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Risk factors of food insecurity among students at diverse post-secondary education institutions: a cross-sectional examination

Heather R. Batchelder, MA^{a*} , Connor Drake, PhD^{a*} , Tyler Johnson, BA^a , Jorge M. Alfaro, BSc^b, Ruth Gilliam Phillips, DPM^{c*}, Thomas Szigethy, MA^d, Marina DelVecchio, PhD^e, Kate Zhang, PhD^d and Ralph Snyderman, MD^{a,f}

^aDuke Center for Personalized Health Care, Office of the Chancellor Emeritus, School of Medicine, Duke University, Durham, North Carolina, USA; ^bSanford School of Public Policy, Duke University, Durham, North Carolina, USA; ^cStudent Health and Counseling, North Carolina Central University, Durham, North Carolina, USA; ^dStudents Affairs, Duke University, Durham, North Carolina, USA; ^eDepartment of English and Communications, Durham Technical Community College, Durham, North Carolina, USA; ^fDepartment of Medicine, Duke University, Durham, North Carolina, USA

ABSTRACT

Objective: Identify the prevalence of food insecurity (FI) and compare sociodemographic, mental, physical, behavioral, and environmental risk factors for FI among students at a private university, community college, and historically black college or university (HBCU).

Participants: Adult students attending a private university, community college, or HBCU ($n=4,140$) located within the southeastern United States.

Methods: Using an online survey (2017–2019), FI, sociodemographic, mental, physical, behavioral, and environmental data were collected to understand their association with FI.

Results: Up to 37.1% of students experienced FI. Identifying as black, other/multi-racial, having poor sleep, federal loans, depressive symptoms, high stress, social isolation, or a chronic condition were associated with FI. These associations varied by institution.

Conclusions: FI is prevalent within diverse post-secondary institutions that serve traditional and nontraditional students with risk factors varying between institutions. The prevalence of FI and risk factors can inform institutional policy responses to ameliorate the effects of FI.

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1. Introduction

Food insecurity (FI), defined as having reduced access to quality and/or quantity of food,^{1,2} is one of the nation's leading health challenges and a consequence of structural and systemic factors (i.e., social determinants of health; SDOH) that shape the distribution of resources across society.³ The consequences of FI, such as obesity,⁴ diabetes,^{5,6} hypertension,⁷ and food restriction,⁸ are far-reaching and often associated with severe negative health outcomes across the individual's lifespan. For college or university students in particular, experiencing FI has been associated with increased substance use,^{9,10} suicidal ideation,⁹ poor sleep,¹¹ disordered eating,¹¹ unsafe coping,^{12–14} elevated stress,^{11,14} depression,^{9,15} housing instability,¹⁶ social isolation,¹⁴ and hindered academic performance.^{11,13,15} In 2019, the rate of FI amongst United States (US) households was at 10.5%; however, on average college students reported FI at much higher rates, with 32%¹³ to 43.5%¹⁷ of students reporting FI. ^{13,17} Without intervention at the societal, community, or individual level,

the consequences of FI experienced early in life, particularly in early adulthood, can lead to an increased risk for poor health and poverty.^{18–20}

Student populations vary in their FI prevalence, with differences occurring by institution, degree, demographic group, and student type. Community colleges, historically black colleges and universities (HBCUs), and private universities tend to report higher rates than four-year public institutions, although the rates of FI do vary widely. Weighted estimates suggest that while up to 36% of four-year public student face FI, up to 47% of students at two year colleges reported FI.²¹ This is consistent across the literature where two year colleges consistently had overall higher rates. One study comparing two year to four year colleges, found that non-athletes and athletes at two year colleges had overall higher FI rates (43% and 39% respectively) compared to their counterparts at four-year colleges (32% and 23% respectively).²² A national study of community colleges reported even higher rates, with up to 67% of community college students experiencing FI,²³ whereas other studies reported FI rates of 20% to

CONTACT Heather R. Batchelder  heather.batchelder@duke.edu  Duke Center for Personalized Health Care, Office of the Chancellor Emeritus, School of Medicine, Duke University, Hock Plaza, 2424 Erwin Road, Durham, NC 27710, USA.

*Heather R. Batchelder is now located in the Department of Family Medicine and Community Health, Duke University, Durham, NC, USA. Connor Drake is now located in the Department of Population Health Sciences, Duke University, Durham, NC, USA. Ruth Gilliam Phillips is now located at the Community Health Coalition in Durham, NC, USA.

