Research Article

Changes in Food Security Status During Undergraduate Enrollment

Cara L. Cuite, PhD[1]; Kelly E. Dietz, MPP[2]; La Reina J. Bates, PhD[3]; Stephanie A. Brescia, PhD[4]

ABSTRACT

Objective: To explore changes in student food security status (FSS) during college enrollment and correlates of those changes.

Design: Two cross-sectional surveys (2016 and 2019).

Participants: Undergraduates (n = 338) at a public university who completed both surveys.

Variables Measured: Food security status (US Department of Agriculture 10- and 18-item measures), demographics, and grade point average (GPA).

Analysis: Chi-square tests of goodness of fit for representativeness, McNemar-Bowker and paired samples Wilcoxon signed rank test for within-student FSS differences over time, logistic regression for the relationship between demographics and FSS over time, and ANCOVA for the relationship between FSS and GPA. Critical $P \leq 0.05$ unless otherwise noted.

Results: The prevalence of food insecurity was 22.4% in 2016 and 41.0% in 2019, and the McNemar-Bowker test indicated a significant asymmetrical relationship in FSS over time ($P < 0.001$). Almost half of the respondents (47.0%) reported experiencing food insecurity at least once. In multivariate analyses controlling for other demographic variables, first-generation students had the most consistent risk of food insecurity with lower FSS in 2016 ($P < 0.001$) and 2019 ($P < 0.001$), and they were more likely to have worsened FSS over time ($P = 0.05$). Food insecurity at either time was related to a lower 2019 GPA ($P < 0.001$).

Conclusions and Implications: Food security status measured cross-sectionally cannot capture changes in student FSS, which many students may experience. Longitudinal research is needed to better understand the role of demographic and student factors in FSS changes over time. Food resources should be offered to all students, as many will need them at some point.

Key Words: food insecurity, college students, higher education (*J Nutr Educ Behav.* 2022;000:1−10.)

Accepted August 5, 2022.

INTRODUCTION

More than 1 in 3 college students experience food insecurity[1] making this problem of particular concern to educators and institutional leaders across the country. Individuals and groups who have been systemically marginalized, such as students of color,[2,3] students from low-income environments,[3] and the first in their families to go to college[2,4,5] are more likely to have inconsistent or insufficient access to food. Furthermore, food insecurity has been linked to poor health[6,7] and academic outcomes[8,9] among those that experience it. Although increased attention to the problem of student food insecurity has resulted in a greater understanding of the prevalence and predictors of food insecurity, less is known about how students experience food insecurity. One underexplored area is whether food insecurity is fluid or remains consistent throughout a student's enrollment. Understanding this aspect of the student experience is critical when it comes to identifying and implementing solutions to food insecurity that are lasting, sustainable, and matched to the changing needs of students throughout their time in college.

Researchers and practitioners have long suspected that individual college students experience changes in their food security status (FSS) during their time in school; however, the most common approaches to studying college student food insecurity limit our ability to see evidence of these changes.[10] Quantitative data about college student FSS are most commonly collected in cross-sectional

[1]Department of Human Ecology, Rutgers University, New Brunswick, NJ
[2]Higher Education Program, Rutgers, the State University of New Jersey, New Brunswick, NJ
[3]Office of Institutional Research and Academic Planning, Rutgers, the State University of New Jersey, New Brunswick, NJ
[4]Graduate School of Education, Rutgers, the State University of New Jersey, New Brunswick, NJ

Conflict of Interest Disclosure: The authors have not stated any conflicts of interest.

Address for correspondence: Cara L. Cuite, PhD, Department of Human Ecology, Rutgers University, 55 Dudley Rd, New Brunswick, NJ 08840; E-mail: cuite@rutgers.edu

https://doi.org/10.1016/j.jneb.2022.08.004

surveys,[11,12] which can describe overall shifts in food insecurity rates over time but cannot identify intraindividual changes in FSS.[13] If the rate of food insecurity at a given school decreases from 1 year to the next, it may indicate that some of the students who were once food insecure are now food secure or that many of the students who were food insecure are no longer enrolled, or that the surveys reached different populations of students in each wave of data collection. Similarly, observed differences in FSS across class years (eg, first-year vs fourth-year students) in a cross-sectional survey could be because students who experience food insecurity have been disenrolled or that more students with food insecurity have transferred into the school in later years.

Factors Related to Food Insecurity

Race and ethnicity are important factors related to food insecurity among college students,[7,11] with students who are Black[2] and Latinx[3] being more likely to experience food insecurity. Students who are the first in their families to go to college have consistently been found to have an increased risk of food insecurity.[2,4,5] Although gender is not often found to be predictive of food insecurity, gender identity and sexual preference are related to food insecurity in many populations, as students who identify as non-cis-gendered and nonstraight are more likely to experience food insecurity.[2,14,15]

The relationship between experiencing food insecurity as a college student and academic performance (usually measured as grade point average [GPA]) is well documented.[3] Students who are food insecure are more likely to be employed than other students,[14] and this can have a negative impact on academic success.[16,17] Students experiencing food insecurity also report having difficulty studying because of worrying about food,[8,9] and some studies have documented students having to choose between paying for food or academic tools such as books.[9,18,19] Those experiencing food insecurity also report increased stress and depression,[7,20] which can interfere with academic success. Food insecurity is only 1 of many predictors of GPA and academic performance, and many factors are interrelated. One recent study found that the relationship between being Black and/or Latinx and having a lower GPA is partially mediated by food insecurity.[3] Finally, students experiencing food insecurity are less likely to complete their degrees.[4]

METHODS

The current study uses 2 surveys conducted at the same university 3 years apart to examine within-student changes in food insecurity over time. This design allows us to better understand dynamics of food insecurity and provides the opportunity to examine what demographic factors may influence the FSS trajectory of an individual student and how this may affect academic performance. This research investigates whether FSS changes throughout a student's enrollment. It then examines whether changes in FSS vary by student demographic characteristics and if changes in FSS over time are related to academic performance.

