (10.8%–14.5%) from before to during the COVID-19 pandemic among students in our sample.

Our results suggest that moving in with family had a positive impact on students' food security status. Students who moved in with family had more than twice the odds of reporting improved food security and were almost half as likely to report worsened

Table 2 | Student characteristics by changes in food security status during the spring 2020 semester from before to during the COVID-19 pandemic

	Improved (<i>n</i> = 239)	Stayed the same (<i>n</i> = 1,391)	Worsened (<i>n</i> = 409)	<i>p</i> -value
	Mean ± <i>SD</i> or <i>n</i> (%) ^a	Mean ± <i>SD</i> or <i>n</i> (%) ^a	Mean ± <i>SD</i> or <i>n</i> (%) ^a	
Age	21.7 ± 4.6	23.8 ± 5.3	23.4 ± 4.9	<.001
Gender				.003
Male	42 (8.5)	360 (72.9)	92 (18.6)	
Female	188 (12.6)	1,006 (67.3)	300 (20.1)	
Other/prefer not to answer	9 (17.7)	25 (49.0)	17 (33.3)	
Ethnicity				.003
Non-Hispanic	211 (11.2)	1,306 (69.2)	371 (19.7)	
Hispanic	28 (18.5)	85 (56.3)	38 (25.2)	
Race				<.001
Asian	48 (13.8)	216 (62.1)	84 (24.1)	
Black or African American	13 (10.0)	76 (58.5)	41 (31.5)	
White	146 (10.6)	997 (72.6)	231 (16.8)	
Biracial or multiracial	23 (19.3)	67 (56.3)	29 (24.4)	
Other	9 (13.2)	35 (51.5)	24 (35.3)	
Program type				.576
Residential	229 (11.7)	1,339 (68.4)	389 (19.9)	
Online	10 (12.2)	52 (63.4)	20 (24.4)	
Year in school				<.001
Freshman	57 (16.4)	234 (67.2)	57 (16.4)	
Sophomore	55 (19.2)	176 (61.5)	55 (19.2)	
Junior	54 (16.3)	201 (60.7)	76 (23.0)	
Senior	25 (12.3)	128 (63.1)	50 (24.6)	
Master's	10 (3.4)	214 (72.3)	72 (24.3)	
Doctoral	25 (7.2)	267 (77.0)	55 (15.9)	
Professional student (medical, pharmacy, etc.)	11 (5.0)	167 (76.3)	41 (18.7)	
Other	2 (22.2)	4 (44.4)	3 (33.3)	
International student				.003
No	231 (12.0)	1,322 (68.6)	373 (19.4)	
Yes	8 (7.1)	69 (61.1)	36 (31.9)	
First-generation college student				<.001
No	169 (10.3)	1,186 (72.2)	287 (17.5)	
Yes	70 (17.6)	205 (51.6)	122 (30.7)	
Marital status				<.001
Single	216 (13.3)	1,069 (65.9)	337 (20.8)	
Living with partner	8 (4.6)	138 (78.9)	29 (16.6)	
Married	10 (4.4)	180 (78.3)	40 (17.4)	
Divorced	5 (41.7)	4 (33.3)	3 (25.0)	
Dependent children				.270
No	230 (11.9)	1,320 (68.3)	382 (19.8)	
Yes	9 (8.4)	71 (66.4)	27 (25.2)	
Disability				<.001
No	155 (10.7)	1,049 (72.4)	245 (16.9)	
Yes	84 (14.2)	342 (58.0)	164 (27.8)	
Military affiliated				.863
No	233 (11.7)	1,358 (68.2)	401 (20.1)	
Yes	6 (12.8)	33 (70.2)	8 (17.0)	

(Continued)