56%.^{23–27} In comparison, several studies of HBCUs found similarly elevated, if not higher, FI levels. Two studies found that over 70% of HBCU students experienced some form of FI,^{28,29} with one finding that of those who were FI, 56.1% experienced very low FI.²⁹ However, in another study of seven Georgia colleges and universities, only 33% of HBCU students experienced FI, as compared to 29% of private university students, 34% of public university, and 37% of technical college students. In contrast to community colleges and HBCUs, private university students generally are expected to generally have lower or no FI, possibly due to their higher than average socio-economic status (SES).³⁰ However, in a study on undergraduate and graduate private university students, 35.8% of students were found to experience FI, with the likelihood of FI increasing as they utilized more of their available funds for tuition.³¹ Similarly, 48.5% of undergraduate students at an urban Midwestern private university³² and 41% of undergraduate students at a large, urban private university reported low to very low FI.³³

Student types also impacts the rates of FI prevalence, with undergraduates reporting a higher incidence of FI compared to graduate students. A study from a large California university system found that over three times more undergraduate students reported FI compared to graduate students (79% vs 22%).³⁴ Another study evaluating students in a larger southeastern university found that, while undergraduate students reported higher levels of FI than graduate students, the rates were closer in range (25.2% vs 17.8%).³⁵ In general though, undergraduates reported higher rates of FI than graduate students,³⁶ regardless of their year in school.²⁸

Certain demographic groups have consistently been more vulnerable to experiencing FI, specifically those who do not fit into standard traditional student characteristics. For example, regardless of institution or degree types, students who are nonwhite,^{13,37,38} first generation,³⁹ have dependents^{39,40} or are financially independent from their families^{13,39} tend to have a much higher risk for FI compared to other demographic groups.^{11,13,14,24,37–39,41–44} Further, nontraditional students, which are typically older, work full-time, are financially independent, have dependents, are single parents, live off campus, enter higher education with a GED, or do not attend more conventional bachelors programs at four-year universities,^{45,46} are more at risk for FI compared to traditional students.^{39,47,48} When combining these sociodemographic influences with other confounding factors, such as experiencing homelessness^{24,49} and the rising cost of college,⁵⁰ students are often forced to rely more heavily on public assistance, go into further debt to acquire basic housing and food,²⁴ or simply go without in order to obtain a college degree.¹²

While our understanding of FI in colleges students has expanded over the last decade, most of the literature still focuses heavily on student populations in public, four-year institutions,^{13,17,36} only incorporates a single institution in their assessment,³⁶ or excludes nontraditional students. This has limited our understanding of the occurrence of FI across the larger landscape of post-secondary education institutions, specifically ones that are less studied in the literature and may have a higher proportion of older or nontraditional

students. This study sought to determine the prevalence of FI and associated risk factors across three diverse post-secondary education institutions in close geographic proximity that serve both traditional and nontraditional students. Potential risk factors measured specific health behaviors (i.e., inadequate sleep, inadequate fruits/vegetables consumption, and excessive alcohol consumption), poor health outcomes (depression risk, high stress, social isolation, and being overweight/obese), and poor academic performance (grade point average; GPA \leq 3.0). A comprehensive range of sociodemographic, physical, mental, behavioral, and environmental factors were evaluated based on the aforementioned literature and consistent with an existing public health framework of factors influenced by FI.^{18,51} We hypothesized that poor health outcomes, lower academic achievement, and the presence of health risk behaviors would be associated with the presence of FI.^{13–15,24,27,37,39,41,44,52–54} As a secondary hypothesis, we anticipated that FI prevalence would be highest at the participating HBCU and community college as these institutions historically enroll larger proportions of populations at risk for FI,^{8,28,29} and typically have more nontraditional students,⁴⁵ who have been shown to have higher FI compared to traditional students.⁴⁰

2. Materials and methods

This study was conducted at three institutions of post-secondary education located within a medium-sized city in the southeastern US (population= 254,620). In 2019, the city had a poverty rate of 14.1%, higher than the 2019 US average rate of 10.5%.^{55,56} Data were collected between 2017 and 2019. The three institutions included a R1 four-year private university (R1 indicating a doctoral university with very high research activity), a two-year technical community college, and a four-year public HBCU. The private university enrolls approximately 16,000 students annually, with the majority being graduate/professional students (60%).⁵⁶ The community college enrolls approximately 5,000 students annually with the majority attending part-time (74%).⁵⁶ The HBCU enrolls approximately 8,000 students annually with the majority being undergraduate students (76%).⁵⁶

2.1. Procedures

Each institution provided student email addresses and participants had to be ages 18 years or older. During 2017 and 2019, students were sent an introductory email between October and early November detailing the survey, as well as providing consenting language to take part in the study. Once they agreed to participate, students completed an electronic cross-sectional survey and were given the option to enter a raffle for a gift card up to \$25 to a major online store. Students were sent up to three reminder emails asking them to participate and complete the survey and were given approximately four weeks to complete the survey. The first author's institutional review board (IRB) approved the study protocol and each institution signed an agreement to conduct research with their respective student population.