Design

We conducted 2 cross-sectional surveys at a public university in the Northeast 3 years apart. Students who completed both surveys comprised the analytical cohort discussed here. Findings from the much larger cross-sectional studies, which include those in the analytical cohort, are reported elsewhere.[21,22]

The first survey was conducted in 2016, and the second in 2019. Both surveys were conducted over 4 weeks, from mid-November to mid-December, using the online survey research platform Qualtrics (SAP, 2016 and 2019). We used a census design; thus, all undergraduate and graduate students were invited to participate; only undergraduate data are presented here. For both surveys, a senior administrator sent 4 emails to all students 1 week apart, department administrators and academic deans sent additional follow-up emails, and we posted flyers around campus. All recruitment materials included a link to the survey. Although in 2016 the survey recruitment materials mentioned hunger as a topic of the survey, this was changed in 2019 to better align with surveys conducted at other universities, and food insecurity was not mentioned to avoid over-response from students who experience this hardship. For both surveys, students who finished the survey were entered into a lottery for the chance to win 1 of several $100 gift cards.

For both administrations, students accessed the survey using their student identification number to authenticate their participation eligibility and ensure each student only responded once per administration. The Rutgers University Institutional Review Board reviewed and approved the project as an exempt protocol. Participants provided electronic consent twice at the beginning of each survey administration. By consenting, students agreed to have their survey responses linked to institutional data from their student records. In 2019, the consent also permitted researchers to connect 2016 survey responses to their 2019 data, allowing us to create the analytical cohort of students who completed both surveys.

Measures

Each survey asked many of the same questions, but the instruments were not identical. The 2016 survey measured FSS using the 10-item Food Security Survey Module,[23] whereas in 2019, the expanded 18-item version included questions about children in the household. In both surveys, a 30-day timeframe was used. This change was aligned with similar surveys at other universities and research centers over the same period. In 2019, we also removed the do not know response option for these questions for the same reason.

Questions in the Food Security Survey Module included items regarding worrying about running out of food, being able to afford balanced meals, being hungry but not eating, and losing weight, with all of the questions centered on being able to afford food. Affirmative responses

received a score of 1 and are summed across all items. The sum is used to create a 4-level FSS scale, with high food security (0), marginal food security (1−2), low food security (3−5), and very low food security (6−10).[23] Scores for respondents with children were calculated out of 18, with high food security (0), marginal food security (1−2), low food security (3−7), and very low food security (8−18). We reverse coded this 4-level variable so that higher scores equated to higher levels of food security (1, very low; 4, high). This 4-level scale was also used to create a binary FSS variable, with high and marginal combined into food secure (1) and low and very low food insecure (0).[23] We also used the 4-level FSS to create binary variables to indicate if FSS had worsened from 2016 to 2019; 1 indicated if FSS was at a lower level (less food secure) in 2019 than in 2016 or remained at very low vs 0 if it had not. We similarly used the 4-level FSS to create binary variables to indicate if FSS had improved from 2016 to 2019; 1 indicated if FSS was at a higher level (more food secure) in 2019 than in 2016 or remained at high vs 0 if it had not. Finally, we used both of the 2-level FSS variables to create a new 4-level variable (FSS in 2016 and 2019) that indicated if the respondent was food secure at both time points (0), food insecure in 2016 only (1), food insecure at 2019 only (2), or food insecure at both time points (3).

Because students logged on to the survey using their student identification number, we linked their responses to institutional data so that we did not need to measure them on the survey. All demographic data were collected on the students' applications to the university, including parents' educational level (no high school, some high school, high school graduate, some college, 2-year degree, 4-year degree, and graduate study), sex (male, female), citizenship (US citizen, not US citizen), race/ethnicity (African American, Asian, Hispanic, White, and other comprised Native American/American Indian, ≥ 2, other and unknown), and age (continuous based on the date of birth). Students could select more than one choice for race/ethnicity. Academic information, including degree level, class level (based on the no. of credits), and cumulative GPA, was provided from internal registrar databases. We used a combination of parents' educational levels to create a variable to indicate first-generation status, defined as neither parent having a bachelor's degree.[24] We also created binary variables for race/ethnicity, with all categories other than White collapsed into the students of color category because of the smaller number of non-White student groups, for sex (male and female), and age (based on age in 2019), with students aged 21−22 as traditional-aged and age ≥ 23 as nontraditional.

