

# Persistent and Changing Food Insecurity Among Students at a Midwestern University is Associated With Behavioral and Mental Health Outcomes

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## Abstract

**Purpose:** To assess associations between persistent and changing food insecurity and behavioral and mental health outcomes in college students.

**Design:** Online surveys conducted November 2018 and March 2019 (freshman year), and March 2020 (sophomore year) were used to assess food insecurity, which was then used to create 4 food security transitions: persistent food insecurity, emergent food insecurity, emergent food security, and persistent food security.

**Setting:** Large Midwestern university.

**Sample:** 593 students completing all 3 surveys.

**Measures:** Dietary intake and behavioral and mental health outcomes (eating disorders, anxiety, depression, sleep quality) were assessed using validated instruments.

**Analysis:** Associations between food security transitions and dietary intake, behavioral, and mental health outcomes were examined using generalized linear models.

**Results:** Compared to persistent food security, emergent and persistent food insecurity was associated with lower (7% and 13% respectively) intake of fruits and vegetables combined; persistent food insecurity was associated with 17% lower intake of fruits, 6% lower intake of fiber and 10% higher intake of added sugar from beverages. Compared to persistent food secure students, eating disorder symptom risk was higher for emergent food insecure (OR = 7.61, 95% CI: 3.32, 17.48), and persistent food insecure (OR = 6.60, 95% CI: 2.60, 16.72) students; emergent (OR = 2.05, 95% CI: 1.14, 3.71) and persistent (OR = 2.55, 95% CI: 1.34, 4.87) food insecure students had higher odds of poor sleep quality, and persistent food insecure, emergent food insecure, and emergent food secure students had higher odds of anxiety and depression (OR range 2.35–2.85).

**Conclusion:** Food security transitions were associated with aspects of low diet quality and poorer behavioral and mental health outcomes among college students.

## Keywords

food insecurity, dietary intake, mental health, health behaviors, college students

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## Purpose

Food insecurity, the lack of consistent access to enough food for a healthy and active lifestyle,<sup>1</sup> among college students has been of increasing concern in recent years due to high prevalence levels.<sup>2</sup> While there is wide variation in food insecurity rates on college campuses,<sup>3</sup> approximately 30%–40% of college students experience food insecurity at some point during their college years.<sup>3–5</sup>

College students with food insecurity are more likely to be financially independent from their parents, younger, and from some minority racial and ethnic groups.<sup>4,5</sup> Food insecure students are also more likely to have lower self-reported health and less nutritious diets.<sup>4,5</sup> Poor sleep quality,<sup>6–8</sup> poor mental health,<sup>6,7,9–11</sup> and higher prevalence of stress and eating disorders<sup>7,12,13</sup> have also been reported among food insecure college students. Food insecurity during college can have effects into adulthood. In a national study, food insecurity during college was a barrier to graduation, especially for first-generation students,<sup>14</sup> and predicted food insecurity in early to mid-adulthood.<sup>15</sup>

Many of the published studies on college food insecurity, noted above, are cross-sectional. A single measurement might not accurately capture college food insecurity due to academic breaks, varying family involvement, the nature of the transition away from family, variable free food opportunities, and changes in financial independence.<sup>16,17</sup> However, to our knowledge, only 1 previous study has investigated changes in food insecurity over time and their effects on students' diet and health outcomes.<sup>18</sup> In this study, concurrent food insecurity was associated with more perceived stress and depressed mood, and inversely associated with consistent meal patterns and self-rated healthy eating habits on campus, but not dietary intake.<sup>18</sup> Additional longitudinal studies are needed to better understand the effect of food insecurity transitions on dietary patterns and mental health outcomes of college students.<sup>4,5,19</sup>

The objectives of the current study were to (1) assess the changing nature of food insecurity between freshman and sophomore year, when students typically transition to off-campus housing and independent food provisioning, and (2) examine associations between food security transitions and behavioral and mental health measures among college students. Specifically, we selected health outcomes that have been significantly associated with college food insecurity in cross-sectional studies.<sup>6,8,9,12,13,20</sup>

## Methods

### Design

Online surveys comprised of questions extracted from previously-validated instruments assessing food insecurity<sup>21</sup> and other health behaviors,<sup>22–27</sup> as detailed below, were sent to students at a large, Midwestern US university. Students residing in on-campus residence halls during the Fall 2018 term

completed online surveys in November 2018 (Fall term) and March 2019 (Winter term), during their freshman year, and a follow-up survey in March 2020, during their sophomore year. Digital informed consent was obtained at the beginning of each survey, and students received a \$10 Amazon gift card upon survey completion. The study was approved by the University of Michigan Institutional Review Boards.

### Sample

Selection of the initial study population has been previously described,<sup>28,29</sup> and included students participating in a quasi-experimental sugar-sweetened beverage intervention at 3 dining halls on campus throughout the Winter term (January–April) 2019. Selection criteria included frequenting the same dining hall at least once a day; no other exclusion criteria were applied.<sup>28,29</sup> All Freshmen surveyed in 2018 ( $n = 804$ ) were invited to complete follow-up surveys in March 2019 and March 2020. In total, 651 students completed both follow-up surveys; surveys with incomplete data were removed from the analytic sample, resulting in a final sample of 593 students. Distributions of demographic variables were similar for the analytic and baseline populations. While not independently verified, it is assumed that all students residing in residence halls have an unlimited meal plan, due to university policies requiring all students living in residence halls to have unlimited meal plans.

