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Title: A broadened understanding of university student food security: undergraduate and graduate student food utilization and access at a Big Ten university

Abstract: Focusing on food access, existing college studies find rates of low or very low food security to range from 10-75%, with little understanding of variation among undergraduate and graduate students. A greater understanding of food security including access *and* utilization for both undergraduate and graduate students will help address its adverse effects on the health and academic outcomes of students. We evaluate food security at a large midwestern university, identifying characteristics related to both access and utilization. This approach allows for the identification of solutions tailored to undergraduate and graduate students living on- and off-campus who lack food security.

Keywords: Food security; college students; food access; food utilization; health outcomes; wellbeing; solutions.

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Introduction

We still do not understand the food security of U.S. college students, who are potentially caught between adult (11.5%) and child (15.2%) levels of low and very low food security.[1] One comprehensive review of college students in the U.S. reports that the rate at which university students lack food security ranges from 10-75%.[2] Because of the high diversity that often exists in student populations, it is important to understand differences between subpopulations. However, only four peer-reviewed studies include undergraduate and graduate students in their samples across universities[3–6], and only one directly compares them.[7] We add to the literature on food security with our study of undergraduate and graduate student food security using a large, representative, random sample of students at a Big Ten university. Understanding and addressing food security issues at universities is critical because periods of inadequate food can result in adverse health effects and academic outcomes.[8]

Food Security

Food security exists when all people in a community, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life.[9] The following components of food security are widely accepted and are used to frame our study:[10]

- ***Food availability:*** The 'supply side' of food security. Determined by the level of food production, stock levels, and net trade. It is generally not in the control of students.
- ***Food access:*** Whether a household or individual has adequate means to obtain food(s) for a nutritious diet and is the result of income plus the cost of and physical access to food.
- ***Food utilization:*** Whether the food being consumed promotes physiological health and a state of wellbeing.
- ***Stability:*** Whether there is consistent and adequate availability, access, and utilization.

When any of the above components are lacking, a person is experiencing food insecurity. In this study, food insecurity is defined by the reduced quality or quantity of food consumed and disruption of eating patterns.[11]

University Student Food Insecurity

College and university student populations are not homogeneous. However, only one previous food security study of university students has explicitly compared undergraduate and graduate students, reporting the rates of low and very low food security of 25.2% and 17.8%, respectively.[7] Undergraduate and graduate students are typically in different stages of their lives, with a range of financial and housing contexts that can impact food security. We believe that a better understanding of the different student populations might support improved food security interventions and policies.

University food security studies have asked respondents about their race and ethnicity, marital status, parental status, family finances, progress to degree, living situation, cooking skills/frequency, resource adequacy, employment, meal plan, and budgeting, and yet there remains varying levels of agreement of what is most influential. Other studies have identified that students of color are disproportionately impacted by a lack of food security.[4,7,12–15] While some suggest that financial factors may play a bigger role in food security of students than race and ethnicity,[16] there is growing recognition that discrimination and structural racism (racism produced and reproduced by-laws, rules, and practices, sanctioned and even implemented by various levels of government, and embedded in the economic system as well as in cultural and societal norms[17]) are key contributors to disparities in people of color's food security, health behaviors, and outcomes.[18–20] Additionally, some researchers have examined food security in the context of inter-generational financial struggles.[4,7,21,22]

Previous research reported that being married increases a student's likelihood of greater food security[7], while other studies found no relationship.[14] It is also asserted that students enrolled in full-time higher education have a reduced ability to work and cover the cost of food.[22] At the same time, one study found that food security did not have significant associations with student employment,[13] while others report finding that being employed was associated with less food security.[23] Other researchers have observed that students with parental support often appeared to have more freedom when purchasing food.[24] However, few food security studies have separated undergraduate and graduate students when examining such characteristics. Some also found that undergraduate students were more likely to lack food security as they progressed through their degree program.[3,25,26] Some have suggested this resulted as student faced increased costs associated with off-campus housing or as they lacked a campus-based meal plan[7,27]. Others have noted that student access to a meal plan does not guarantee food security, and one study reported that 43% of students in their study who had a meal plan reported lower food security.[4] Other significant factors identified in previous work in student food security may be budgeting behaviors - students who were in the habit of budgeting tended to be less food secure.[18]

Overall, research about food security in universities has focused largely on food access (although uncertainty remains, as outlined above) and has not equally integrated the food utilization component of food security.[14,15,28] Food utilization concerns the nutritional and social value of food; it recognizes that while someone may consume enough calories, it is also important that food meets dietary and cultural needs. Some related literature has examined if characteristics related to assets, knowledge, and skills are associated with food security, finding that young adults who have adequate knowledge and resources to prepare food tend to have a higher quality diet.[29] Having access to appliances, time for food preparation, and transportation have also been found to be positively associated with food security.[18,22] Therefore, we include questions about food

utilization and cooking skill/frequency in our study in addition to food access characteristics as we explore food security to support effective solutions for undergraduate and graduate students.