Analysis

This paper provides basic descriptive statistics on the demographic and student characteristics of the participants. To test for the representativeness of the analytical cohort compared with the eligible population of participants (ie, students who were enrolled in both 2016 and 2019) in terms of age, citizenship, class level, sex, race/ethnicity, and first-generation college student status, we conducted chi-square goodness of fit tests. We used Cramers V to determine the effect size.[25]

To understand if students' FSS is constant over the 2 time points (our first research question), we used a McNemar-Bowker test of symmetry to analyze within-subject change on the 4-level FSS variable. To further understand the direction of any significant change, we used the Wilcoxon signed-ranked test for paired samples. The 4-level FSS variable was treated as ordinal, with high FSS having the highest value. Three students were excluded from the analytical cohort because they answered the FSS questions in 2016 but not in 2019.

To test for an association between demographic variables and change in FSS (our second research question), we tested for both bivariate and multivariate associations between our 4 binary demographic variables (age, first-generation student status, sex, and race/ethnicity) and binary FSS at 2016, binary FSS at 2019, binary worsening FSS variable, and binary improving FSS variable. These analyses were largely exploratory, given the small sample size. We conducted 4 cross-tabulations, 1 each for FSS in 2016, FSS in 2019, FSS worsening over time, and FSS improving over time, which were broken out by each demographic variable. We conducted chi-square tests of independence to test the bivariate relationships between the demographics and the 4 FSS-related variables. We also conducted 4 multivariate logistic regressions to understand the associations between the demographic variables and these FSS variables while controlling for the effects of the other demographic variables. These FSS variables were treated as outcome variables, whereas the binary demographic variables were treated as the predictor variables in the model. Students with missing demographic data were removed from the relevant analyses (sex, n = 1; race/ethnicity, n = 2; first-generation student, n = 3).

Finally, to test our third research question, we used a between-groups ANCOVA to analyze the effect of FSS over time on 2019 GPA. The dependent variable was the 2019 GPA, as most students in the analytical cohort did not yet have a GPA during the 2016 survey. The independent variable was the 4-level FSS change over time, and we controlled for the effects of demographic variables, age in 2019 (continuous), and the binary variables for first-generation student status, sex, and race/ethnicity. We then conducted pairwise comparisons of the 4 levels of the FSS change over time.

Significance criterion α was set at $P \leq 0.05$, except for the pairwise comparisons in which it was $P \leq 0.0125$ using a Bonferroni correction for 4 comparisons. Analyses were conducted using SPSS (version 28, IBM Corp, 2021), SAS (version 9.4, SAS Institute Inc, 2013), and R Statistical Software (version 4.0.4, R Core Team, 2021).

RESULTS

In 2016, 6,823 undergraduates (19.7% response rate) completed the survey, whereas 5,063 undergraduates (14.5% response rate) completed

Table 1. Representativeness of Sociodemographic and Student Characteristics for Analytical Cohort of Undergraduates

Characteristic	2016 and 2019 Eligible Population[a] (N = 7,702)	Analytical Cohort[b] (n = 338)	Representativeness of Analytical Cohort	
			χ^2 (*P*)[c]	Cramers V
Age group			18.62 (0.00)	0.05
Traditional college age (21-22 y)	6,383 (82.9)	310 (91.7)		
Nontraditional (23-82 y)	1,319 (17.1)	28 (8.3)		
Citizenship[d]			8.96 (0.00)	0.03
US citizen	6,999 (90.9)	323 (95.6)		
Non-US citizen	703 (9.1)	15 (4.4)		
2016 Class level			12.29 (0.01)	0.04
First-year	5,537 (71.9)	268 (79.3)		
Second-year	1,581 (20.5)	57 (16.9)		
Third-year	424 (5.5)	12 (3.6)		
Fourth-year	160 (2.1)	1 (0.3)		
2019 Class level			7.44 (0.06)	0.03
First-year	10 (0.1)	0 (0.0)		
Second-year	99 (1.3)	2 (0.6)		
Third-year	827 (10.7)	23 (6.8)		
Fourth-year	6,766 (87.8)	313 (92.6)		
First-generation college student			0.46 (0.80)	0.01
Yes	2,392 (31.1)	107 (31.7)		
No	5,262 (68.3)	228 (67.5)		
Unknown	48 (0.6)	3 (0.9)		
Sex			105.28 (0.00)	0.12
Female	3,664 (47.6)	255 (75.4)		
Male	4,038 (52.4)	83 (24.6)		
Race/ethnicity			6.96 (0.14)	0.03
African American	548 (7.1)	19 (5.6)		
Asian	2,990 (38.8)	120 (35.5)		
Hispanic	1,010 (13.1)	38 (11.2)		
White	2,749 (35.7)	138 (40.8)		
Other	405 (5.3)	23 (6.8)		

[a]The eligible population comprises those students enrolled in 2016 and 2019 who were invited to complete both surveys and were eligible to be in the analytical cohort.

Note: Demographic data for the eligible population and analytical cohort are from 2019 except for the 2016 class level. Values are n (%). U.S. Citizen includes permanent residents. Other race/ethnicity includes Native American/American Indian, > 2, other, and unknown. Statistical tests performed: Chi-square test of goodness of fit. Critical $P \leq 0.05$. Cramers V effect sizes[25] < 0.10 indicates negligible effect, 0.10 > 0.20 indicates weak effect.

the survey in 2019. Among the 1,814 undergraduates who took the 2016 survey and were still enrolled in 2019, 338 (18.6%) completed the survey (and the FSS) in 2019. This group comprised our analytical cohort.