### Measures

**Food Insecurity.** Food security status was assessed using the USDA 6-item Short Form Food Security Survey model.<sup>21</sup> Per USDA guidelines,<sup>21</sup> total number of affirmative (yes) responses were counted. The total raw score ranged from zero to 6, and food security was defined as secure (0–1) or insecure (2–6). For the freshman surveys (November 2018 and March 2019), food security status over the prior 30 days was assessed while for the sophomore survey (March 2020), students were asked about food security over the course of the academic year. Students were defined as being food insecure in freshman year if they were food insecure at either point in the academic year (November 2018 or March 2019), to allow for comparison with the sophomore year survey data.

Students were classified into 4 food security transition groups: (1) persistent food security, ie, food secure in both freshman and sophomore years; (2) emergent food security, ie, moving from food insecurity in freshman year to food security in sophomore year; (3) emergent food insecurity, ie, moving from food security in freshman year to food insecurity in sophomore year; and (4) persistent food insecurity, ie, food insecure in both freshman and sophomore years.

**Dietary and Other Behavioral Health Measures.** Dietary intake, behavioral health measures, and mental health measures were assessed in the March 2020 survey. Dietary intake was

assessed using the National Cancer Institute 26-item Dietary Screener Questionnaire (DSQ), a questionnaire measuring frequency of consumption in the past month.<sup>22</sup> Dietary outcomes from the DSQ included intakes of fruits and vegetables, including legumes (cup equivalents), fruits (cup equivalents), vegetables including legumes (cup equivalents), whole grains (ounce equivalents), dairy (cup equivalents), added sugars from sugar-sweetened beverages (teaspoon equivalents), total added sugars (teaspoon equivalents), calcium (milligrams), and fiber (grams). Dietary data were converted to daily intake using publicly available SAS code.<sup>22</sup>

Other behavioral health measures collected in March 2020 included eating disorder behaviors and sleep quality. Eating disorder symptoms were assessed using the short form Eating Disorder Examination Questionnaire (EDE-QS),<sup>23</sup> and designed to assess the range and severity of behaviors associated with eating disorders during the past 7 days. Scores range from 0-36, and a score of  $\geq 15$  was used to identify significant clinical eating disorder symptoms;<sup>24</sup> the survey had strong internal reliability in the current dataset (Cronbach's  $\alpha = .88$ ). Sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI), a self-rated questionnaire created to measure sleep quality during the previous month.<sup>25</sup> The PSQI score has a range of 0-21, with scores  $\geq 5$  indicating poor sleep quality,<sup>25</sup> and had sufficient internal reliability in the current dataset (Cronbach's  $\alpha = .72$ ).

**Mental Health Measures.** Generalized anxiety was assessed using the GAD-7 screening tool, a questionnaire designed to assess range of anxiety symptoms over the past 2 weeks.<sup>26</sup> GAD-7 scores range from 0-21; a score of  $\geq 10$  represents moderate to severe levels of anxiety;<sup>26</sup> the screening tool had strong internal reliability in the current dataset (Cronbach's  $\alpha = .92$ ). Depression was measured using the Patient Health Questionnaire (PHQ-9), a questionnaire used to screen for the presence and severity of depression over the past 2 weeks.<sup>27</sup> PHQ-9 scores range from 0-27; a score of  $\geq 10$  captures moderate to severe depression,<sup>27</sup> and the survey showed high internal reliability in the current dataset (Cronbach's  $\alpha = .89$ ).

**Sociodemographic Covariates.** Students self-reported their age, sex/gender (male, female), and race/ethnicity (reclassified into White/MENA, Asian/Pacific Islander, and other race categories including Black/African American, Hispanic, Multiracial/Multiethnic due to low numbers) in the initial freshman year (November 2018) survey.

Students were asked to report the highest education level of their mother and father. First-generation students were defined as having no parent with a bachelor's degree. Students self-reported receipt of Pell grant in each academic year (yes/no), and dining plan sophomore year (yes/no). Per university policy, all freshmen students living in university housing are required to have an unlimited meal plan. Additionally, students were classified as living on-campus or off-campus for sophomore year.

## Analysis

Descriptive statistics were used to examine students' socio-demographic characteristics. Differences in food security transitions by student characteristics were compared using chi-square tests. Associations between food security and diet were examined using generalized linear models with a log link and gamma distribution. Relative differences (RD) are reported, representing percent lower intake by food security transition groups with persistent food security as the reference. Associations between food security and other behavioral and mental health outcomes were examined using logistic regression. All models were adjusted for all sociodemographic covariates. Statistical tests were two-sided, and statistical significance was considered at  $P < .05$ . Statistical analyses were performed using SAS, version 9.4.<sup>30</sup>

## Results

In the analytical sample ( $n = 593$ ), 71% of students had persistent food security, 10% had emergent food security, 10% had emergent food insecurity, and 9% had persistent food insecurity (Table 1). Food security transition classification varied significantly with age ( $P = .01$ ), race/ethnicity ( $P = .02$ ), first generation status ( $P < .0001$ ), Pell grant status ( $P < .01$ ), and off campus housing status sophomore year ( $P = .02$ ). Students who identified as Other/Multiracial groups, were first generation, and on Pell grants generally had lower rates of persistent food security. A higher proportion of older students and those living off campus sophomore year fell into emergent food insecurity categories. Food security transition status did not differ significantly by sex/gender or dining plan use sophomore year.