Students provided consent to participate in the study by reviewing the introductory email and then clicked the survey link indicating their consent. Overall, the study's response rate was 15.2%, which is consistent with online surveys sent to students.^{57,58} However, the total survey sample differs from the institutional populations in several ways as described elsewhere.⁵⁸ The private university had the highest response rates for both 2017 and 2019 respectively (23.9% and 26.8%) while the HBCU had the lowest response rates for 2017 and 2019 respectively (9.6% and 9.7%). The community college had a response rate of 13.2% in 2017 and 13.4% in 2019.

2.2. Assessments

The online survey was created using Qualtrics software.⁵⁹ In addition to demographics, validated assessments of social isolation, academic performance (based on reported GPA), depression, stress, health behaviors, and physical and mental health history were included based on existing literature.^{2,11,13-15,17,24,37,39,41-43,60-62}

2.2.1. Food insecurity

FI was the dependent variable for the study and was collected using the USDA Adult Food Security Module. This module is a validated 10-item self-report questionnaire that ascertains the level of food security over the past 12 months, as well as how frequently specific items were assessed over this period (e.g., "Almost every month.")¹ This time reference was chosen in order to be consistent with the USDA Adult Food Security Module. There are four distinct levels of food security: high, marginal, low, and very low. This variable was dichotomized for the logistic regression analysis into food security (high or marginal) and food insecurity (low or very low). Originally, this module was validated in an adult population and has good reliability, content validity, and construct validity.^{1,63}

2.2.2. Social isolation

The Patient-Reported Outcomes Measurement Information System (PROMIS) Short Form, a four-item self-report measurement tool, was used to evaluate perceived social isolation.⁶⁴ Higher scores indicate higher levels of perceived social isolation. The four-item PROMIS Short Form has good reliability, criterion validity, and construct validity, and was originally validated in diverse adult, English and Spanish-speaking populations.⁶⁴

2.2.3. Depression risk

Overall depression risk was evaluated using the Patient Health Questionnaire 2 (PHQ-2), a two-item depression risk screening assessment used to assess symptoms of depression over the past two weeks.⁶⁵ Scores of three or more indicate that a student may be at risk for depression. The PHQ-2 has strong criterion, construct validity, excellent test-retest reliability, and was originally validated in a primary care based adult population.^{65,66}

2.2.4. Stress

The Perceived Stress Scale-4 (PSS-4) was utilized to evaluate perceived stress. The PSS-4 is a four-item self-report questionnaire that asks individuals to rate how often they have experienced stressful situations over the past month using a five-point Likert scale.⁶⁷ Higher values indicate more perceived stress. This scale has been shown to have good reliability, internal consistency, and construct validity^{68,69} and was originally validated in both a college student population and an adult population in a smoking cessation program.⁶⁷

2.2.5. General self-reported health status

A one-item question was utilized to assess students' general self-reported health. The item, "in general, would you say that your health is..." asked students to describe their health as *excellent*, *very good*, *good*, *fair*, or *poor*. The measure has been shown to be predictive of mortality risk.⁷⁰ This item was originally validated in an older adult population (aged 65+ years)⁷¹ and later in young adult to middle-aged adult populations.⁷⁰

2.2.6. Health behaviors

Students were asked to report on the frequency they performed certain health behaviors in a given day or week. The behaviors included: sleep duration, water/beverage consumption, fruit and vegetable consumption, and substance use. Their responses were converted to binary variables to indicate whether students performed the health behaviors at recommended levels. For example, if the USDA recommends that adults consume three cups of vegetables daily and a student reported they ate four cups of vegetables daily, they were considered to be consuming the recommended quantity of vegetables.