Based on the gaps within the literature, we see a need to sample and collect data from undergraduate and graduate students to examine multiple elements of food security by measuring food access *and* food utilization. We do so with the expectation that a broader measure of food security will foster better informed university policies for addressing undergraduate and graduate student barriers to food security. This more comprehensive approach to improving food utilization and access may drive improved academic outcomes[30] and student wellbeing[31] in higher education.

Materials and Methods

Research Site

This study took place at Michigan State University (MSU), a large public university with about 24% BIPOC (Black, Indigenous, and Persons of Color) and 76% white students, according to the 2018-19 Student and Workforce Data Report.[32] At one time, a small number of the university's students (approximately 250) were included in a study across 34 universities that reported that 48% of university students lack food security (n=3,765), with no specific results/statistics attributed to MSU.[33] For some time, the university has acknowledged the prevalence of and need to address food insecurity of its students by helping to support a student-run, on-campus food bank. In 2018, the MSU Student Food Bank reported the results of a survey it administered (n=363) and reported finding 4.4% of students to be lacking food security.[34] Survey details, including how food security measures were designed, pretested, and implemented are not clear. Therefore, uncertainty about food security exists at MSU. The research team received permission and support for this study from the MSU Provost's Office. A survey was distributed to a large random sample of undergraduate and graduate students. This study was reviewed and

approved by the MSU's Institutional Review Board (Study 0002441) who determined it to be exempt under 45 CFR 46.104(d) 2(i).

Survey Items

The study developed a survey that builds on previous research to ask about students' ability to access and utilize food while collecting demographic and socio-economic data. Table 1 outlines the variables that we used, grouped by food security component – the whole survey is available in Appendix 1.

Table 1. Food security survey components, characteristics, and items.

Component	Characteristics	Survey Items (Variables)
Food access	Demographics	Race/Ethnicity
		Marital status
		Parental status
	Socio-economics	History of family financial struggle
		Employment
	Where meals are obtained	Living on/off campus
		Fruit and vegetable access adequacy
	Money spent on groceries	Food money adequacy
		Budgeting
Food access & utilization	Money spent on groceries	Meal plan
	Resource adequacy	Food prep time adequacy
	Meal preparation frequency	Kitchen adequacy
		Home cooking
		Eating out
	Nutrition	Diet health
	Nutrition knowledge confidence	Cooking skills
Outcomes	Access - Food security	6-item USDA FS module
	Academic outcome	GPA
	Wellbeing	Overall health

		Energy
		Concentration

Food Access: To further understand respondents' food access, they were asked to provide demographic information including their race/ethnicity, marital, and parental status in addition to their current employment, budgeting, adequacy of money for food, and history of family financial struggle. Food access also includes physical access to a grocery store, so we asked respondents whether there are healthful groceries available to them within walking distance.

Food Access & Utilization: Some characteristics of respondents may be relevant to both food access and food utilization. For example, having a required meal plan may control some students' food access but it also may influence a student's food utilization. As such we asked respondents questions about resource capacity, their knowledge acquisition regarding food, their resources such as time to prepare food, their access to a kitchen, the kinds of food the respondent eats, and how often they eat at home versus eat out/take in (this study took place in a pre-COVID-19 context).

Outcomes: To include food utilization and conduct a more comprehensive study of food security on campus, we asked respondents about the quality of their diet and outcomes on their wellbeing. Respondents were asked to rate their current diet, overall health, concentration, energy levels, and wellbeing using a Likert-style scale (response options: excellent, very good, good, fair, poor). Finally, given the academic setting, we asked about respondents' GPA (a final outcome measure) and an open-ended question about what suggestions they had to improve student food security.