Associations between food security transition categories from freshmen to sophomore year, compared to the persistent food secure reference group, and dietary intake during sophomore year are shown in Table 2. Compared to persistent food security, emergent food security was associated with lower intakes of dairy (RD = .89, 95% CI: .82, .97) and calcium (RD = .95, 95% CI: .91, .99). Emergent food insecurity was associated with lower intakes of fruits and vegetables (RD = .93, 95% CI: .87, .99) and vegetables, including legumes (RD = .92, 95% CI: .85, .99). Persistent food insecurity was associated with lower intakes of fruits and vegetables combined (including legumes) (RD = .87, 95% CI: .81, .93), fruits alone (RD = .83, 95% CI: .73, .94), vegetables alone (including legumes) (RD = .88, 95% CI: .82, .96), and fiber (RD = .94, 95% CI: .90, .98), and higher intake of added sugar from beverages (RD = 1.10, 95% CI: 1.00, 1.27). No differences were observed in the intakes of added sugar or whole grains comparing students with food security transitions to persistently food secure students.

Table 3 presents associations between food security transitions between freshmen and sophomore year, compared with persistent food security, and behavioral and mental health outcomes in sophomore year. Compared with persistent food security, emergent food insecurity (OR = 7.61, 95% CI: 3.32, 17.48) and persistent food insecurity (OR = 6.60, 95% CI:

**Table 1.** Sociodemographic Characteristics of College Students at a Large, Public Midwestern University, Stratified by Food Security Transition.<sup>a</sup>

	Total n (%)	Persistent food security n (%)	Emergent food security n (%)	Emergent food insecurity n (%)	Persistent food insecurity n (%)	P-value <sup>b</sup>
<b>Total (%)</b>	593 (100.0)	418 (70.5)	60 (10.1)	61 (10.3)	54 (9.1)	
Age						
18-19 years	507 (85.5)	366 (87.6)	50 (83.3)	44 (72.1)	47 (87.0)	<b>.01</b>
≥20 years	86 (14.5)	52 (12.4)	10 (16.7)	17 (27.9)	7 (13.0)	
Sex/gender						
Male	277 (46.7)	198 (47.4)	33 (55.0)	23 (37.7)	23 (42.6)	.25
Female	316 (53.3)	220 (52.6)	27 (45.0)	28 (62.3)	31 (57.4)	
Race/ethnicity						
White or MENA <sup>c</sup>	326 (55.0)	229 (54.8)	27 (45.0)	35 (61.4)	32 (59.3)	<b>.02</b>
Asian or Pacific Islander	184 (31.0)	139 (33.3)	20 (33.3)	16 (28.1)	9 (16.7)	
Other/Multiracial	83 (14.0)	50 (12.0)	13 (21.7)	6 (10.5)	13 (24.1)	
First generation						
No	507 (85.5)	379 (90.7)	47 (78.3)	47 (77.1)	34 (63.0)	<b>&lt;.0001</b>
Yes	86 (14.5)	39 (9.3)	13 (21.7)	14 (23.0)	20 (37.0)	
Pell grant						
Freshman year	139 (24.0)	79 (19.0)	15 (29.4)	23 (38.3)	22 (40.7)	<b>&lt;.0001</b>
Sophomore year	138 (23.3)	80 (19.1)	20 (33.3)	21 (34.4)	17 (31.5)	<b>.003</b>
Dining plan	271 (45.7)	195 (46.7)	32 (53.3)	20 (32.8)	24 (44.4)	.13
sophomore year <sup>d</sup>						
Off campus	342 (57.7)	234 (56.0)	29 (48.3)	45 (73.8)	34 (63.0)	<b>.02</b>
sophomore year <sup>e</sup>						

Bolded results are used to highlight statistical significance ( $P < 0.05$ ).

<sup>a</sup>Column percentages represent percent of students falling into each food security classification category, total percentages represent percent of total sample population.

<sup>b</sup>P-value indicates statistical significance of comparisons between groups using  $\chi^2$  tests.

<sup>c</sup>Middle Eastern/North African.

<sup>d</sup>Students with a dining plan sophomore year.

<sup>e</sup>Students who did not live in on-campus housing (residence hall, fraternity/sorority house, other university housing) sophomore year.

2.60, 16.72) were associated with higher odds of eating disorder symptoms. Poor sleep quality was associated with emergent food insecurity (OR = 2.05, 95% CI: 1.14, 3.71) and persistent food insecurity (OR = 2.55, 95% CI: 1.34, 4.87); no significant association was observed with emergent food security. Moderate to severe anxiety was associated with emergent food security (OR = 2.18, 95% CI: 1.14, 4.18), emergent food insecurity (OR = 2.54, 95% CI: 1.35, 4.75), and persistent food insecurity (OR = 3.95, 95% CI: 2.06, 7.59). Higher odds of moderate to severe depression was observed with emergent food security (OR = 2.35, 95% CI: 1.22, 4.53), emergent food insecurity (OR = 2.86, 95% CI: 1.51, 5.40), and persistent food insecurity (OR = 2.85, 95% CI: 1.45, 5.63) compared to persistent food security.