Sample Demographics

Demographics for the analytical cohort are shown in Table 1. Any demographic variables that may have changed for an individual student (eg, change in sex) are reported as they were recorded in 2019, except class year was reported for both time points. The analytical cohort consisted largely of students of traditional college age (< 23 years) and US citizens. The analytical cohort was almost exclusively fourth-year students in 2019. About 1-in-3 were first-generation students. Females comprised 75.4% of the analytical cohort, and there was a mix of race/ethnicity, none of which constituted a majority. There were some significant differences between the analytical cohort and the eligible population of students (those enrolled at both time points) in terms of these demographics, in which the analytical cohort was more likely to be traditional college-aged, less likely to be a US citizen, more likely to be in a more advanced class level, and more likely to be female; however, the Cramer's V < 0.10 indicated that these were negligible effects, except for sex, which was a weak effect (Cramer's V = 0.15).[25] Thus, the sample largely represented the eligible population in the variables presented in Table 1.

Does Food Insecurity Change Throughout a Student's Enrollment?

Frequencies of FSS for the analytical cohort at each timepoint are presented in the totals row and column of Table 2. In 2016, 22.4% of students

Table 2. 2016 FSS by 2019 FSS Among Undergraduates (n = 338)

	2019 FSS[b]				
2016 FSS[a]	**High**	**Marginal**	**Low**	**Very Low**	**Total**
High	106 (31.4)	36 (10.7)	38 (11.2)	18 (5.3)	198 (58.6)
Marginal	21 (6.2)	16 (4.7)	16 (4.7)	11 (3.3)	64 (18.9)
Low	9 (2.7)	9 (2.7)	9 (2.7)	13 (3.8)	40 (11.8)
Very low	1 (0.3)	1 (0.3)	17 (5.0)	17 (5.0)	36 (10.6)
Total	137 (40.4)	62 (18.3)	80 (23.6)	59 (17.4)	338 (100)

FSS indicates food security status.
[a]Measured using the 10-item Food Security Survey Module; [b]Measured using the 18-item Food Security Survey Module.
Note: Values displayed as n (% of total). Statistical test conducted is the McNemar-Bowker test ($\chi^2 = 47.878$, degrees of freedom = 6, $P < 0.001$) and paired samples Wilcoxon signed rank test ($P < 0.001$). Critical $P \leq 0.05$.

experienced food insecurity (combined low and very low FSS); in 2019, the prevalence was 41.0%. The prevalence of food insecurity at either time (ie, anyone who had low or very low food security in 2016, 2019, or both) was 47.0%.

The McNemar-Bowker test conducted on the data presented in Table 2 indicated that there was a significant asymmetrical relationship between students' FSS in 2016 and 2019 ($\chi^2 = 47.878$, degrees of freedom = 6, $P < 0.001$), meaning that within-subject FSS was significantly different across the 2 time points. A paired sample Wilcoxon signed rank test indicated that students' FSS was significantly lower in 2019, meaning that students were more likely to be food insecure in 2019 than in 2016 ($P < 0.001$).

Table 2 also demonstrates that fewer than half (44%) of the students had the same FSS in both 2016 and 2019 (ie, 56% reported different FSS at each time point using the 4-level variable). However, the largest cell in the table represents students who reported high FSS at both time points (31%; n = 106). At the 3 lower FSS levels, relatively few students remained at the same level from 2016-2019.

Conversely, the majority (56%; n = 190) of students reported different FSS levels at the 2 time points when using the 4-level FSS variable. As we would expect on the basis of the paired samples Wilcoxon signed rank test, more students were classified at a lower FSS in 2019 than in 2016 (39%; n = 132) than at a higher FSS in 2019 than in 2016 (17%; n = 58).

Do Changes in Food Insecurity Over Time Vary by Student Demographic Characteristics?

Table 3 presents the 2-level FSS of the analytical cohort in 2016 and 2019, broken out by 4 demographic variables and chi-square tests of independence for the bivariate relationships. When examining the effects of each demographic variable individually, we see that being a student who is the first in their family to attend college and being non-White were associated with being food insecure in both 2016 ($P < 0.001$ and $P = 0.02$, respectively) and 2019 ($P < 0.001$ and $P = 0.01$, respectively). In addition, students who are not traditionally aged were significantly more likely to be food insecure in 2016 ($P < 0.001$).

Table 3 also presents an examination of the multivariate relationships using logistic regression. When controlling for the effects of the other demographic variables, nontraditional aged and first-generation students had significantly lower FSS in 2016 (both $P < 0.001$), whereas race/ethnicity was no longer significantly related to FSS in this multivariate analysis. The Nagelkerke pseudo r^2 indicated that the model explained 14.3% of the variance in 2016 FSS. First-generation students and students of color had lower FSS in 2019 in the multivariate analyses ($P < 0.001$ and $P = 0.02$, respectively), and the Nagelkerke r^2 indicated that the model explained 8.8% of the variance in 2019 FSS.

Table 4 presents an exploratory analysis of the variables measuring if FSS worsened from 2016 to 2019, as well as results of chi-square tests of independence for these bivariate relationships and multivariate logistic regression. Although there were no differences by age, race, or sex, first-generation students were significantly more likely to have worsened FSS in both the bivariate and multivariate analyses ($P = 0.03$ and $P = 0.05$, respectively). Nagelkerke's pseudo r^2 indicated that the multivariate model explained 3.4% of the variance in worsening FSS.