Food security module: The most common approach for measuring food security in the U.S. has been the USDA Adult Food Security Survey Module[35] which focuses primarily on food access; there are indirect references to some of the other food security components, but they are not explicitly measured. The USDA survey has been widely used; one review identified 59 such food security studies of university students with food insecurity averages based on studies in "gray"

literature of 36% and peer reviewed literature of 42%.[36] Other reviews of studies in U.S. higher education reported a weighted average of all types of study, finding 37%[37] and 41%[2] of students lack food security. While averages are consistent the reviews outline wide variation (10-75%)[2] which may reflect the use of different survey versions (the survey comes in multiple lengths) and time periods that respondents were asked to use when formulating their responses (e.g., during last 3 months versus during the last 12 months).[2] Some studies report that different versions of the USDA survey in university settings generated different results, with the shorter versions of the survey yielding lower food security rates.[38] Regarding food access outcomes, we follow the majority of the college food security studies and use the Six-item Short Form of the USDA's Adult Food Security Survey Module.[35] This measure is centered on understanding respondents' food security outcomes as a function of them being able to employ coping strategies (i.e., being hungry, lack of ability to afford balanced meals, eating less than desired, cutting the size of meals, skipping meals, and reduced meal frequency). To evaluate our participants' experience regarding food security while at college, we administered the survey towards the end of an academic year and asked respondents to consider that 9-month period (fall 2018-spring 2019). As per USDA instructions, responses of "often", "sometimes", "almost every month" and "some months but not every month" were coded as affirmative. The sum of all the affirmative responses results for a respondent is their food security raw score. Students with raw scores totaling 0-1 are considered to have high or marginal food security, while students with scores of 2-4 are considered to have low food security and those who scored 5-6 are considered to have very low food security.[35]

Pre-testing

We pre-tested the pilot survey three times in focus group settings, with two groups of twenty-five undergraduate students and a group of 7 graduate students. The pre-test participants were asked to first fill out the survey individually in Qualtrics; our response rate for each of the

pre-test groups was 100%. After taking the survey, students were prompted by the research team to indicate anything they found to be confusing or unclear. Keeping notes of discussion points, the research team used the feedback to collectively adjust questions and definitions more clearly - specifically response options for types of housing, meal plans, and grocery stores.

Sample and Response Rates

The final 45-item survey was designed and distributed online using Qualtrics. At the time of the data collection, MSU had 39,423 undergraduate and 10,928 graduate students.[32] Email invitations to participate in a study of MSU students' food security went out during April and May 2019 to random sample of 8,000 students - 6,000 undergraduates and 2,000 graduate students. Students who did not respond to the initial survey invitation received up to three reminders through email over the course of the four weeks that the survey was open. There was no compensation for students' participation in this study. To promote a uniform reference period that reflected the college experience, we asked all participants to consider the entire academic year as the time frame for their answers.

Respondents who did not answer all six of the USDA survey questions were taken out of the sample used in our analysis. We received complete food security questions from 1,408 respondents. The response rate for undergraduate students was 8.1% (n=654) and 37.7% for graduate students (n=754). Although our sample was randomly generated, there is potential for response bias in who chooses to complete the survey – for example, students who struggle with food security may have been more likely to participate in the survey, making the rate of food security appear lower than it is. Additionally, all data based on self-reported measures may reflect some response bias in under- or over-reporting or some understanding differences.[24]

Results and Discussion

Graduate students were overrepresented in our sample, accounting for 54.4% of respondents while 46.6% of the respondents were undergraduates; at MSU at the time, 21.7% of the student population were graduate students while 78.3% were undergraduates. Women are overrepresented, accounting for 60.8% of respondents compared to the 51.3% of undergraduates who are women and the 56.9% of graduate students who are women in the university population. We were limited by university reporting limitations and requirements and cannot directly compare the race and ethnicity we collected with university data, but we can say that our sample contains 30.5% students of color as compared to an overall university average of 23.0% students of color. The analyses have not been adjusted to account for differences in the proportion of undergraduates and graduate students, gender, or race. We did not adjust undergraduate and graduate students because their analyses are separate. We did not weight by gender because there were no significant differences regarding food security and other important variables and for race/ethnicity, we were limited by university data constraints. The below sections discuss outcomes, then characteristics that help explain these outcomes.

Food Security Outcome as per Food Access

Overall, our sample of students reports a combined low and very low food security rate of 26.9% based on the Short-form USDA survey—14.0% of respondents received a 'low' food security score and 12.9% of respondents received a 'very low' food security score. These scores are broken down for undergraduate and graduate sub-samples in Figure 1. The overall rate of about 26.9% for MSU is lower than the 48% reported in a previous study[33] that included some MSU students and is significantly larger than the 4.4% reported in the MSU Food Bank's survey.[34] When compared to the results of large reviews of food insecurity studies across campuses,[2] our results fall below the weighted mean (41%) but within the range (10-75%). When examining the

difference in food security scores for undergraduate and graduate students consistent with the one prior study,[7] we found undergraduates (32.3%) to report a lack of food security more frequently than graduate students (22.5%). As Table 2 shows (via overall rates combining groups with low and very low food security), undergraduate students report decreasing levels of food security as they progress in school.