## Discussion

In this longitudinal study focusing on the critical transition from freshman to sophomore year, approximately 30% of students experienced food insecurity at some point during their first or second year of college. Furthermore, about 9% of students

experienced persistent food insecurity from freshman to sophomore year. Compared with persistent food security, persistent food insecurity was significantly associated with some components of dietary intake including lower fruit and vegetable intake, lower fiber intake, and higher intake of added sugar from beverages, suggesting cumulative exposure to food insecurity may be particularly detrimental to students' nutritional intake. Students with persistent food insecurity, emergent food insecurity, and emergent food security had higher odds of anxiety and depression than students with persistent food security. Furthermore, eating disorder symptoms and poor sleep quality were associated with both emergent and persistent food insecurity compared with persistent food security. These findings highlight the dynamic effects of food security transitions, and have important implications for future studies measuring student food insecurity, student health and well-being, and institutional policies and support programs.

Previous studies have utilized cross-sectional measures of food insecurity on college campuses, possibly creating an incomplete snapshot of campus food security issues.<sup>4,5</sup> In the current study, about 10% of students were classified as having

**Table 2.** Adjusted<sup>a</sup> Relative Differences (RD), and 95% Confidence Interval (CI), in Mean Daily Dietary Intake by Food Security Transition for College Students at a Large, Public Midwestern University (n = 593).

Dietary component <sup>b</sup>	Persistent food security (n = 422)		Emergent food security (n = 66)		Emergent food insecurity (n = 57)		Persistent food insecurity (n = 48)	
	RD <sup>c</sup>	95% CI	RD	95% CI	RD	95% CI	RD	95% CI
Fruits and vegetables, including legumes <sup>d</sup>	Ref.	-	1.01	.95, 1.08	<b>.93</b>	<b>.87, .99</b>	<b>.87</b>	<b>.81, .93</b>
Fruits <sup>d</sup>	Ref.	-	1.01	.90, 1.15	.94	.83, 1.06	<b>.83</b>	<b>.73, .94</b>
Vegetables, including legumes <sup>d</sup>	Ref.	-	1.02	.95, 1.10	<b>.92</b>	<b>.85, .99</b>	<b>.88</b>	<b>.82, .96</b>
Dairy <sup>d</sup>	Ref.	-	<b>.89</b>	<b>.82, .97</b>	1.08	.99, 1.17	1.00	.92, 1.09
Added sugar <sup>e</sup>	Ref.	-	.98	.91, 1.04	.98	.91, 1.05	1.00	.93, 1.07
Added sugar from beverages <sup>e</sup>	Ref.	-	1.02	.94, 1.11	1.01	.92, 1.10	<b>1.10</b>	<b>1.00, 1.21</b>
Whole grains <sup>f</sup>	Ref.	-	.97	.86, 1.09	1.06	.94, 1.19	.98	.87, 1.10
Fiber <sup>g</sup>	Ref.	-	1.00	.96, 1.04	.98	.94, 1.02	<b>.94</b>	<b>.90, .98</b>
Calcium <sup>h</sup>	Ref.	-	<b>.95</b>	<b>.91, .99</b>	1.03	.98, 1.08	.99	.95, 1.04

Bolded results are used to highlight statistical significance ( $P < 0.05$ ).

<sup>a</sup>All models were adjusted for age, sex/gender, race/ethnicity, first generation status, and Pell grant status in Year 1.

<sup>b</sup>Measured by the Dietary Screener Questionnaire-26.

<sup>c</sup>RD = Relative difference.  $[1 - \text{RD}] \times 100$  represents percent lower intake for students with emergent food insecurity or persistent food insecurity when compared with students with persistent food security (reference group).

<sup>d</sup>Units are cup equivalents.

<sup>e</sup>Units are teaspoon equivalents.

<sup>f</sup>Units are ounce equivalents.

<sup>g</sup>Units are gram equivalents.

<sup>h</sup>Units are milligram equivalents.

**Table 3.** Adjusted<sup>a</sup> Odds Ratios (OR) and 95% Confidence Intervals (CI) for Associations Between Food Security Transition and Behavioral and Mental Health Measures in College Students at a Large, Public Midwestern University (n = 593).

Behavioral or mental health outcome	Persistent food security (n = 418)		Emergent food security (n = 60)		Emergent food insecurity (n = 61)		Persistent food insecurity (n = 54)	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Eating disorder symptoms <sup>b</sup>	Ref.	-	2.27	.79, 6.52	<b>7.61</b>	<b>3.32, 17.48</b>	<b>6.60</b>	<b>2.60, 16.72</b>
Poor sleep quality <sup>c</sup>	Ref.	-	.98	.56, 1.71	<b>2.05</b>	<b>1.14, 3.71</b>	<b>2.55</b>	<b>1.34, 4.87</b>
Moderate to severe anxiety <sup>d</sup>	Ref.	-	<b>2.18</b>	<b>1.14, 4.18</b>	<b>2.54</b>	<b>1.35, 4.75</b>	<b>3.95</b>	<b>2.06, 7.59</b>
Moderate to severe depression <sup>e</sup>	Ref.	-	<b>2.35</b>	<b>1.22, 4.53</b>	<b>2.86</b>	<b>1.51, 5.40</b>	<b>2.85</b>	<b>1.45, 5.63</b>

Bolded results are used to highlight statistical significance ( $P < 0.05$ ).

<sup>a</sup>All models were adjusted for age, sex/gender, race/ethnicity, first generation status, and Pell grant status in Year 1.

<sup>b</sup>Assessed using the Eating Disorder Examination Questionnaire (EDE-QS); a cut-off score of 15 was used to identify clinical eating disorder symptoms.