In terms of improving FSS from 2016 to 2019, in the bivariate analysis, students who were not first-generation and those who were White were significantly more likely to have improved FSS ($P = 0.03$ and $P = 0.02$, respectively), and students who were White were more likely to have improved FSS in the multivariate analysis as well ($P = 0.03$).

Are There Differences in Academic Performance by Changes in Food Insecurity Over Time?

We examined the relationship between FSS levels at both time points and GPA while controlling for the effects of demographic variables. Table 5 shows the results of the ANCOVA, and we see a significant relationship between FSS and GPA ($F(7, 325) = 5.74$, $P < 0.001$) when controlling for the demographic covariates. The adjusted r^2 indicated that the

Table 3. Associations Between 2016 and 2019 FSS With Demographic Characteristics in Undergraduates (n = 338)

	2016 FSS					2019 FSS				
	Bivariate Associations			Multivariate Logistic Regression		Bivariate Associations			Multivariate Logistic Regression	
Characteristics	**Food Insecure, n (%)**	**Food Secure, n (%)**	**χ^2 (*P*)**	**Adjusted OR (95% CI)**	***P***	**Food Insecure, n (%)**	**Food Secure, n (%)**	**χ^2 (*P*)**	**Adjusted OR (95% CI)**	***P***
Age			25.60 (< 0.001)	5.68 (2.44-13.24)	< 0.001			1.95 (0.16)	1.40 (0.62-3.19)	0.42
Traditional (n = 310)	59 (19.0)	251 (81.0)				124 (40)	186 (60.0)			
Nontraditional (n = 28)	17 (60.7)	11 (39.3)				15 (53.6)	13 (46.4)			
First-generation student			14.25 (< 0.001)	2.29 (1.31-4.01)	< 0.001			13.79 (< 0.001)	2.24 (1.38-3.62)	< 0.001
Yes (n = 107)	37 (34.6)	70 (65.4)				59 (55.1)	48 (44.9)			
No (n = 228)	37 (16.2)	191 (83.8)				77 (33.8)	151 (66.2)			
Race/ethnicity			5.50 (0.02)	1.76 (0.98-3.17)	0.06			7.41 (0.01)	1.75 (1.10-2.79)	0.02
White (n = 138)	22 (15.9)	116 (84.1)				45 (32.6)	93 (67.4)			
Students of color (n = 198)	53 (26.8)	145 (73.2)				94 (47.5)	104 (52.5)			
Sex			0.50 (0.48)	0.97 (0.52-1.85)	0.92			1.74 (0.19)	1.59 (0.92-2.75)	0.10
Male (n = 83)	21 (25.3)	62 (74.7)				29 (34.9)	54 (65.1)			
Female (n = 255)	55 (21.6)	200 (78.4)				110 (43.1)	145 (56.9)			

CI indicates confidence interval; FSS, food security status; OR, odds ratio.

Note. Students were considered food insecure if they had low or very low food security status (FSS) on the 4-level FSS variable; marginal and high were considered food secure. Age is binary, with traditional student age (21-22 y) as 0 and nontraditional (≥ 23 y) as 1. A first-generation student is coded as 0 (no) and 1 (yes); race/ethnicity is coded as 0 (White) and 1 (student of color); sex is coded as 0 (male) and 1 (female). Statistical tests performed: chi-square tests of independence for bivariate associations and multivariate logistic regression with demographic predictor variables and 2016 and 2019 FSS as the outcome variables. Critical $P \leq 0.05$. Nagelkerke pseudo r^2 was 0.14 for the 2016 model and 0.09 for the 2019 model.

model explained 9.1% of the variance in GPA and that FSS had a medium effect size ($\eta_p^2 = 0.081$).[25] None of the demographic covariates had a significant effect on GPA. Pairwise comparisons indicated no significant differences in GPA among the 3 groups that had experienced food insecurity at least 1 time. However, students who experienced food insecurity in 2016, 2019, or both had significantly lower GPAs than students who did not experience food insecurity at either time point (see Table 5 for adjusted means and pairwise comparisons).

DISCUSSION

This study aimed to explore changes in student food insecurity over time and determine if these changes were associated with student demographic characteristics or GPA. Our findings illustrate that the experience of food insecurity is not a constant, static characteristic for undergraduates but is fluid and can change over time. Most students reported some change in their FSS, and they were significantly more likely to report becoming less food secure over time. The changes in FSS over time demonstrated here indicate that the most common analytical approaches to measuring student food insecurity may be insufficient to fully understand the issue, as cross-sectional surveys are likely to underestimate the likelihood of a college student experiencing food insecurity at some point in their college enrollment. For example, although the likelihood that a student in the analytical cohort would report experiencing food insecurity at each timepoint was about 1 in 5 (2016) and 2 in 5 (2019), the likelihood of a student reporting experiencing food insecurity at either point was higher, at almost 1 in 2.

