

Nourishing student success and wellbeing: Unveiling the impact of food environments on student food security challenges through a case study from Montana

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Abstract

Food insecurity among U.S. college and university students surpasses respective levels in the general population. Previous research has primarily focused on demographic and economic explanations, neglecting other risk factors such as student place of residence and specific food environments. In addition, most studies have been conducted

before the COVID-19 pandemic, which further exacerbated food security challenges. To address these gaps, our comprehensive case study at Montana State University (MSU) assessed risk factors for student food insecurity, considering food access and the students' food environments. From March to November 2020, we collected online survey responses from a diverse sample of 443 MSU students. Approximately one-third experienced food insecurity during this period, with their food insecurity status linked to housing type and academic level. Despite students' reported knowledge of healthy diets and cooking skills, consuming inadequate and insufficient food had a significant impact on their dietary quality, well-being, and physical and mental health. Just under half of the surveyed students (44%) reported increased difficulties in accessing food due to the pandemic. Addressing food insecurity among college students is crucial for their well-being and academic success, not only because of additional stressors such as COVID-19. Dealing with food

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insecurity requires improving economic situations and creating a reliable and diverse food environment that ensures affordable, healthy, safe, convenient, desirable, and sustainable food options. Special increased support from universities and governments should be given to students living off-campus. By recognizing these unique challenges and implementing targeted interventions, we can foster a supportive food environment for students.

Keywords

food access, food systems, food insecurity, college students, higher education, student housing, COVID-19, pandemic

Introduction

The 21st century is witnessing global disruptions that significantly challenge the food security of diverse populations. Pandemics, political conflicts, economic crises, crop and livestock diseases, and climate change threaten the stability of agri-food supply chains. These disruptions have highlighted the interdependent nature of food systems at local, regional, national, and international scales. Fragmented interactions within these supply chains exacerbate shocks and amplify risks, particularly for the most vulnerable populations.

Alongside low-income, rural, and other marginalized populations, U.S. university and college students have consistently faced a higher prevalence of food insecurity (Freudenberg et al., 2019; Nikolaus et al., 2020). The disproportionate experience of food insecurity among students has been frequently attributed to their added financial burden upon entering college or university. Besides tuition, many students need to split their budget among rent, utilities, healthcare, and food, with the latter often taking less priority among mounting financial burdens, thus increasing the risk of food insecurity (Henry, 2017). The first study of U.S. student food insecurity, in 2007 at the University of Hawaii-Manoa, found that 21% of students there struggled with food insecurity (Chaparro, 2007). After the Big Recession, numbers seem to have increased: in a 2011 study at City University New York, 40% of surveyed students were reported as food insecure (Freudenberg et al., 2011); in 2014, at Western Oregon University, the share was 59%

(Patton-López et al., 2014), and in a 2015 study conducted at Arizona State University, 34% of students were food insecure. Other studies have reported similar findings (Chaparro et al., 2009; Freudenberg et al., 2019; Gaines et al., 2014; Hughes et al., 2011). The majority of these studies assess the economic causes and consequences of student food insecurity, generally emphasizing student financial situations and addressing subsets of student populations, such as students from ethnic minorities. However, little research has been conducted on other dimensions of the food insecurity equation. Some research, primarily case studies from individual U.S. colleges, assesses student diet quality (Bruening et al., 2016; Chaparro et al., 2009; Deliens et al., 2014; Hughes et al., 2011; Larson et al., 2020; Matthews et al., 2022; Powell et al., 2021) and overall access to food (Bruening et al., 2016; Greaney et al., 2009; Martinez et al., 2018; Patton-López et al., 2014; Waity et al., 2023). However, most of these studies neglect the bigger picture, the food environments in all their complexity that surround students. Food environments include internal (accessibility, affordability, convenience, and desirability) and external (availability, prices, vendor and product properties, marketing, and regulation) domains (Turner et al., 2018). The way each student experiences these domains is influenced by their individual determinants of health, including social determinants.

In addition to this research gap, the occurrence of the COVID-19 pandemic, an unprecedented natural experiment in the context of a globalized economy, presented a unique additional challenge for students, affecting their access to food, diets, and overall lifestyles, livelihoods, and wellbeing (Davitt et al., 2021; Sidebottom et al., 2021). First studies of the pandemic indicated contradictory effects on student food security, with improvements for some and increased challenges for others (Davitt et al., 2021; Owens et al., 2020). We consider it crucial to explore the underlying causes of this ambiguity, and, more important, the mid-term consequences of an event like the COVID-19 pandemic on student food security. Thus, our case study aimed to explore the accessibility of food environments and the accompanying resources that affect food security among university students,

with specific emphasis on the impact of the COVID-19 pandemic.

This study was conducted in Montana, a large rural and agricultural state in the Northwestern U.S., at Montana State University (MSU). It is situated in Bozeman, a college town evolving into a small city that is currently characterized by high rental prices and low housing supply. We administered a structured survey to MSU students during Fall 2020, just as the strictest university and governmental pandemic regulations were being phased out in Montana (Ebel & Byker-Shanks, 2022) and students were returning to campus. The survey addressed the following research questions concerning MSU Bozeman students: (1) What characterizes student food access and food environments? (2) Which associated resources support student food security? (3) How were food access and food environments affected by the COVID-19 pandemic? (4) How do food access and food environments differ based on student demographic characteristics? It is hoped that our findings can be applied to design and implement programs at MSU and similar universities to strengthen food environments and enhance access to resources that will better support student food security.