<sup>c</sup>Measured using the Pittsburgh Sleep Quality Index (PSQI); a score  $>5$  indicates poor sleep quality.

<sup>d</sup>Assessed using the GAD-7 screening tool; a score  $\geq 10$  captures moderate to severe levels of anxiety.

<sup>e</sup>Assessed using the Patient Health Questionnaire (PHQ-9); a score  $\geq 10$  captures moderate to severe depression.

emergent food security, and 10% had emergent food insecurity. Similar to our finding of emergent food security prevalence, a recent study reported 11% of college students surveyed experienced episodic food insecurity, or food insecurity within the past 12 months but not the past 30 days.<sup>31</sup> These findings are important for understanding the temporal reliability of cross-sectional food security measurements and the fluid nature of campus food security, and how higher education policies can better support students' food security.

In sophomore year, 74% of students with emergent food insecurity lived off campus compared to 56% of students with persistent food security. Financial and residential independence, food procurement and preparation challenges, and diminishing savings in the second year are likely important factors contributing to emergent food insecurity on campus. A higher percentage of students with changing or persistent food insecurity were Pell grant recipients; this finding suggests that Pell grants may not provide sufficient financial support to students to support their basic needs on top of their academic

expenses. Receiving financial aid has been previously associated with food insecurity in college students.<sup>5,20</sup> Bruening et al. also reported temporal changes in food security over the course of the year, with students reporting higher food insecurity at the ends of semesters.<sup>18</sup> Price has also been shown to be more important in student food choice priorities at the end of the first year of college compared with the beginning,<sup>32</sup> reiterating the role of temporal variability of student finances in maintaining food security.

Previous studies have reported lower diet quality in college students with food insecurity;<sup>4,20,29</sup> however, statistical significance is reported in only a small number of studies, possibly due to lack of longitudinal and consistent measurement,<sup>4</sup> among other factors. Bruening et al.<sup>18</sup> reported that concurrent food insecurity over the course of 1 academic year was inversely associated with perception of healthful eating and consistent consumption, but no significant associations were observed between dietary intake and concurrent food insecurity. The current study suggests that repeated exposure to food insecurity may have a significant impact on students' dietary quality. This may in part be due to stronger use of unhealthy coping strategies, such as eating less healthy meals or attending functions with free food, in students with persistent food insecurity compared with episodic food insecurity.<sup>31</sup> Furthermore, food insecurity has been associated with alcohol and tobacco use in young adults,<sup>33-35</sup> further research is needed to understand if these behaviors, which may cluster with poor diet,<sup>36-38</sup> are coping mechanisms for food insecurity in college students. Given that the transition to adulthood is generally associated with a decline in dietary quality,<sup>39</sup> addressing factors impacting dietary quality in vulnerable subsets of this population is critical. Additionally, dietary habits in adolescence<sup>40,41</sup> and young adulthood<sup>42</sup> can track to adulthood, reinforcing the importance of nutritional programming for college students.

The current study corroborates previous findings associating food insecurity with disordered eating,<sup>12,13</sup> poor sleep quality,<sup>8</sup> anxiety,<sup>9</sup> and depression<sup>9,43,44</sup> in US college students; but also indicates that transitions in food insecurity may play a role in students' behavioral and mental health outcomes, stressing the importance of repeated food security measurements. This is particularly evident given the risks associated with emerging food security, which suggest prior exposure to food insecurity during early adulthood may have continuing effects on mental health. It is also possible that emerging food security may coincide with new responsibilities or life changes, such as employment or transitioning to independent living situations, which could affect mental and behavioral health.

Students with persistent food insecurity had over 6 times greater odds of eating disorder symptoms, compared with students with persistent food security. Students experiencing emergent food insecurity during this transition time had over 7 times greater odds of eating disorder symptoms when compared with persistent food secure students. To further

understand these risks, it is important for future studies to evaluate the effect of food security transitions on different eating disorder symptoms. Nonetheless, these results are substantial given that age 18-21 is the median age of onset for most eating disorders,<sup>45</sup> and the high prevalence of eating disorders (median estimates 54% for female students and 19% for male students) on college campuses.<sup>46,47</sup> Eating disorders are associated with impairment in cognitive and emotional functioning, low quality of life, and social impairment,<sup>48</sup> but campus interventions can be effective at preventing onset of eating disorders in this age group.<sup>47</sup> Given elevated risk of eating disorder symptoms for students experiencing both changing and persistent food insecurity patterns, repeated monitoring of student food security by higher education institutions or student health services may assist in identification of high-risk students for such interventions.

Both emergent and persistent food-insecure students were roughly twice as likely as food secure students to experience poor sleep quality. While insufficient sleep is common among college students, poor sleep quality can have negative impacts on academic performance, grade point average, and mood.<sup>49</sup> Therefore, identifying both emergent and persistent food security for second year students and channeling resources to this vulnerable population could be important for ensuring academic success.