We observed differences by demographic characteristics in terms of FSS at each timepoint and worsening and improving FSS over time; however, these analyses were exploratory and should be interpreted cautiously. As expected from the literature,[2,4,5] students who are the first in their families to go to college were significantly more likely to be food insecure

Table 4. Associations Between Worsening and Improving FSS With Demographic Characteristics in Undergraduates (n = 338)

Characteristics	Worsening FSS From 2016 to 2019: Bivariate Associations: FSS Worsened Or Stayed Very Low (n = 149), n (%)	FSS Did Not Worsen (n = 189), N (%)	χ^2 (*P*)	Multivariate Logistic Regression: Adjusted OR (95% CI)	*P*	Improving FSS From 2016 to 2019: Bivariate Associations: FSS Improved Or Stayed High (n = 164), n (%)	FSS Did Not Improve (n = 174), N (%)	χ^2 (*P*)	Multivariate Logistic Regression: Adjusted OR (95% CI)	*P*
Age			0.02 (0.89)	0.77 (0.34-1.74)	0.53			0.03 (0.87)	1.30 (0.58-2.92)	0.53
Traditional (n = 310)	137 (55.8)	173 (44.2)				150 (48.4)	160 (51.6)			
Nontraditional (n = 28)	12 (42.9)	16 (57.1)				14 (50.0)	14 (50.0)			
First-generation student			4.56 (0.03)	1.62 (1.01-2.61)	0.05			4.52 (0.03)	0.63 (0.39-1.01)	0.06
Yes (n = 107)	56 (52.3)	51 (47.7)				43 (40.2)	64 (59.8)			
No (n = 228)	91 (39.9)	137 (60.1)				120 (52.6)	108 (47.4)			
Race/ethnicity			3.35 (0.07)	1.46 (0.93-2.29)	0.10			5.39 (0.02)	0.61 (0.39-0.95)	0.03
White (n = 138)	53 (38.4)	85 (61.6)				77 (55.8)	61 (44.2)			
Students of color (n = 198)	96 (48.5)	102 (51.5)				85 (42.9)	113 (57.1)			
Sex			0.83 (0.36)	1.30 (0.77-2.18)	0.33			2.10 (0.15)	0.67 (0.40-1.13)	0.13
Male (n = 83)	33 (39.8)	50 (60.2)				46 (55.4)	37 (44.6)			
Female (n = 255)	116 (45.5)	139 (54.5)				118 (46.3)	137 (53.7)			

CI indicates confidence interval; FSS, food security status; OR, odds ratio.

Note: Students were considered to have worsened FSS if they scored lower on the 4-level FSS in 2019 compared with 2016 (lower score means more food insecure), or if they were at very low FS at both times and thus could not have had a lower score. Students were considered to have improved FSS if they scored higher on the 4-level FSS in 2019 compared with 2016 or had high FSS at both time points and thus could not have a higher score. Age is binary, with traditional student age (21-22 y) as 0 and nontraditional (≥ 23 y) as 1. First-generation student is coded as 0 (no) and 1 (yes); race/ethnicity is coded as 0 (White) and 1 (student of color); sex is coded as 0 (male) and 1 (female). Statistical tests performed: chi-square tests of independence for bivariate associations and multivariate logistic regression with demographic predictor variables and worsening and improving 2019 FSS as the outcome variables. Critical $P \leq 0.05$. Nagelkerke pseudo r^2 was 0.03 for the model of worsening FSS and 0.05 for the model of improving FSS.

at both time points. This study adds to the literature by finding that first-generation students are also significantly more likely to experience worsening food insecurity across the 2 timepoints and less likely to have improved FSS than those who are not. Again, as was expected on the basis of existing cross-sectional research,[2,7,11] our data indicated that students of color were significantly more likely to be food insecure (at the 2019 timepoint). Adding to this literature, students of color were significantly less likely to have improved FSS across the 2 time points than White students.

The findings regarding changes in FSS among first-generation students and students of color may be especially problematic given that these students were already reporting significantly lower FSS in 2016. This indicates that there may be a compounding effect over time, in which certain groups of students who are most likely to experience food insecurity at the start of their time in college are the same students who may be more likely to experience even worse FSS later.

This study highlights the potential role that food insecurity may have on academic performance, as we explored with our third research question. Based on the existing literature, we expected that 2019 FSS and GPA would be related.[3,8,9] Our study contributes to the literature by demonstrating that the impact of food insecurity on academic performance is not limited to the time at which FSS and GPA are measured. Students who were food insecure in 2016 but food secure in 2019 had significantly lower GPAs than those who never experienced food insecurity. Thus, our data indicate that cross-sectional studies may not fully account for the longer-term impacts of being food insecure on academic performance and, as a result, may underestimate them. In addition, our results indicate that FSS was a much stronger predictor of GPA than the 4 demographic covariates included in our model.

There are several limitations to the current study. Although this study describes how FSS changes during students' time in college and

Table 5. Association Between FSS in 2016 and 2019 on GPA Controlling for Demographic Covariates in Undergraduates (n = 338)

Variables	Adjusted Mean GPA	SE	Paired Comparisons: Food secure both years, *P*	Paired Comparisons: Food insecure 2016 only, *P*	Paired Comparisons: Food insecure 2019 only, *P*	Paired Comparisons: Food insecure both years, *P*	*F*	*P*	η_p^2
FSS in 2016 and 2019							9.60	< 0.001	0.08
Food secure both years	3.50^a	0.04		0.01	< 0.001	< 0.001			
Food insecure 2016 only	3.19^b	0.11	0.01		0.99	0.57			
Food insecure 2019 only	3.19^b	0.05	< 0.001	0.99		0.41			
Food insecure both years	3.26^b	0.07	< 0.001	0.57	0.41				
Covariates									
Age							1.39	0.24	< 0.001
First-generation student							1.35	0.25	< 0.001
Race							1.85	0.18	0.01
Sex							1.56	0.21	0.01

FSS indicates food security status; GPA, grade point average.