Table 2 | Continued

	Improved (n = 239)	Stayed the same (n = 1,391)	Worsened (n = 409)	p-value
	Mean ± SD or n (%) ^a	Mean ± SD or n (%) ^a	Mean ± SD or n (%) ^a	
Participated in free or reduced-price meals in high school				<.001
No	192 (10.8)	1,282 (72.3)	300 (16.9)	
Yes	47 (17.7)	109 (41.1)	109 (41.1)	
Spring semester housing				<.001
Off-campus	105 (8.6)	874 (71.2)	249 (20.3)	
On-campus residence hall	120 (18.0)	425 (63.6)	123 (18.4)	
On-campus apartment	12 (10.9)	66 (60.0)	32 (29.1)	
Fraternity or sorority	2 (6.1)	26 (78.8)	5 (15.2)	
Spring semester meal plan				<.001
No	130 (9.5)	964 (70.1)	281 (20.4)	
Yes	109 (16.4)	427 (64.3)	128 (19.3)	
Moved in with family				<.001
No	51 (5.3)	680 (70.9)	228 (23.8)	
Yes	188 (17.4)	711 (65.8)	181 (16.8)	
Spring semester employment				<.001
Unemployed	108 (13.4)	574 (71.0)	126 (15.6)	
Employed part time	116 (12.5)	593 (63.6)	223 (23.9)	
Employed full time	14 (5.3)	197 (74.3)	54 (20.4)	
Other	1 (2.9)	27 (79.4)	6 (17.7)	
Loss of employment				<.001
No	141 (10.1)	1,041 (74.6)	214 (15.3)	
Yes	98 (15.2)	350 (54.4)	195 (30.3)	
Loss of household employment				<.001
No	129 (9.9)	972 (74.7)	200 (15.4)	
Yes	103 (15.2)	386 (56.8)	191 (28.1)	
Financial aid				.001
No	57 (10.9)	390 (74.3)	78 (14.9)	
Yes	182 (12.0)	1,001 (66.1)	331 (21.9)	
Received SNAP during pandemic				<.001
No	230 (11.4)	1,380 (68.7)	400 (19.9)	
Yes	9 (31.0)	11 (37.9)	9 (31.0)	
Received financial support from family				<.001
No	44 (6.7)	464 (70.2)	153 (23.2)	
Before pandemic only	8 (19.1)	18 (42.9)	16 (38.1)	
During pandemic only	161 (13.5)	838 (70.4)	192 (16.1)	
Both before and during pandemic	26 (17.9)	71 (49.0)	48 (33.1)	
Provided financial support to family				<.001
No	188 (10.6)	1,269 (71.3)	323 (18.2)	
Before pandemic only	3 (9.1)	16 (48.5)	14 (42.4)	
During pandemic only	27 (19.0)	72 (50.7)	43 (30.3)	
Both before and during pandemic	21 (25.0)	34 (40.5)	29 (34.5)	

SD standard deviation; SNAP Supplemental Nutrition Assistance Program.

^aPercentages may not add up to 100% due to rounding.

food security. These students may have been able to rely more on their families for providing them with access to food after moving home.

We found that both a loss of employment for the student and loss of household employment were

associated with a higher odds of having worsened food security during the pandemic. Niles et al. found that job loss was associated with food insecurity during the COVID-19 pandemic [6]. College students who were furloughed, laid off, lost part-time work, or

Table 3 | Multinomial logistic regression for student characteristics associated with food security status improving or worsening during the spring 2020 semester from before to during the COVID-19 pandemic