Students classified into all food security transition categories had about 2 to 4 times higher odds of anxiety or depression when compared to persistently food secure students. Students with persistent food insecurity had the highest risk for anxiety, followed by students with emergent food insecurity, and emergent food security. Depression risk was similar for students with emergent and persistent food insecurity, and only slightly lower for emergent food secure students. Concurrent food insecurity over the course of 1 academic year was previously associated with higher odds of perceived stress and depressed mood.<sup>18</sup> The current study corroborates this finding and suggests that prior food insecurity, new food insecurity, or continuing food insecurity can have differential impacts on students' mental health. Given that approximately 63% of mental health disorders emerge before age 25,<sup>50</sup> and mental health trends and disparities continue to worsen on college campuses,<sup>51</sup> secondary educational institutions can play a critical role in intervention and prevention.<sup>50,52</sup>

Food insecurity on college campuses is a continuing concern, complicated by the dynamic and evolving nature of higher education and intensified by rising food costs. College campuses continue to implement multiple programs to mitigate student food insecurity, including: food pantries, meal vouchers, emergency funds, outreach and education programs, financial coaching, garden programs, farmers markets, and diversion of food waste programs.<sup>2,5,16</sup> Federal changes to the US Supplemental Nutrition Assistance Program (SNAP) to account for changing college demographics and to improve accessibility for eligible students is another way to mitigate

food insecurity on campus,<sup>2,16</sup> as was temporarily implemented during the COVID-19 pandemic.

The current research suggests that efforts should also be made by institutions to frequently monitor student food insecurity, particularly as students move into off-campus housing. The percentage of students falling into each food transition group did not vary significantly by dining plan status sophomore year, suggesting that dining plan access is not the only contributor student food security. University programs supporting the transition to residential independence during early adulthood could help smooth the transition to adulthood and mitigate food insecurity and associated health risks. While further research is needed to evaluate the effectiveness of such programs in different populations, campus settings, and over time, a multifaceted approach including educational programs addressing financial management,<sup>53</sup> food procurement and preparation<sup>54</sup> skills, and awareness of and access to existing support programs may improve food campus food security and provide longer-term benefits<sup>19,55,56</sup> that could help support students into adulthood.

### Limitations

Due to the cross-sectional nature of the survey data collection, causality of the associations cannot be determined. Additionally, due to smaller sample size upon stratification, it is possible that weaker associations between emergent food insecurity and mental health and dietary outcomes might not be detectable in the current study. Similarly, due to small sample sizes for some racial/ethnic groups, stratification of associations by demographic subgroups who might be at higher risk for food insecurity was not possible. Behavioral and mental health outcomes were not measured at baseline, and therefore we are unable to determine changes in these outcomes over time. Given the same survey was used for all students, any misclassification is likely to be nondifferential. Additionally, the findings might not be representative of all student populations, as racial/ethnic representation varies across institutions,<sup>57</sup> and costs of food, housing, and tuition vary by university as well as at 4-year colleges vs 2-year colleges.<sup>4</sup>

Lastly, we cannot completely eliminate the possibility of effect of COVID-19 on student responses. While it is possible that uncertainty surrounding the emerging COVID-19 pandemic may have influenced the March 2020 food insecurity measurements reported herein, and therefore the number of emergent food insecure students, the timing of the survey lessened this possibility. Surveys were emailed to students on March 11th, the day the university announced a COVID-19 lockdown, and survey questions asked about food insecurity, dietary and mental health outcomes for the weeks and month prior. While this effect is unlikely due to timing of the study responses, awareness of the impending virus might have influenced responses.

## Conclusions

This is 1 of the few studies, to our knowledge, to investigate food insecurity among university students over 2 academic years, particularly during the critical transition between freshman and sophomore years, and to examine the effects of food security transitions in relation to behavioral and mental health outcomes. Furthermore, it highlights the importance of distinguishing between emergent food security, emergent food insecurity, and persistent food insecurity in terms of behavioral and mental health interventions. These findings have important implications for university policies, national policies supporting college students, and the nutritional and mental health of young adults.

## So What? (Implications for Health Promotion Practitioners and Researchers)

### *What is Already Known on this Topic?*

Food insecurity on college campuses is a growing concern and has been associated with some aspects of physical, mental, and behavioral health; but few studies have assessed the dynamic effect of food security on college campuses.

### *What Does This Article Add?*

Compared with persistent food security, persistent food insecurity as well as food security transitions between freshman and sophomore year were significantly associated with components of poorer dietary intake and increased odds of some behavioral and mental health outcomes.

### *What are the Implications for Health Promotion Practice or Research?*

These results highlight the importance of distinguishing between emergent food security, emergent food insecurity, and persistent food insecurity in terms of programs and policies supporting student health.

## Author Contributions

MS: analysis, interpretation of results, writing of the manuscript, critical revisions of the manuscript; SA: literature review and writing of the manuscript; SA, LP, AG, JW: review of results, critical revisions of the manuscript; CL: conception of study idea, data collection, analysis, critical revisions of the manuscript.