Note: A 1-way ANCOVA was conducted to evaluate the relationship of FSS in 2016 and 2019 (a combination of the 2-level 2016 and 2-level 2019 FSS variables) on mean GPA. Covariates appearing in the model are evaluated at the following values: age (continuous) = 21.65, first-generation college student (binary yes or no) = 0.3183, race (binary White or student of color) = 0.5856, sex (male or female) = 0.7628. Means with different superscript letters (a and b) indicate significant differences with pairwise comparisons using Bonferroni corrected critical $P \leq 0.01$. The overall model ($F(7, 325) = 5.74$, $P < 0.001$) has an adjusted $r^2 = 0.091$.

demographic correlates of improved and worsening FSS, we only collected data at 2 time points. In addition, we used a 30-day retrospective period to measure FSS at each time point. Thus, we examine self-reported FSS over 60 days, representing a small percentage of students' time in college. There was likely even more change in FSS than what this study was able to capture, and therefore we may have inaccurately described some students as remaining food secure across their college enrollment when in fact, their FSS may have changed multiple times. Thus, the number of students who experience food insecurity across their enrollment is likely higher than reported here. The slight differences in the methodology of each survey (recruitment approaches and FSS measurement) could explain differences in the food insecurity rates between the groups in 2016 and 2019.

An additional limitation is that the study was conducted at only 1 university and may not be representative of college students at other schools (though it is generally representative of the students at the university where the research was conducted, which is a strength of this study). The small size of the analytical cohort included here meant that some analyses were exploratory, particularly for the demographic variables. In addition, for some of these analyses, we had to combine groups of students for less fine-grained analysis. For example, we combined all non-White students of color into 1 group, which oversimplifies the effects of race and ethnicity on food insecurity. Similarly, while we asked about a range of gender identities in 2019, we used the simplified data on sex from the university database with only male and female categories, resulting in a less nuanced analysis. We also recognize that other variables that could impact FSS, such as employment status or experience with housing insecurity, were not included in this study.

It is possible, and even quite likely that retention varied by food security status,[4] but that cannot be measured using the current dataset. Because we did not ask participants to consent to connect their data over multiple

time points in 2016 (but did in 2019), we were not able to include those students who may have paused, discontinued enrollment, or been dismissed from the university, nor those who may have graduated early. If students experiencing food insecurity were more likely to have paused or discontinued enrollment without graduating, food insecurity at both time points is likely under-reported in the panel data, and the impacts of food insecurity on GPA are likely to be larger than indicated here.

IMPLICATIONS FOR RESEARCH AND PRACTICE

Cross-sectional studies capture food insecurity at a point in time, but the dynamic experiences of students may be missed. Future research using panel survey designs, especially those that measure food insecurity at > 2 points in time, would be valuable in further understanding this complex issue. In addition, panel studies with larger samples than the current study would allow for a deeper understanding of how the demographic factors explored here, as well as others such as being a parenting student, a veteran, and financially independent,[1,26] interact with food insecurity over time. They could also help identify which students are most at risk for food insecurity and what colleges can do to help students lower their risk for becoming food insecure over time. Finally, disaggregating GPA data to analyze academic achievement by individual semester would allow for a more nuanced understanding of how and when food insecurity affects GPA.

In terms of nutrition education practice, this study indicates that targeting interventions solely at students currently experiencing food insecurity is likely insufficient. These data indicate that on-campus and off-campus food resources should be advertised and shared early and often to ensure that students who are not currently experiencing food insecurity know how and where to access services should they need them later, as our data suggest many will need these services. This is especially true for first-generation students and students of color. Finally, the academic performance of students who had experienced food insecurity at any point in time was more alike than those who had not, regardless of their current food insecurity level. This indicates that in addition to food support, additional academic support may help to ameliorate this important correlate of food insecurity.

ACKNOWLEDGMENTS

The authors wish to thank the Rutgers University-New Brunswick Division of Student Affairs, particularly Vice Chancellor Salvador Mena, Dean Kerri Willson, Director Dayna Weintraub, and former Executive Vice Chancellor Felicia McGinty. The authors also thank the Rutgers University Office of Institutional Planning and Academic Affairs, particularly former Director Robert Heffernan, for their help administering the survey and providing institutional data. In addition, the authors thank Marc Weiner for providing methodological expertise and Isabel Craig for help with formatting. This paper benefited greatly from the comments of anonymous reviewers. Finally, the authors thank the students who participated in the surveys.