Table 2. The proportion of food secure undergraduate students generally decreased with progress through their degree increased.

	First year	Second year	Third year	Fourth years	Fifth year+
Proportion of undergraduate students lacking food security	19.3%	27.0%	42.1%	60.0%	48.0%

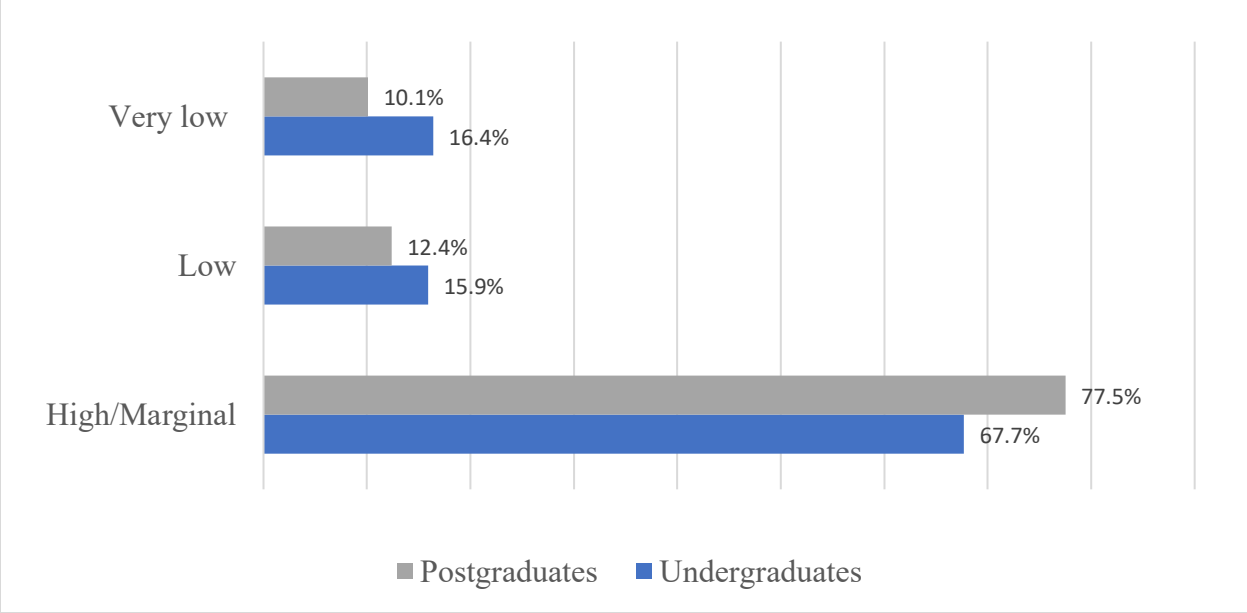

Figure 1. The proportion of undergraduates reporting both low and very low food security was higher than for graduate students.

Characteristics Explaining Student Food Access Outcomes

Chi-square tests were used to evaluate the significance of differences in responses to survey items provided by undergraduate and graduate students.[39] First, "low" and "very low" food security categories were combined to create a dichotomous variable – food secure versus food insecure. Statistically significant differences among undergraduate and graduate student food

security outcomes and other measures are shown in Table 3. Self-reported race and ethnicity data were not significant in relation to the reported food access of undergraduate students, diverging from some of the previously mentioned literature. However, the self-reported race and ethnicity data were significant with respect to graduate student food security (X^2 (2, 710) = 9.92, p=<0.05). MSU's large number of international students or our failure to adequately account for the race and ethnicity of our sample may be a factor impacting the undergraduate results, and future work should address these limitations.

Marital status does not appear to be significant for undergraduate student food security, but it was found to be significant for graduate students (X^2 (2, 711) = 14.5, p=<0.001) consistent with other studies finding that married graduate students have an increased likelihood of food security.[7] We hypothesize married graduate students have additional income from their partners to buffer the financial strain of being in school. Only two undergraduates indicated that they were married so we were unable to test for its significance regarding undergraduate food security. There is little consensus in the literature on whether parental status has a relationship with food security – our data found it was not significant for either undergraduate or graduate students.