	Unadjusted		Adjusted	
	Improved	Worsened	Improved	Worsened
	OR [95% CI]	OR [95% CI]	AOR ^a [95% CI]	AOR ^a [95% CI]
Age	0.90 [0.86, 0.93]***	0.99 [0.97, 1.01]	0.99 [0.92, 1.08]	0.97 [0.93, 1.02]
Gender				
Male	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Female	1.60 [1.12, 2.29]**	1.17 [0.90, 1.52]	1.35 [0.85, 2.14]	0.98 [0.72, 1.32]
Other/prefer not to answer	3.09 [1.35, 7.05]**	2.66 [1.38, 5.13]**	1.82 [0.62, 5.36]	1.15 [0.53, 2.51]
Ethnicity				
Non-Hispanic	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Hispanic	2.04 [1.30, 3.20]**	1.57 [1.06, 2.35]*	1.35 [0.69, 2.64]	0.91 [0.56, 1.48]
Race				
Asian	1.52 [1.06, 2.17]*	1.68 [1.26, 2.24]***	1.04 [0.62, 1.74]	1.60 [1.10, 2.32]*
Black or African American	1.17 [0.63, 2.16]	2.33 [1.55, 3.49]***	0.59 [0.26, 1.35]	1.38 [0.85, 2.25]
White	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Biracial or multiracial	2.34 [1.42, 3.88]***	1.87 [1.18, 2.96]**	1.43 [0.71, 2.89]	1.44 [0.84, 2.47]
Other	1.76 [0.83, 3.73]	2.96 [1.73, 5.07]***	0.52 [0.17, 1.57]	1.58 [0.81, 3.10]
Year in school				
Freshman	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Sophomore	1.28 [0.84, 1.95]	1.28 [0.84, 1.95]	0.98 [0.56, 1.71]	0.88 [0.54, 1.45]
Junior	1.10 [0.73, 1.67]	1.55 [1.05, 2.30]*	1.11 [0.57, 2.15]	0.87 [0.50, 1.52]
Senior	0.80 [0.48, 1.35]	1.60 [1.04, 2.48]*	0.66 [0.28, 1.59]	0.84 [0.44, 1.63]
Master's	0.19 [0.10, 0.39]***	1.38 [0.93, 2.05]	0.49 [0.15, 1.59]	0.88 [0.43, 1.83]
Doctoral	0.38 [0.23, 0.64]***	0.85 [0.56, 1.27]	1.83 [0.57, 5.81]	0.60 [0.27, 1.31]
Professional student (medical, pharmacy, etc.)	0.27 [0.14, 0.53]***	1.01 [0.64, 1.58]	0.76 [0.26, 2.24]	0.88 [0.43, 1.81]
Other	2.05 [0.37, 11.49]	3.08 [0.67, 14.14]	6.52 [0.74, 57.66]	1.63 [0.27, 9.72]
International student				
No	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Yes	0.66 [0.32, 1.40]	1.85 [1.22, 2.81]**	0.71 [0.25, 2.07]	1.82 [1.04, 3.20]*
First-generation college student				
No	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Yes	2.40 [1.75, 3.29]***	2.46 [1.90, 3.19]***	1.58 [1.00, 2.49]*	1.27 [0.92, 1.76]
Marital status				
Single	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Living with Partner	0.29 [0.14, 0.59]***	0.67 [0.44, 1.01]	0.62 [0.24, 1.58]	0.63 [0.39, 1.03]
Married	0.28 [0.14, 0.53]***	0.71 [0.49, 1.01]	1.14 [0.45, 2.89]	0.75 [0.46, 1.23]
Divorced	6.19 [1.65, 23.23]**	2.38 [0.53, 10.68]	3.65 [0.32, 41.96]	2.09 [0.39, 11.30]
Disability				
No	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Yes	1.66 [1.24, 2.23]***	2.05 [1.63, 2.59]***	1.17 [0.79, 1.75]	2.01 [1.53, 2.64]***
Participated in free or reduced-price meals in high school				
No	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Yes	2.88 [1.98, 4.19]***	4.27 [3.19, 5.73]***	0.76 [0.41, 1.40]	2.15 [1.46, 3.15]***
Spring semester housing				
Off-campus	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
On-campus residence hall	2.35 [1.77, 3.13]***	1.02 [0.80, 1.30]	1.10 [0.59, 2.08]	0.79 [0.48, 1.32]
On-campus apartment	1.51 [0.79, 2.89]	1.70 [1.09, 2.66]*	0.76 [0.31, 1.84]	1.19 [0.70, 2.03]
Fraternity or sorority	0.64 [0.15, 2.74]	0.68 [0.26, 1.78]	0.53 [0.11, 2.50]	0.77 [0.26, 2.28]
Spring semester meal plan				
No	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Yes	1.89 [1.43, 2.50]***	1.03 [0.81, 1.31]	1.24 [0.71, 2.16]	1.17 [0.76, 1.79]

(Continued)