REFERENCES

1. The Hope Center for College, Community, and Justice. #RealCollege 2021: basic needs insecurity during the ongoing pandemic. https://hope4college.com/rc2021-bni-during-the-ongoing-pandemic/. Accessed July 11, 2022.
2. Laska MN, Lenk K, Lust K, McGuire CM, Porta CM, Stebleton M. Sociodemographic and health disparities among students screening positive for food insecurity: findings from a large college health surveillance system. *Prev Med Rep*. 2021;21:101297.
3. Camelo K, Elliott M. Food insecurity and academic achievement among college students at a public university in the United States. *J Coll Stud Dev*. 2019;60:307–318.
4. Wolfson JA, Insolera N, Cohen AJ, Leung CW. The effect of food insecurity during college on graduation and type of degree attained: evidence from a nationally representative longitudinal survey. *Public Health Nutr*. 2021:1–22.
5. Riddle ES, Niles MT, Nickerson A. Prevalence and factors associated with food insecurity across an entire campus population. *PLoS One*. 2020;15:e0237637.
6. Knol LL, Robb CA, McKinley EM, Wood M. Food insecurity, self-rated health, and obesity among college students. *Am J Health Educ*. 2017;48:248–255.
7. Payne-Sturges DC, Tjaden A, Caldeira KM, Vincent KB, Arria AM. Student hunger on campus: food insecurity among college students and implications for academic institutions. *Am J Health Promot*. 2018;32:349–354.
8. O'Neil M, Maguire J. College students self-reported food insecurity andcorrelations with health and academic performance. *J Behav Soc Sci*. 2017;4:34–40.
9. Martinez SM, Maynard K, Ritchie LD. C *Student Food Access and Security Study*. Nutrition Policy Institute, University of California; 2016. https://regents.universityofcalifornia.edu/regmeet/july16/e1attach.pdf. Accessed July 11, 2022.
10. Hendriks SL. The food security continuum: a novel tool for understanding food insecurity as a range of experiences. *Food Secur*. 2015;7:609–619.
11. Baker-Smith C, Coca V, Goldrick-Rab S, Looker E, Williams T. #RealCollege 2020: five years of evidence on campus basic needs insecurity. https://hope4college.com/realcollege-2020-five-years-of-evidence-on-basic-needs-insecurity/. Accessed July 11, 2022.
12. Nazmi A, Martinez S, Byrd A, et al. A systematic review of food insecurity among US students in higher education. *J Hunger Environ Nutr*. 2019;14:725–740.
13. Gundersen C, Ziliak JP. Food insecurity research in the United States: where we have been and where we need to go. *Appl Econ Perspect Policy*. 2018;40:119–135.
14. Testa A, Jackson DB. Sexual orientation and food insecurity: findings from the New York City Community Health Survey. *Public Health Nutr*. 2021;24:5657–5662.
15. Russomanno J, Jabson Tree JM. Food insecurity and food pantry use among transgender and gender non-conforming people in the Southeast United States. *BMC Public Health*. 2020;20:590.

16. Pike GR, Kuh GD, Massa-McKinley RC. First-year students' employment, engagement, and academic achievement: untangling the relationship between work and grades. *NASPA J.* 2008;45:560–582.
17. Bozick R. Making It through the first year of college: the role of students' economic resources, employment, and living arrangements. *Sociol Educ.* 2007;80:261–285.
18. Dubick J, Mathews B, Cady C. Hunger on campus: the challenge of food insecurity for college students. https://studentsagainsthunger.org/hunger-on-campus/. Accessed July 11, 2022.
19. Brescia SA, Cuite CL. Understanding coping mechanisms: an investigation into the strategies students use to avoid, manage, or alleviate food insecurity. *J Coll Character.* 2019;20:310–326.
20. Freudenberg N, Manzo L, Jones H, Kwan A, Tsui E, Gagnon M. *Food Insecurity at CUNY: Results From a Survey of CUNY Undergraduate Students.* Healthy CUNY Initiative, City University of New York; 2011. https://food.ucsb.edu/docs/default-source/default-document-library/foodinsecurity-cuny-copy.pdf?sfvrsn=a5af4669_0. Accessed April 1, 2022.
21. Cuite CL, Brescia SA, Porterfield V, Weintraub DS, Willson KA. Food insecurity among students at Rutgers University-New Brunswick. http://humeco.rutgers.edu/documents_pdf/RU_Student_Food_Insecurity_2018.pdf. Accessed July 11, 2022.
22. Cuite CL, Brescia SA, Willson K, Weintraub D, Walzer M, Bates L. Basic needs insecurity among Rutgers-New Brunswick students. https://newbrunswick.rutgers.edu/sites/default/files/2020-11/Basic-Needs-Insecurity-Report-2020-FINAL3.pdf. Accessed July 11, 2022.
23. Economic Research Service, United States Department of Agriculture. *Household Food Security Survey Module: Three Stage Design, with Screeners.* Economic Research Service, USDA; 2012. https://www.ers.usda.gov/media/8271/hh2012.pdf. Accessed July 11, 2022.
24. Ives J, Castillo-Montoya M. First-generation college students as academic learners: a systematic review. *Review of Educational Research.* 2020;90:139–178.
25. Kotrlik JW, Williams HA, Jabor MK. Reporting and interpreting effect size in quantitative agricultural education research. *J Agric Educ.* 2011;52:132–142.
26. Maroto ME, Snelling A, Linck H. Food insecurity among community college students: prevalence and association with grade point average. *Community Coll J Res Pract.* 2015;39:515–526.

ORCIDs

Cara L. Cuite: http://orcid.org/0000-0003-1076-0110
Kelly E. Dietz: http://orcid.org/0000-0002-6106-4230