## Declaration of Conflicting Interests

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## References

1. U.S. Department of Agriculture. Food Security in the U.S. U.S. Department of Agriculture Economic Research Service, United States Government; 2023. Updated 6/20/2023. <https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-u-s/>. Accessed 9 8 2023.
2. Freudenberg N, Goldrick-Rab S, Poppendieck J. College students and SNAP: the new face of food insecurity in the United States. *Am J Publ Health*. 2019;109(12):1652-1658.
3. Nikolaus CJ, An R, Ellison B, Nickols-Richardson SM. Food insecurity among college students in the United States: a scoping review. *Adv Nutr*. 2020;11(2):327-348.
4. Shi Y, Davies A, Allman-Farinelli M. The association between food insecurity and dietary outcomes in university students: a systematic review. *J Acad Nutr Diet*. 2021;121(12):2475-2500.
5. Bruening M, Argo K, Payne-Sturges D, Laska MN. The struggle is real: a systematic review of food insecurity on postsecondary education campuses. *J Acad Nutr Diet*. 2017;117(11):1767-1791.
6. Hagedorn RL, Olfert MD, MacNell L, et al. College student sleep quality and mental and physical health are associated with food insecurity in a multi-campus study. *Publ Health Nutr*. 2021;24(13):4305-4312.
7. El Zein A, Shelnett KP, Colby S, et al. Prevalence and correlates of food insecurity among US college students: a multi-institutional study. *BMC Publ Health*. 2019;19(1):1-12.
8. Martinez SM, Grandner MA, Nazmi A, Canedo ER, Ritchie LD. Pathways from food insecurity to health outcomes among California University students. *Nutrients*. 2019;11(6):1419.
9. Oh H, Smith L, Jacob L, et al. Food insecurity and mental health among young adult college students in the United States. *J Affect Disord*. 2022;303:359-363.
10. Becerra MB, Becerra BJ. Psychological distress among college students: role of food insecurity and other social determinants of mental health. *Int J Environ Res Publ Health*. 2020;17(11):4118.
11. Raskind IG, Haardörfer R, Berg CJ. Food insecurity, psychosocial health and academic performance among college and university students in Georgia, USA. *Publ Health Nutr*. 2019;22(3):476-485.
12. Barry MR, Sonnevile KR, Leung CW. Students with food insecurity are more likely to screen positive for an eating disorder at a large, public university in the Midwest. *J Acad Nutr Diet*. 2021;121(6):1115-1124.
13. Royer MF, Ojinnaka CO, Bruening M. Food insecurity is related to disordered eating behaviors among college students. *J Nutr Educ Behav*. 2021;53(11):951-956.
14. Wolfson JA, Insolera N, Cohen A, Leung CW. The effect of food insecurity during college on graduation and type of degree attained: evidence from a nationally representative longitudinal survey. *Publ Health Nutr*. 2022;25(2):389-397.
15. Leung CW, Insolera N, Cohen AJ, Wolfson JA. The long-term effect of food insecurity during college on future food insecurity. *Am J Prev Med*. 2021;61(6):923-926.
16. Landry MJ, Gundersen C, Eicher-Miller HA. Food insecurity on college and university campuses: a context and rationale for solutions. *J Acad Nutr Diet*. 2022;122(3):519-524.
17. Ellison B, Bruening M, Hruschka DJ, et al. Food insecurity among college students: a case for consistent and comparable measurement. *Food Pol*. 2021;101:102031.
18. Bruening M, Van Woerden I, Todd M, Laska MN. Hungry to learn: the prevalence and effects of food insecurity on health behaviors and outcomes over time among a diverse sample of university freshmen. *Int J Behav Nutr Phys Activ*. 2018;15(1):1-10.
19. Landry MJ, Heying E, Qamar Z, et al. Advancing college food security: priority research gaps. *Nutr Res Rev* 2023;1-34.
20. Leung CW, Wolfson JA, Lahne J, Barry MR, Kasper N, Cohen AJ. Associations between food security status and diet-related outcomes among students at a large, public midwestern university. *J Acad Nutr Diet*. 2019;119(10):1623-1631.
21. USDA. Food Security in the US Survey Tools. U.S. Department of Agriculture Economic Research Service, United States Government; 2022. <https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-u-s/survey-tools/>. Accessed 14 April 2022.
22. NCI. *Dietary Screener Questionnaire in the NHANES 2009-10: Background*. National Cancer Institute, National Cancer Institute Division of Cancer Control and Population Sciences; 2022. Updated 12/14/21. Accessed 05/03/22. <https://epi.grants.cancer.gov/diet/screeners/files.html>
23. Gideon N, Hawkes N, Mond J, Saunders R, Tchanturia K, Serpell L. Development and psychometric validation of the EDE-QS, a 12 item short form of the Eating Disorder Examination Questionnaire (EDE-Q). *PLoS One*. 2016;11(5):e0152744.
24. Prnjak K, Mitchison D, Griffiths S, et al. Further development of the 12-item EDE-QS: identifying a cut-off for screening purposes. *BMC Psychiatr*. 2020;20(1):1-7.
25. Buysse DJ, Reynolds CF III, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatr Res*. 1989;28(2):193-213.
26. Spitzer RL, Kroenke K, Williams JB, Löwe B. A brief measure for assessing generalized anxiety disorder: the GAD-7. *Arch Intern Med*. 2006;166(10):1092-1097.



27. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. *J Gen Intern Med.* 2001;16(9):606-613.
28. Leung CW, Wolfson JA, Hsu R, Soster K, Mangan S, Falbe J. Warning labels reduce sugar-sweetened beverage intake among college students. *J Nutr.* 2021;151(1):179-185.
29. Mei J, Fulay AP, Wolfson JA, Leung CW. Food insecurity and dietary intake among college students with unlimited meal plans at a large, midwestern university. *J Acad Nutr Diet.* 2021;121(11):2267-2274.
30. SAS. *Version 9.4.* Cary, NC: SAS Institute, Inc.; 2013.
31. Mitchell A, Ellison B, Bruening M. Persistent and episodic food insecurity and associated coping strategies among college students. *J Nutr Educ Behav.* 2022;54(11):972-981.
32. Vilaro MJ, Colby SE, Riggsbee K, et al. Food choice priorities change over time and predict dietary intake at the end of the first year of college among students in the US. *Nutrients.* 2018;10(9):1296.
33. Larson N, Laska MN, Neumark-Sztainer D. Food insecurity, diet quality, home food availability, and health risk behaviors among emerging adults: findings from the EAT 2010–2018 study. *Am J Publ Health.* 2020;110(9):1422-1428.
34. Oh H, Smith L, Jacob L, et al. Food insecurity and substance use among young adult college students in the United States. *J Addiction Med.* 2023;17(2):163-168.
35. Nagata JM, Whittle HJ, Ganson KT, Tabler J, Hahn JA, Weiser SD. Food insecurity risk and alcohol use disorder in US young adults: findings from the national longitudinal study of adolescent to adult health. *Am J Addict.* 2021;30(6):601-608.
36. Larson NI, Story M, Neumark-Sztainer D, Hannan PJ, Perry CL. Peer Reviewed: are diet and physical activity patterns related to cigarette smoking in adolescents? Findings from Project EAT. *Prev Chronic Dis.* 2007;4(3):A51.
37. Meader N, King K, Moe-Byrne T, et al. A systematic review on the clustering and co-occurrence of multiple risk behaviours. *BMC Publ Health.* 2016;16(1):1-9.
38. Noble N, Paul C, Turon H, Oldmeadow C. Which modifiable health risk behaviours are related? A systematic review of the clustering of Smoking, Nutrition, Alcohol and Physical activity ('SNAP') health risk factors. *Prev Med.* 2015;81:16-41.
39. Nelson MC, Story M, Larson NI, Neumark-Sztainer D, Lytle LA. Emerging adulthood and college-aged youth: an overlooked age for weight-related behavior change. *Obesity.* 2008;16(10):2205.
40. Craigie AM, Lake AA, Kelly SA, Adamson AJ, Mathers JC. Tracking of obesity-related behaviours from childhood to adulthood: a systematic review. *Maturitas.* 2011;70(3):266-284.
41. Mikkilä V, Räsänen L, Raitakari O, Pietinen P, Viikari J. Consistent dietary patterns identified from childhood to adulthood: the cardiovascular risk in Young Finns Study. *Br J Nutr.* 2005;93(6):923-931.
42. Dunn JE, Liu K, Greenland P, Hilner JE, Jacobs DR Jr. Seven-year tracking of dietary factors in young adults: the CARDIA study. *Am J Prev Med.* 2000;18(1):38-45.
43. Reeder N, Tapanee P, Persell A, Tolar-Peterson T. Food insecurity, depression, and race: correlations observed among college students at a university in the Southeastern United States. *Int J Environ Res Publ Health.* 2020;17(21):8268.
44. Bruening M, Brennhofner S, Van Woerden I, Todd M, Laska M. Factors related to the high rates of food insecurity among diverse, urban college freshmen. *J Acad Nutr Diet.* 2016;116(9):1450-1457.
45. Hudson JI, Hiripi E, Pope HG Jr, Kessler RC. The prevalence and correlates of eating disorders in the National Comorbidity Survey Replication. *Biol Psychiatr.* 2007;61(3):348-358.
46. Lipson S, Sonnevile K. Eating disorder symptoms among undergraduate and graduate students at 12 US colleges and universities. *Eat Behav.* 2017;24:81-88.
47. Harrer M, Adam SH, Messner EM, et al. Prevention of eating disorders at universities: a systematic review and meta-analysis. *Int J Eat Disord.* 2020;53(6):813-833.
48. Klump KL, Bulik CM, Kaye WH, Treasure J, Tyson E. Academy for eating disorders position paper: eating disorders are serious mental illnesses. *Int J Eat Disord.* 2009;42(2):97-103.
49. Hershner SD, Chervin RD. Causes and consequences of sleepiness among college students. *Nat Sci Sleep.* 2014;6:73.
50. Solmi M, Radua J, Olivola M, et al. Age at onset of mental disorders worldwide: large-scale meta-analysis of 192 epidemiological studies. *Mol Psychiatr.* 2021;27:1-15.
51. Lipson SK, Zhou S, Abelson S, et al. Trends in college student mental health and help-seeking by race/ethnicity: findings from the national healthy minds study, 2013–2021. *J Affect Disord.* 2022;306:138-147.
52. Pedrelli P, Nyer M, Yeung A, Zulauf C, Wilens T. College students: mental health problems and treatment considerations. *Acad Psychiatr.* 2015;39(5):503-511.
53. Gundersen CG, Garasky SB. Financial management skills are associated with food insecurity in a sample of households with children in the United States. *J Nutr.* 2012;142(10):1865-1870.
54. Matias SL, Rodriguez-Jordan J, McCoin M. Integrated nutrition and culinary education in response to food insecurity in a Public University. *Nutrients.* 2021;13(7):2304.
55. Hickey A, Brown O, Fiagbor R. Campus-based interventions and strategies to address college students with food insecurity: a systematic review. *J Hunger Environ Nutr.* 2023;18(1):81-95.
56. Savoie-Roskos MR, Hood LB, Hagedorn-Hatfield RL, et al. Creating a culture that supports food security and health equity at higher education institutions. *Publ Health Nutr.* 2023;26(3):503-509.
57. Monarrez T, Washington K. *Racial and Ethnic Representation in Postsecondary Education. Research Report.* Washington, DC: Urban Institute; 2020.