2.2.7. Physical and mental health

To evaluate physical and mental health, students were asked to report any history of a chronic physical or mental health condition to the question, "have you been diagnosed with any of the following? Check all that apply." Examples of conditions students could select from include: type 2 diabetes, cancer, generalized anxiety disorder, and major depression. A binary variable was created to capture students who reported a history of any chronic condition versus those without any history.

2.3. Statistical analysis

An observational, cross-sectional analysis study design was used. Descriptive analyses were run to determine population demographics and one-way analysis of variance (ANOVA) tests were run to compare means by institution. Logistic regression was used to examine the relationship between FI and various physical, mental, behavioral, and environmental factors. Due to the higher proportion of graduate students in our sample, we also included degree type in the models to control for this. This analysis was performed by each institution given that FI is binary and the strength of this dataset

is the richness of covariates and diversity of respondents. Variation inflation factors were run to check for multicollinearity and postestimation analyses were run to assess for similarities between the institutional models on factors that were statistically significant for at least two of the three institutional models. A complete case analysis was used and assumes data is missing at random. The complete sample size for the regression analyses included 2,535 students. Any subjects with missing data based on the institutional variable (e.g., which institution students came from) were dropped prior to analysis ($n=20$ students). All statistical analyses were performed using Stata statistical software (version 16.0 StataCorp LLC, College Station, TX, USA).⁷²

3. Results

The sample size included 4,140 students with 48.4% from the private university ($n=2,005$), 25.0% from the community college ($n=1,036$), and 26.6% from the HBCU ($n=1,099$; Table 1). A large proportion of students identified as female (71.2%; $n=2,911$), living off-campus, (63.1%; $n=2,515$) and white

(46.6%; $n=1,454$). Just under half sought a graduate degree from their institution (48.6%; $n=2,002$). Over 54% of the sample was 25 years or younger, with the average age being 27.8 years old. Over 22% reported FI, with a higher proportion of HBCU students (37.1%) reporting FI compared to community college (29.2%) and private university students (11.8%). Out of 4,140 students, 10.8% described their health as fair or poor and 51.2% reported a body mass index (BMI) in the healthy range (18.5–24.9; Table 1). However, 49.4% reported a chronic illness, over 17% reported depressive symptoms and, 9.5% reported elevated stress. For health behaviors, the majority reported poor vegetable/fruit intake (77.7%) and 37.4% reported excessive alcohol use. Finally, 17.3% reported feeling socially isolated. One-way ANOVAs found that each institution was statistically different from one another (see Table 1).

3.1. Food insecurity models by institution

3.1.1. Private university

For the analyzed private institution sample, several demographic, behavioral, mental, and environmental factors were

Table 1. Demographic and health related variable prevalence from All institutions.

Variables	Private University ($n=2,005$) ^a %	Community College ($n=1,036$) ^a %	HBCU ($n=1,099$) ^a %	Total ($n=4,140$) %	<i>P</i> Value ^b
<i>Demographics</i>					
Female	64.2	74.0	83.0	71.2	<0.001
≤25 years	53.2	46.1	65.5	54.7	<0.001
Single	46.4	43.2	51.8	46.9	0.002
<i>Race</i>					
White	58.8	49.0	18.9	46.6	<0.001
Black	5.6	28.6	67.1	26.2	<0.001
Asian	27.5	5.7	2.2	16.0	<0.001
Other ^c	8.1	16.8	11.8	11.3	<0.001
Hispanic/Latino/a	9.0	18.6	6.1	10.7	<0.001
<i>Degree Type</i>					
Graduate/Professional	85.0	1.0	26.9	48.6	<0.001
Bachelors	12.4	5.3	69.0	25.6	<0.001
Associates	0.2	52.3	0.1	13.2	<0.001
Vocational/Certificate	0.6	38.1	1.7	10.3	<0.001
Other	1.9	3.3	2.3	2.3	0.044
Low Grade Point Average (≤3.00)	1.3	19.1	24.4	12.0	<0.001
<i>Housing Type</i>					
Off-Campus	83.2	43.6	44.1	63.1	<0.001
Family/Guardian	4.7	48.6	16.9	18.8	<0.001
On-Campus	11.1	0.4	35.9	15.0	<0.001
Other ^d	1.0	7.4	3.1	3.1	<0.001
Receives Federal Loans	15.2	16.4	45.1	23.5	<0.001
Works Full Time	4.6	15.5	8.4	8.3	<0.001
<i>Health and behavior</i>					
Food Insecurity	11.8	29.2	37.1	22.4	<0.001
Socially Isolated	13.5	20.1	22.2	17.3	<0.001
<i>Body Mass Index</i>					
Underweight (<18.5)	4.6	2.9	3.4	3.9	0.102
Healthy (18.5–24.9)	64.2	39.7	37.3	52.0	<0.001
Overweight (25–29.9)	22.3	23.9	25.9	23.5	0.823
Obese (≥ 30.0)	8.9	33.5	33.5	20.7	<0.001
Fair/Poor General Self-reported Health	6.9	16.7	12.6	10.8	<0.001
Any Chronic Illness	43.3	58.8	52.3	49.6	<0.001
At Risk for Depression	13.1	20.8	23.9	17.8	<0.001
High Stress	6.5	12.6	12.4	9.5	<0.001
Elevated Alcohol Use	48.4	24.7	27.1	37.4	<0.001
Poor Sleep (6≤ hours)	9.1	19.4	23.5	15.2	<0.001
Poor Vegetable/Fruit Intake	75.1	79.7	81.1	77.7	0.007
Socially Isolated	13.5	20.1	22.2	17.3	<0.001