*Table 3. Four respondent characteristics show significance for either undergraduate or graduate students, four are significant for both undergraduate and graduate students, and one was not significant for either group demonstrating differences between characteristics of food insecure for undergraduate and graduate students (bold indicates significance, * indicates a p-value <.01, ** indicates a p-value <.001)*

Characteristic	**Sub-Sample**	**P**	**X^2**
Race/Ethnicity	UG	0.683	0.17
	PG	**0.002***	9.92
Marital status	UG	0.399	0.07
	PG	**<.001****	14.55
Parental status	UG	0.203	1.62
	PG	0.113	0.74

History of Food insecurity	**UG**	**<.001****	12.5
	PG	**<.001****	11.69
Employment	**UG**	**0.003***	8.84
	PG	0.319	0.99
Living on/off campus	**UG**	**<.001****	37.3
	PG	0.567	0.03
Fruit and vegetable access adequacy	**UG**	**<.001****	20.43
	PG	**<.001****	20.49
Food money adequacy	**UG**	**<.001****	123.68
	PG	**<.001****	271.41
Budgeting	**UG**	**<.001****	82.17
	PG	**<.001****	116.32

Respondents were asked to indicate if their childhood household had received food assistance (i.e., SNAP, WIC) before they went to university. Those responses were found to have a significant relationship with respondents current self-reported food security status for both undergraduate (X^2 (2, 733) = 11.7, p=<0.001) and graduate students (X^2 (2, 605) = 12.5, p=<0.001), in line with previous studies.[4,21,22] For undergraduate students a job was associated with lower food security (X^2 (2, 636) = 37.3, p=<0.001), aligning with other studies[23], but for graduate students there was no relationship between employment and reported food security.

At MSU, the food experience appears to be more tied to campus for undergraduates. For graduate students, living on or off campus was not associated with food security. In contrast, undergraduate students living on campus (X^2 (2, 616) = 28.3, p=<0.001) reported greater food security. At the time of the study, living on the MSU campus was mandatory for one year for undergraduates, during which they are required to have a meal plan with unlimited access to dining halls – this may explain this result and is explored further below to also take food utilization into account. Relating more to students living off-campus, the adequacy of affordable fruit and

vegetables within walking distance was found to be positively associated with food security for undergraduate (X^2 (2, 577) = 20.43, p=<0.001) and graduate students (X^2 (2, 721) = 20.49, p=<0.001). Triangulating this, the USDA's food desert locator indicates that many parts of MSU and East Lansing, where the majority of the university's students live, are classified as a food desert[40] which means that students have inadequate access to grocery stores and reliable transportation. When asked about desired improvements to the MSU's food system, many students asked for a grocery store that is accessible, affordable, while offering high quality foods.

Not surprisingly, both undergraduate (X^2 (2, 577) = 123.68, p=<0.001) and graduate (X^2 (2, 724) = 271.41, p=<0.001) respondents who reported having more money for food also reported higher food security. The students who reported the lowest levels of food security spent the least on groceries weekly ($53.34) while those who were most food secure spent more ($71.51). Relatedly, students were asked to report if they budgeted their finances for food and budgeting was found to be associated with respondents reporting low food security at both the undergraduate (X^2 (2, 606) = 82.17, p=<0.001) and graduate (X^2 (2, 743) = 116.32, p=<0.001) level. Budgeting's usefulness is critical for many people successfully managing high financial need.[18] Our interpretation is that students who have greater food security likely can afford not to budget.

Characteristics Explaining Combined Student Food Access & Utilization Outcomes

Although the USDA 6-item survey does ask about the ability to afford balanced meals, the emphasis is placed on access. There may be barriers other than affordability preventing students from accessing healthful meals as discussed above (e.g., transportation, food choice in dining halls). Therefore, we expanded our study beyond common characteristics that explain food access to those that relate to food utilization and access, as shown in Table 4. Consistent with others,[26,41] our results show that undergraduate students having a meal plan seems to promote their food security (X^2 (2, 616) = 28.3, p=<0.001) but that it was not significant for graduate students. As

undergraduate students progress in their studies, they tend to choose off-campus living options, which may explain the trend of decreasing food security during an undergraduate's time in school (see above). Also, the one-time fixed cost of a meal plan may be an easier mechanism for some students (or their parents/guardians) to pay than finding the time, money, and transportation for regular grocery shopping and cooking. Our findings, consistent with previous literature,[42] supports the idea that meal plans help undergraduate students access food but it should be noted that it is not a guarantee of food security - of the undergraduates with a meal plan in our sample, 24% still reported experiencing low or very low food security. Additionally, 45% of students who report having a meal plan also reported that their diet was "Very unhealthy" while only 5% said their diet was "Very healthy." When asked in the survey about potential improvements for the MSU's food system, many students felt that the current dining hall and near-campus food options should provide healthier choices. As one undergraduate student put it, there is a need for "*More healthy options in terms of balancing different kinds of foods."* Others expressed that the dining halls do not adequately meet their dietary needs or preferences, resulting in sourcing food from other places or choosing not to eat. As one respondent reported, *"Being a vegetarian, I ate out/stayed hungry the whole time I lived on campus."* It seems that such experiences of having access to food but food that is not of type desired by students influence reported food security.