Table 3 | Continued

	Unadjusted		Adjusted	
	Improved	Worsened	Improved	Worsened
	OR [95% CI]	OR [95% CI]	AOR ^a [95% CI]	AOR ^a [95% CI]
Moved in with family				
No	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Yes	3.53 [2.54, 4.89]***	0.76 [0.61, 0.95]*	2.36 [1.34, 4.15]**	0.53 [0.38, 0.75]***
Spring semester employment				
Unemployed	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Employed part time	1.04 [0.78, 1.38]	1.71 [1.34, 2.19]***	0.98 [0.60, 1.61]	1.03 [0.72, 1.48]
Employed full time	0.38 [0.21, 0.67]**	1.25 [0.87, 1.79]	0.53 [0.20, 1.37]	1.26 [0.75, 2.11]
Other	0.20 [0.03, 1.46]	1.01 [0.41, 2.50]	0.28 [0.03, 2.31]	0.65 [0.22, 1.89]
Loss of employment				
No	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Yes	2.07 [1.56, 2.75]***	2.71 [2.16, 3.41]***	1.26 [0.78, 2.03]	2.24 [1.62, 3.10]***
Loss of household employment				
No	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Yes	2.01 [1.51, 2.67]***	2.41 [1.91, 3.03]***	0.89 [0.61, 1.31]	1.81 [1.38, 2.35]***
Financial aid				
No	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Yes	1.24 [0.90, 1.71]	1.65 [1.26, 2.17]***	1.43 [0.93, 2.21]	1.32 [0.93, 1.86]
Received SNAP during pandemic				
No	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Yes	4.91 [2.01, 11.98]***	2.82 [1.16, 6.86]*	2.50 [0.64, 9.82]	1.77 [0.66, 4.74]
Received financial support from family				
No	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Before pandemic only	4.69 [1.93, 11.39]***	2.70 [1.34, 5.42]**	3.31 [1.07, 10.18]*	1.63 [0.71, 3.75]
During pandemic only	2.03 [1.43, 2.88]***	0.70 [0.55, 0.88]**	1.84 [1.04, 3.27]*	0.81 [0.57, 1.14]
Both before and during pandemic	3.86 [2.24, 6.66]***	2.05 [1.36, 3.09]***	2.22 [1.02, 4.83]*	1.79 [1.11, 2.88]*
Provided financial support to family				
No	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Before pandemic only	1.27 [0.37, 4.39]	3.44 [1.66, 7.12]***	0.45 [0.09, 2.35]	1.45 [0.61, 3.45]
During pandemic only	2.53 [1.59, 4.04]***	2.35 [1.58, 3.49]***	1.17 [0.57, 2.39]	1.36 [0.84, 2.22]
Both before and during pandemic	4.17 [2.37, 7.34]***	3.35 [2.01, 5.58]***	2.00 [0.87, 4.59]	1.97 [1.08, 3.58]*

AOR adjusted odds ratio; OR odds ratio; CI confidence interval; SNAP Supplemental Nutrition Assistance Program.
^aModels include age, gender, ethnicity, race, year in school, international student, first-generation college student, marital status, disability status, participation in free or reduced-price meals in high school, spring semester housing, spring semester meal plan, moved in with family, spring semester employment, loss of employment, loss of household employment, financial aid, received SNAP during the pandemic, received financial support from family, provided financial support to family, and baseline number of affirmative responses.
 * $p < .05$, ** $p < .01$, *** $p < .001$.

experienced other changes in employment had a significantly higher odds of being food insecure during the COVID-19 pandemic in a study of college students in Texas [8]. Past research conducted prior to the COVID-19 pandemic has also suggested that loss of employment is associated with food insecurity [18].

The majority (68%) of students in our sample received financial support from family at some point during the spring 2020 semester. Receiving financial support from family at any point during the spring semester was associated with a higher odds of improved food security; however, receiving financial support from family both before and during the pandemic was also associated with a higher odds of worsened food security during the pandemic. Students come from families with a variety of

financial backgrounds, so those coming from families with a better financial situation may have seen improvements, while those coming from families who are struggling financially may have seen their food security status worsen during the pandemic.

It is also important to keep in mind that some students provide financial support to their families. In our sample, 13% of students provided financial support to their family at some point during the spring 2020 semester. Students providing financial support to their family both before and during the COVID-19 pandemic had a higher odds of reporting worsened food security status. It is possible that some students may have been struggling financially themselves but were doing better financially than other members of their family and/or still felt a need to help.