^a= We are assuming missing values have a distribution similar to the observed values.

^b=One-way ANOVAs were run only for the institutions and not the total sample.

^c= includes individuals who identified as American Indian/Native Alaskan, Native Hawaiian/Pacific Islander, or more than one race.

^d= includes individuals who selected they were in transitional housing or were homeless.

significantly associated with FI (Table 2). Individuals who identified as black ($\beta=1.48$; $p<0.001$), or other/multi-racial ($\beta=0.92$; $p=0.002$), were significantly more likely to report FI. However, other demographic factors, such as sex or age, were not statistically significant. Students who lived off campus ($\beta=1.08$; $p=0.003$), had a lower GPA ($\beta=1.39$; $p=0.026$), received a federal loan ($\beta=0.58$; $p=0.016$), reported fair/poor health ($\beta=0.77$; $p=0.011$), reported poor sleep ($\beta=0.73$; $p=0.007$), or felt socially isolated ($\beta=0.57$; $p=0.018$) were also significantly more likely to report experiencing FI. Other health behavior variables included in the private university model were not statistically significant.

3.1.2. Community college

For the analyzed community college students, several demographic, behavioral, mental, and environmental factors were significantly associated with FI (Table 2). Students who identified as black ($\beta=0.54$; $p=0.025$) were significantly more likely to report FI. Further, students who lived off campus ($\beta=0.67$; $p=0.002$) or reported they had fair/poor health ($\beta=0.58$; $p=0.024$), high stress ($\beta=0.95$; $p=0.002$), poor sleep ($\beta=0.50$; $p=0.032$), or poor intake of vegetables or fruit ($\beta=0.63$; $p=0.02$) were significantly more likely to report FI. Other demographic and health behavior variables included in the community college model were not statistically significant.

3.1.3. HBCU

For the analyzed HBCU students, several demographic, behavioral, and mental factors were significantly associated with FI (Table 2). Students who identified as black ($\beta=0.84$;

$p=0.005$) or other/multi-racial ($\beta=1.03$; $p=0.005$) were significantly more likely to report experiencing FI (Table 2). Further, students who reported depressive symptoms ($\beta=1.17$; $p<0.001$), poor sleep ($\beta=0.47$; $p=0.036$), or a chronic condition ($\beta=0.46$; $p=0.021$) were also significantly more likely to report FI. However, students who worked full-time (40 h per week; $\beta=-0.77$; $p=0.048$) or were a graduate student ($\beta=-0.62$; $p=0.009$) were statistically less likely to experience FI. Other demographic and health behavior variables included in the HBCU model were not statistically significant.

When comparing the three logit models, postestimation analyses revealed that there were no statistically significant differences between the models for any variable significant for two or more models. Students who identified as black ($\chi^2=5.56$, $p=0.062$), other/multi-racial ($\chi^2=3.26$, $p=0.196$), lived off campus ($\chi^2=3.31$, $p=0.191$), reported fair/poor health ($\chi^2=3.55$, $p=0.170$), or reported poor sleep ($\chi^2=0.63$, $p=0.729$) were not significantly different between institutions.

4. Discussion

Attendance at post-secondary institutions can provide the opportunity for academic advancement as well as health promotion and psychosocial growth, but such opportunities may be hindered by FI. In this study, FI was reported by 22.4% of the sample, with 37.1% of HBCU students, 29.2% of community college students, and 11.8% of private university students reporting low or very low FI. For risk factors, students who identified as black or reported poor sleep were significantly more likely to report FI regardless of institution. These findings are consistent with other literature

Table 2. Logit model of food insecurity on student demographics and health behaviors by each institution.