*Table 4. Four of our five access and utilization characteristics demonstrated significance – meal plan for UG only, eating out for PG only, and food prep time and kitchen adequacy for both UG and PG (bold indicates significance, * indicates a p-value <.01, ** indicates a p-value <.001).*

Characteristic	**Sub-Sample**	**P**	**X^2**
Meal plan	**UG**	**<.001****	28.3
	PG	0.21	1.57
Food prep time adequacy	**UG**	**0.008***	13.7
	PG	**<.001****	29.89
Kitchen adequacy	**UG**	**0.003***	16.3

	PG	**0.018***	11.93
Home cooking	UG	0.299	4.89
	PG	0.315	4.74
Eating out	UG	0.875	1.22
	PG	**0.003***	16.38
Diet health	**UG**	**0.016***	12.13
	PG	0.196	6.04
Cooking skills	UG	0.516	3.25
	PG	0.918	0.95

Undergraduate and graduate students who reported adequate time to prepare meals also reported higher food security, consistent with the findings of others.[22] Being enrolled in college full time in addition to potentially having a job may make it difficult for students to make it to the grocery store and to prepare a healthful meal at home. We also asked about students' access to an adequate kitchen and found that such access was associated with higher food security for both groups of students, as per other studies who found that students with higher resource adequacy (including appliances for food preparation) are more likely to be food secure.[18] On-campus respondents indicated that they had trouble accessing their residence hall kitchen which may be an additional barrier for on-campus students consuming desired foods. While we anticipated this result for undergraduates, particularly those living in university residence halls, it is apparent that some off-campus housing is not fully adequate to support food security either. Furthermore, there were no significant relationships with cooking skills, indicating that resources are more important. Except for graduate students eating out, we found no significant associations between self-reported food security and either eating homecooked meals or fast food. Graduate students who reported eating out often (framed as fast food) tended to be less food secure, as per the literature.[43]

Students were asked to rate how healthy they felt their diet was, leaving the interpretation of healthy up to respondents and their understanding of their own dietary needs and preferences.

How students perceived the health of their diet was significant for undergraduate food security (X^2 (2, 550) = 82.17, p=<0.001) but not for graduate students. Interestingly, almost 42% of all respondents rated their diet either "unhealthy" or "very unhealthy," which indicates that even those who have access to food may not have the desire to consume foods that are healthful, aligning with stereotypes of student diets. To explore this further, Figure 2 shows the frequency of undergraduate students who perceive the health of their diet on a scale of "Very healthy" to "Very unhealthy" by food security grouping, indicating that those who have higher food security are more likely to say their diet is healthy. All of the food access groups tended to perceive their diet health as on one end of the spectrum or the other, rather than in the middle. Farahbakhsh et al.'s (2017)[44] findings underpin the relationship between diet health and food security in undergraduates, noting that students who are less food secure had lower fruit and vegetable consumption.