Prior to the COVID-19 pandemic, many colleges and universities used strategies, such as campus food pantries and meal swipe programs, to address campus food insecurity, although there is limited peer-reviewed research looking at the efficacy of these programs [19]. With the increased use of remote learning among colleges and universities [20], new strategies are needed for helping students to meet their food needs regardless of where they are located, as well as evaluations of the efficacy of these strategies. With high rates of food insecurity found at institutions across the USA [12, 13], it is important to consider federal policies for addressing this issue. Most college students are categorically ineligible for SNAP, which is the largest federal nutrition program in the USA, due to additional exemptions college students who are attending more than half-time are required to meet, such as working at least 20 hr/week, in addition to the standard eligibility requirements [21]. Recent requests to waive the eligibility restrictions for college students during the COVID-19 pandemic were denied [22].

Several bills have recently been introduced, with an article finding 17 bills introduced during the 2019–2020 legislative session; however, all bills were still in early stages [23]. Since the pandemic, there have been two bills introduced to ensure that college students meeting eligibility requirements for SNAP are not denied access to the program during the COVID-19 pandemic [23]. The CARES Act provided some funding for institutions to provide emergency financial aid grants for students, which could be used for unexpected expenses due to the COVID-19 pandemic, including food costs. It is important for future legislation to not only provide short-term support but also include long-term sustainable approaches for helping college students meet their food needs.

To our knowledge, this is the first study looking at changes in food security status during the COVID-19 pandemic among a sample of college students. We looked not only at overall changes in the prevalence of different food security status categories but also examined the proportion of students whose food security status improved, worsened, or stayed the same based on the number of affirmative responses to the 10-item U.S. Adult Food Security Module to give a more precise estimate of how food security status changed during the COVID-19 pandemic and differences among these groups of students. This study does include some limitations. Students self-reported all measures, which could lead to response bias. The low response rate (7% of invited students included in the analytical sample) is an additional limitation, although it is similar to response rates found in other studies using a similar census sampling approach not limited to a single school within a university (i.e., School of Social Work), which ranged from 3% to 18% [13]. Our sample also differed from the overall student population on certain characteristics (higher

proportion of females and lower proportion of undergraduate students). While the approach of modifying the reference period of the tool used to assess food security status has been used in other studies of food insecurity during the pandemic [4, 6], this approach has not been validated. We did not ask whether students utilized campus resources for addressing food insecurity either before or during the pandemic. This information could have been helpful for assessing changes in the utilization of these resources, as well as whether changes in utilization were associated with changes in food security status. The study was also limited to a single university, which could limit the generalizability of the results.

CONCLUSIONS

Food insecurity among college students was an important issue that needed to be addressed before the COVID-19 pandemic but has become an even more important issue with the increasing prevalence rates. The prevalence of marginal, low, and very low food security among college students in our sample increased in the spring 2020 semester from before to during the COVID-19 pandemic. The changes in food security status were not all in one direction, however. For some students, food security status improved, for some, it stayed the same, and, for others, it worsened. The findings from this study help to understand characteristics associated with changes in food security status, which may be helpful in planning for strategies to support food security in college students. New approaches for addressing food insecurity among college students are needed as the strategies promoted in the past, such as campus food pantries and meal swipe programs, may be of limited value with the need for social distancing and use of remote learning. Policies for addressing food insecurity among college students should also be explored. Future studies looking at changes in food security status should be conducted with students from other universities, as well as explore strategies for addressing food insecurity among college students during the COVID-19 pandemic.

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Compliance with Ethical Standards

Conflicts of Interest: All authors declare that they have no conflicts of interest.

Author Contributions: All authors contributed to the conception and design of the study and writing of the manuscript. J.S. analyzed the data.

Ethical Approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study was

reviewed and determined to be exempt by the Institutional Review Board at the University of North Carolina at Chapel Hill. This article does not contain any studies with animals performed by any of the authors.

Informed Consent: Informed consent was obtained from all individual participants included in the study.

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