Variables	Private University		Community College		HBCU		Post-estimate χ^2
	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI	
Female	.002	-0.38, 0.38	0.28	-0.17, 0.73	0.20	-0.31, 0.71	
18–25 years	0.18	-0.21, 0.57	-0.32	-0.8, 0.15	0.19	-0.27, 0.66	
Single	-0.02	-0.39, 0.35	0.30	-0.11, 0.71	0.11	-0.28, 0.5	
Black ^a	1.48***	0.85, 2.11	0.54*	0.07, 1.00	0.84**	0.26, 1.43	5.56
Asian ^a	0.22	-0.23, 0.69	0.23	-0.82, 1.28	0.54	-0.89, 1.96	
Other Race ^{a,b}	0.92**	0.33, 1.49	0.28	-0.32, 0.87	1.03**	0.31, 1.74	3.26
Hispanic/Latino/a	0.07	-0.63, 0.76	-0.10	-0.72, 0.51	-0.20	-0.99, 0.6	
Obese Body Mass Index	0.03	-0.55, 0.62	0.00	-0.42, 0.43	0.23	-0.17, 0.62	
Lives Off-Campus ^c	1.08**	0.36, 1.80	0.67**	0.25, 1.10	0.38	-0.03, 0.8	3.31
Low Grade Point Average (≤ 3.00)	1.34*	0.16, 2.52	0.33	-0.19, 0.84	-0.25	-0.69, 0.18	
Receives Federal Loans	0.60*	0.11, 1.08	0.46	-0.04, 0.96	0.30	-0.09, 0.69	
Works Full Time	-0.70	-1.83, 0.43	-0.08	-0.59, 0.44	-0.77*	-1.54, -0.01	
Fair/Poor GSRH	0.77**	0.18, 1.36	0.58*	0.08, 1.09	0.03	-0.53, 0.59	3.55
Chronic Condition	0.03	-0.36, 0.41	0.41	-0.04, 0.86	0.46**	0.07, 0.85	
Risk for Depression	0.25	-0.29, 0.80	-0.22	-0.77, 0.34	1.17***	0.68, 1.66	
High Stress	0.18	-0.51, 0.86	0.95**	0.35, 1.55	0.22	-0.38, 0.83	
Elevated Alcohol Use	0.11	-0.26, 0.48	0.20	-0.22, 0.63	0.27	-0.15, 0.68	
Poor Sleep	0.73**	0.20, 1.26	0.50*	0.04, 0.95	0.47**	0.03, 0.9	0.63
Poor Vegetable/Fruit Intake	0.11	-0.33, 0.55	0.63*	0.11, 1.15	0.04	-0.44, 0.53	
Socially Isolated	0.57*	0.10, 1.04	0.34	-0.18, 0.87	0.16	-0.31, 0.63	
Graduate student	-0.25	-0.90, 0.40	-	-	-0.62**	-1.09, -0.15	

Boldface indicates statistical significance ($*p<0.05$, $**p<0.01$, $***p<0.001$, $+p<0.10$). Private University Model: Pseudo $R^2 = 0.101$; Log likelihood = -424.036; No. of Observations = 1,290. Community College Model: Pseudo $R^2 = 0.117$; Log likelihood = -335.170; No. of Observations = 622. HBCU Model: Pseudo $R^2 = 0.134$; Log likelihood = -352.750; No. of Observations = 618.

^a= White is reference.

^b=individuals who identified as American Indian/Alaskan Native, Native Hawaiian/Pacific Islander, or more than one race.

^c=indicates students who live off-campus and not within a family or guardian home.

where college students experience FI at significantly higher rates than the general US population,^{24,73,74} especially amongst HBCUs,^{28,29} as well as by students who identified as a person of color,^{11,13,17,37,39,41,44,53,61} or those who report other behavioral/health concerns, such as poor sleep.^{11,54,75}

In this study, private university students were at greater risk for FI when receiving federal loans or feeling socially isolated, an association not seen in the other schools. Students who have to rely on scholarships, financial aid, and federal loans to afford higher education are frequently more at risk for FI, especially as the financial strain from other basic needs, like housing, can increase the likelihood a college student will be risk for FI.^{24,76–78} Further, experiencing embarrassment, shame, or stigma from the lived experience of FI is not uncommon.^{14,79} For private university students in particular, these feelings may lead them to socially isolate themselves from their peers,^{12,14,30,79} especially in private universities where the socioeconomic divide between students can be quite large.³⁰