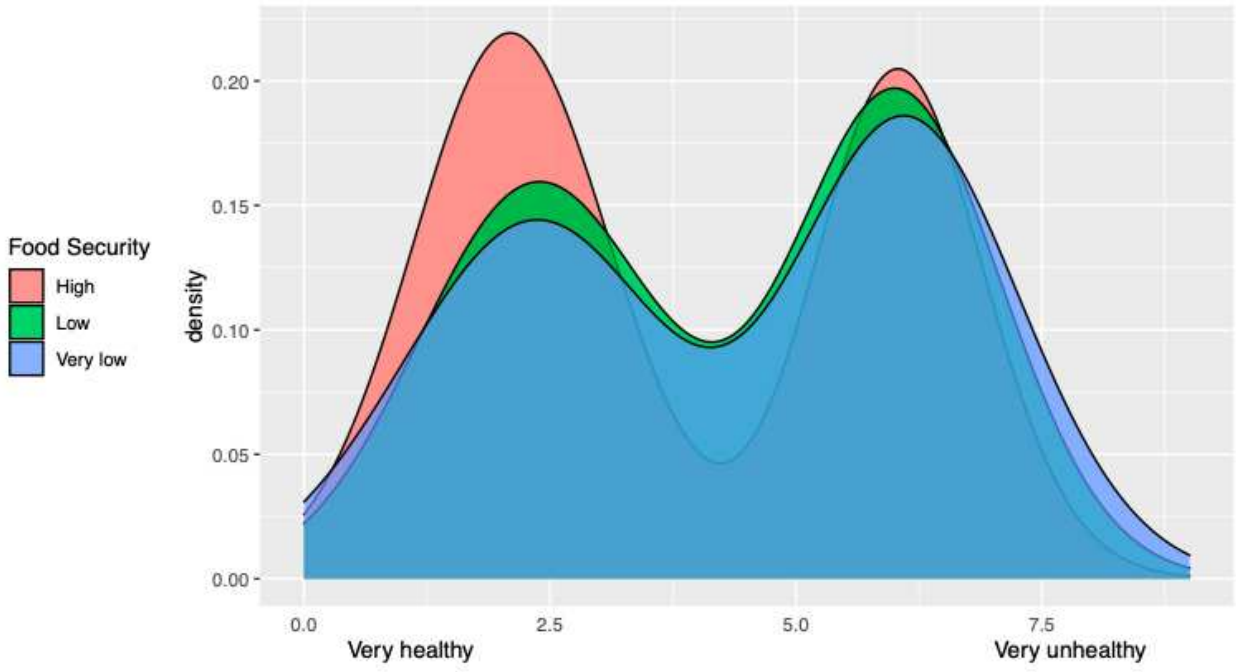

Figure 2 shows the density of how undergraduate students perceive the health of their diet on a scale of "Very healthy" to "Very unhealthy" by food security status.

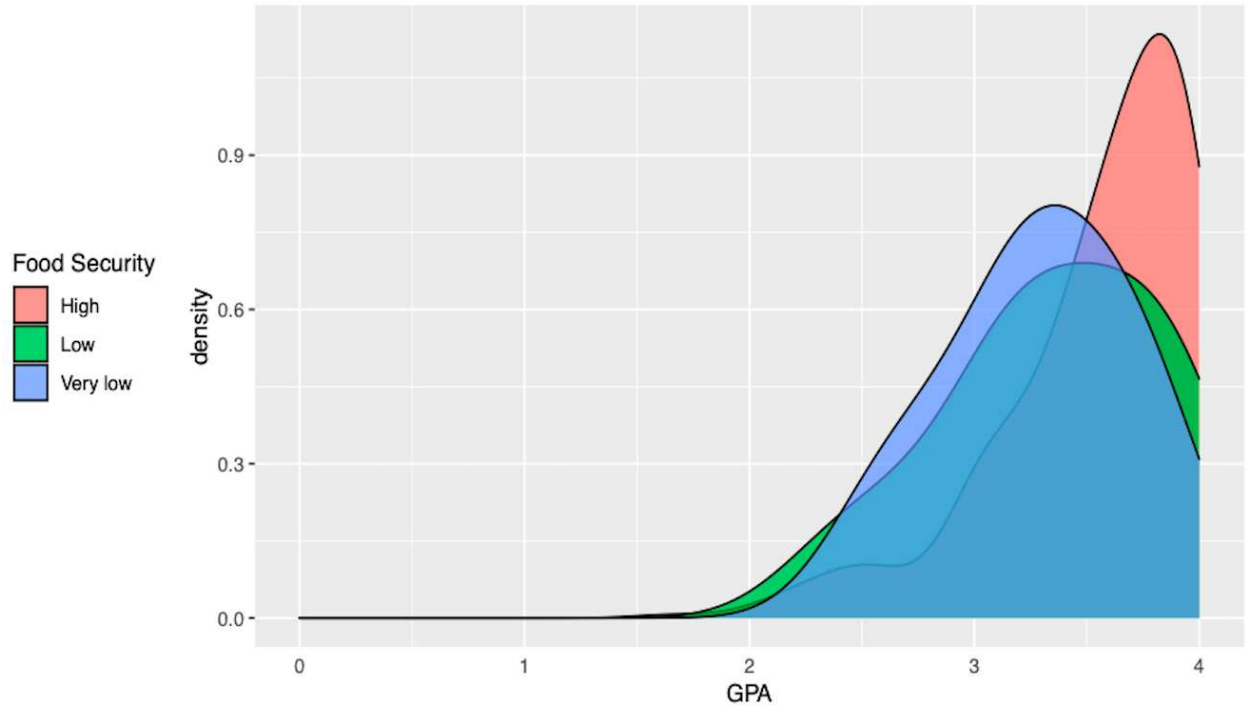

Figure 3. The frequency of GPA of undergraduate students grouped by food security levels shows that increased food security is associated with higher average GPA.