In contrast, poor vegetable/fruit intake and experiencing high stress were significant FI risk factors only for our sample of community college students. Studies show that FI is associated with overall poorer nutrition,³⁶ with students experiencing FI generally consuming fewer fruits and vegetables compared to food secure students,⁸⁰ and the relationship between stress and FI is well documented across a variety of institutions.^{11,13,43,62} However, community college students face unique barriers that differ from students attending larger 4-year public or private institutions. Community colleges often have fewer institutional resources to support basic needs, like housing or food needs,^{81–83} and community college students frequently experience more psychological distress than other students.⁸³ Further, community colleges are the most likely to enroll nontraditional students,⁴⁵ who are often older, have dependents, or work full-time,^{48,84,85} thus making the flexibility in class scheduling and financial availability less than ideal when pursuing an education.³⁶ However, nontraditional students are also more likely to experience stress compared to traditional students, which was exacerbated during the recent COVID-19 pandemic.⁸⁶ This trend may explain the association between high stress and poor vegetable/fruit intake and FI amongst community college students.

Finally, for HCBU students both symptoms of depression and working full-time were significantly associated with FI. The relationship between FI and depression and FI and full-time work is well documented within public institutions, and may support what is occurring in the HBCU sample.^{13–15,39,41,87} Lin et al. found that FI predicted lower self-esteem in HBCU female students,⁸⁸ and self-esteem has been shown to contribute to depression.⁸⁹ Further, working full-time is associated with lower FI risk.⁸⁷ The literature regarding HBCUs is relatively sparse and more research is needed to more fully understand the unique risk factors of HBCUs. However, some reasons for why rates may be elevated at HBCUs could be attributed to the other known risk factors. Identifying as black, Hispanic, or other/multi-racial is associated with a higher risk for FI,¹³ and HBCUs historically enroll more black,

Hispanic, or other/multi-racial students compared to four-year public or private institutions.⁹⁰

Over the past 20 years, great strides have been taken to understand FI experienced by college students and to develop solutions to address it at multiple levels. Because of the changing landscape of higher education and the diverse needs of students, a multi-dimensional, multi-level approach is needed.⁹¹ With almost 71% of students meeting some criteria as a non-traditional student,⁴⁸ this includes understanding the how we tailor food resources to the students and institution.^{46,92}

At the institutional and individual level, some of the most common approaches to supporting FI on college campuses involve food provision initiatives. These include programs like campus food pantries, meal share programs, and campus gardens.^{47,49,93} While these programs have brought more awareness regarding FI, and have provided immediate on-site options for students struggling with hunger,⁹⁴ more research is needed to understand how the different approaches impact FI reduction.^{47,91} Further programs, like campus food pantries, are not consistently available on campuses, specifically those that are private or two-year institutions. In the national study on food pantries on college campuses, food pantries were much more common in public institutions (85%) compared to private institutions (14%).⁹³ Further, when comparing four to two-year institutions, twice as many four-year institutions reported food pantry availability compared to two-year institutions,⁹³ even though two-year institutions report much higher rates of FI compared to four-year institutions.¹⁷ Initiating food resources, like food pantries, has challenges including staffing needs, food donations, and general funding.⁹³ However, institutions, specifically those who are private or two-year institutions, could begin by first assessing the contextual needs of their students, including if they are FI and what basic needs are going unmet.

Contextual surveys that assess for several basic needs like housing, food security, and access to healthcare, could help institutions assess which students are experiencing FI most severely, and what other factors may contribute to that experience.^{95–98} For example, in one study, students reported that poor financial aid, high campus food costs, and expensive meal plan options with unrealistic requirements, were extenuating barriers that impacted their food security.⁹⁹ By assessing for these factors, institutions would be able to tailor their investment and support in developing food initiatives, and institutional practices, that match on to what students actually want and need. Institutions could also help eliminate the extenuating barriers that students face when attempting to access campus food programs.⁴⁷ Many students report experiencing stigma when utilizing food resources from college campuses⁵² and for nontraditional students, the availability to attend food programs during daytime hours or the on-campus location of resources is limiting.^{52,78,97} Campus leadership could provide alternative options, such as situating the program within other campus services or varying the hours of operation,⁹¹ as well as increasing outreach to increase awareness and decrease stigma over hunger relief programs.¹⁰⁰ Additionally, faculty and student organizations, who often have the most direct contact with students, could also work toward fostering a culture destigmatizing FI and

support proactive outreach *via* basic needs statements on syllabi, welcome emails, and voluntary welcome surveys to assess for basic needs.^{54,93,101,102}

At the system and policy level, approaches for mitigating FI on college campus include federal initiatives such as the Supplemental Nutrition Assistance Program (SNAP). SNAP has been successful in reducing FI since introduced in 1963, especially in light of recent temporary expansions to students with the COVID-19 pandemic.¹⁰³ Prior to the temporary expansion of SNAP, only 18% of FI students were eligible for SNAP benefits;¹⁰⁰ however, with that expansion now expired,¹⁰⁴ permanent options are needed. State and federal policymakers could permanently expand SNAP and other federal hunger relief bills that allow greater access to these programs on college campuses, especially for students who are now ineligible for SNAP.^{48,91,105,106} Campuses could also further support students by providing better outreach on available federal programs, and helping walk students through the application process.^{47,91,107} In a recent report on basic needs amongst HBCUs, minority serving institutions, and predominantly black institutions, students reported that they do not seek out campus resources, because they do not think they are eligible, do not know how to apply, or think others need the programs more than they do.¹⁰⁸ Institutions could incorporate education on how to apply for federal resources and other campus aid as part of their food provision initiatives to help inform students of what options are available to them.

5. Limitations

The findings of this study should be interpreted within the context of several important limitations. The private university had a much higher response rate compared to the community college and HBCU and our samples were not completely representative of the institutional populations we pulled from, as noted elsewhere.⁵⁸ Further, the private university sample had a much larger proportion of graduate students, as compared to the HBCU and the community college samples. This could have impacted the type of responses received due to the total sample being more heavily represented by private university students, graduate students, white students, older students, and students who identified as female. Further, as the online survey was voluntary, self-selection bias may have been introduced as we utilized convenience sampling.⁵⁸ Another limitation includes the scale utilized to assess FI. The 10-item USDA module was only validated in an adult sample,⁶³ and not explicitly assessed with college students. Moreover, recent findings discussing the timeframe inconsistencies for measuring FI may mean these results are not as comparable to other literature utilizing alternative timeframes (e.g., past 30 days).⁹⁶ Another limitation is that our study did not evaluate the impact of racial, geographic, or environmental disparities on the prevalence and risk for FI.^{109,110} Finally, causal interpretation is not possible given the study design and results may not be generalizable to other institutional settings. Despite these limitations, this study describes FI at post-secondary institutions, details the prevalence of FI at post-secondary institutions that tend to be understudied (HBCUs, community

colleges, and private universities), and identifies specific and unique FI risk factors related to campus health promotion efforts.

6. Conclusion

This cross-sectional study evaluated the prevalence and risk factors of FI across three post-secondary education institutions in close geographic proximity. Consistent with the literature, our study shows that private university, community college, and HBCU students who have high stress,^{11,14} poor sleep,^{11,54} a chronic condition,⁶ social isolation,^{12,14} poor fruit/vegetable intake,^{13,42,54,82} and lower self-reported health^{13,33,41,54,60,62} are at higher risk for FI. Further, FI prevalence was two to three times higher in the community college and HBCU (37.1% and 22.4% respectively) than the private university (11.8%). These results suggest that prevalence and risk factors for FI may vary between these types of institutions, but are similar to those experienced in public four-year institutions. However, more research is needed to evaluate the experience of FI in private, community college, and HBCU students, especially regarding the impact of racial and environmental disparities, and to expand our understanding of how to continue to enhance programs that alleviate FI. Further they highlight the need to understand what resources are specifically available to students on these campuses, and the importance of multi-level strategies to address FI,¹⁰⁷ especially in light of the COVID-19 pandemic which saw FI rise in vulnerable communities.^{17,52,93,105,106}

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Conflict of interest disclosure

Dr. Snyderman serves on the board of directors of iRhythm Technologies, DNAnexus, the Whole Health Institute, and ZealCare, where he is also a co-founder. No other conflicts of interest were reported by the authors of this paper.

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ORCID

Heather R. Batchelder  <http://orcid.org/0000-0002-1237-7441>
 Connor Drake  <http://orcid.org/0000-0002-5393-6246>
 Tyler Johnson  <http://orcid.org/0000-0003-2235-9391>

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