Outcomes of Low Food Security

An understandable concern centers on lower student food security as a barrier to academic success. Our results are consistent with studies that have shown higher food security to be associated with a higher GPA.[3,13,31,45] Figure 3 shows the density (how frequently each GPA was reported) of respondents' GPAs grouped by high, low, and very low food security for undergraduate students. The GPAs of undergraduates who have high food security cluster towards the higher end of reported GPA. Respondents who reported low and very low food security are more spread and peak around lower average GPAs.

Beyond the outcomes of food access and academic success, we examined wellbeing outcomes of energy level, overall health, and concentration – all were strongly significant for both undergraduate and graduate students. Table 5 shows that students who reported having higher

energy levels, higher overall health, and higher concentration tended to be those who reported higher levels of food security. Previous work agrees, showing that less food secure students report lower energy levels and lower overall health as compared to their food secure counterparts[13] and that students who are hungry may have trouble concentrating in class.[46] Others find that psychological distress is significantly associated with low food security[47]. Comparing Figure 2 and 3 demonstrates that when physiological needs are not being met due to a poor diet, the result is often a struggle to perform in school, and Table 5 demonstrates the negative impacts on overall wellbeing. These findings justify our focus on identifying characteristics of food security to inform interventions that promote students' academic success and overall quality of life.

*Table 5. Multiple wellbeing outcomes demonstrated significant relationships – energy, overall health, and concentration for both undergraduates and graduates and diet health for undergraduates (bold indicates significance, * indicates a p-value <.01, ** indicates a p-value <.001).*

Characteristic	Sub-Sample	P	X^2
Energy	**UG**	**<.001****	73.44
	PG	**<.001****	27.51
Overall health	**UG**	**<.001****	45.15
	PG	**<.001****	43.56
Concentration	**UG**	**<.001****	34.93
	PG	**<.001****	37.29

Conclusion and Recommendations

We found that the overall rate of low and very low food security in our sample of MSU students (26.9%) is much higher than the U.S. national average pre-Covid-19. Therefore, it seems important to focus more attention on why student food security is lower for university students than that of the general population and solutions to combat it. We also find that by taking a more holistic approach to assessing food security that includes questions about both food access and utilization as well as academic and wellbeing outcomes, we can reveal important opportunities for

university food system improvement. Our results show that those who lack food security (according to the USDA's module) are not consuming as healthful a diet as their food secure peers (Figure 3), with negative impacts on energy, concentration, health, and GPA. Thus, food security measures for college students could benefit from incorporating indicators of utilization and wellbeing.

Our results also make clear that university students should not be treated as one homogenous group in food security studies as there are clear differences between undergraduate and graduate student food experiences, an understanding of which would support more specific solutions. As reflected in our high response rate, particularly for graduate students, our study also shows that students are motivated by this topic and want to contribute their perspective to its solution. Table 6 summarizes student input received about areas for MSU to focus on, organized by the characteristics we know are significant from our data to address food access and utilization issues. Both groups report wanting improved healthy and affordable food on-campus or in proximity to campus, but it was also suggested that both undergraduates and graduate students on- and off-campus could benefit from greater access to the Food Bank and education on budgeting and SNAP eligibility. We recommend that universities and colleges evaluate campus food security in a more holistic manner, keeping in mind both access and utilization as well as potential subpopulation differences and tailoring solutions to meet their specific needs.

Table 6. Proposed solutions from participants differed for those relevant to undergraduate and graduate students (normal text); just undergraduate students (italics), or graduate students (bold), as well as whether students were on or off campus.

	For students living on-campus	For students living off-campus
Access	*Easier access to kitchens and cooking utensils in dorms*	**Increase living stipends or hourly wages**
	Expand dining hall hours	*More affordable dining hall access/swipes for off-campus students*

		Expand food bank hours & raise awareness of food bank
		Increased awareness of budgeting and SNAP eligibility
Utilization	Healthier foods served in the dining halls, particularly in between mealtimes	Healthier on campus meal options
	Expand dining halls to accommodate special dietary needs	**Provide microwaves & refrigerators to store packed lunches**
	Make dining hall nutrition information available	
Access & Utilization	Small grocery stores on or within walking distance of campus that have healthy and affordable food	

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