Definitions

The survey instrument and study discussion make use of important food system concepts, including food insecurity and food security, sustainable diet, food environment, and resilient food system. We will briefly define them.

In alignment with the definition by the UN Food and Agriculture Organization [FAO], *food insecurity* is defined by the U. S. Department of Agriculture as the lack of consistent access to enough food for every person in a household to live an active, healthy life. Food insecurity includes food insecurity with hunger (very low food security) and food insecurity without hunger (low food security) (U.S. Department of Agriculture Economic Research Service [USDA ERS], 2022). *Food security* is defined as access by all people at all times to enough food for an active, healthy life (USDA ERS, 2022). In the U.S., food security and food insecurity are measured by the U.S. Household Food Security Survey Module, or an adaptation of

the survey module to fit the context, such as households with or without children, or a shortened version to take account of reduced respondent burden (USDA ERS, 2022).

The FAO (2008) has identified four dimensions of food security: availability (whether food is locally produced or imported), accessibility (whether a consumer is able to reach food or has the economic means to procure it), utilization (whether food is safe to consume, or the consumer has the skills to prepare food in a manner that is safe and culturally relevant), and stability (whether the consumer, household, or nation is equipped to counter food system shocks such as natural disasters and political crises). Sustainability as a fifth dimension of food security has more recently been considered, especially the relationship between environmental sustainability and long-term food security (Berry et al., 2015). This includes the impact of biodiversity loss on food security or ecosystem services that support thriving agricultural systems (Bélanger & Pilling, 2019).

Sustainable diet has been defined as safeguarding ecosystems, optimizing natural and human resources, and providing diets that are culturally acceptable, accessible, economically fair and affordable, nutritionally adequate, safe, and healthy (Burlingame et al., 2012; FAO, 2010). Sustainable diets are being increasingly promoted in recognition of the interconnected challenges of food production, procurement, preparation, consumption, and waste (Burlingame et al., 2009; Davis et al., 2021; Springmann et al., 2018). Approaches to fostering sustainable diets acknowledge the ecological, economic, human health, sociocultural, and political dimensions linked to food access and dietary choices (Ahmed et al., 2019; Jones et al., 2016). A diet that does not support food security is defined as not sustainable (Berry et al., 2015).

The *food environment* is a critical site to advance sustainable diets, as it includes all factors that influence consumer food procurement (Downs & Demmler, 2020). It is defined as the consumer interface with the food system that encompasses the availability, affordability, convenience, promotion and quality, and sustainability of foods and beverages in wild, cultivated, and built spaces that are influenced by the socio-cultural and political

environment and ecosystems within which they are embedded (Downs et al., 2020). Built food environments include market food environments such as supermarkets, food banks, and formal farmers markets, as well as food services such as restaurants and cafes (Ahmed et al., 2020; Downs et al., 2020). Natural food environments encompass wild and cultivated food environments. Wild food environments comprise forests, open pastures, and aquatic areas, and cultivated spaces include agricultural areas, ranging from garden containers and backyard gardens to large-scale production; consumers directly procure food from both types of environment (Downs et al., 2020; Kelly et al., 2011). While most food environment research emphasizes built food environments, natural food environments are equally important to recognize as rural communities continue to access food for direct consumption to support their food security, nutrition, and health, particularly in the context of food system shocks such as the COVID-19 pandemic (Ahmed et al., 2020; 2022).

Discussion of *resilient food systems* has increased as a response to global temporary food supply chain disruptions because of the COVID-19 pandemic (Naja & Hamadeh, 2020). Resilient food systems are generally defined as those that can withstand and adapt to economic, social, and environmental shocks while ensuring equitable access to sufficient, affordable, safe, nutritious, and culturally relevant food for all (Tendall et al., 2015).

COVID-19 and U.S. Food Security

Food insecurity and its underlying social inequities have been persistent problems in the U.S., and the COVID-19 pandemic exacerbated all dimensions of food insecurity, from availability and access to food to social and racial disparities (Niles et al., 2020; O'Hara & Toussaint, 2021). In the Spring 2020, a substantial percentage of low-income adults in the U.S., including students, experienced food insecurity, reaching 44% in March 2020. Minority communities faced the most severe food security challenges (Huizar et al., 2020; Morales et al., 2020; Wolfson & Leung, 2020).

Despite a lack of nationwide data, a survey of more than 100,000 students at 202 colleges by Goldrick-Rab et al. (2022) indicates that students'

food security was disproportionately negatively affected by the pandemic, especially for students who were sick themselves (e.g., self-reported COVID-19 infection). A case study from a Texas university (Owens et al., 2020) found one-third of the students self-reporting food insecurity. However, during the lockdown phase a significant share of Iowa State University students was less likely to experience food insecurity as they returned to live with their parents rather than on campus (Davitt et al., 2021). A case study from a large public university in the Southeastern U.S. reiterates the ambiguous patterns of student food security in Spring 2020: While food security improved for 12% of students, at the same time it worsened for another 20% (Soldavini et al., 2020). This is similar to findings from Kim-Mozeleski et al. (2023), albeit not specifically targeting university student populations, in which one-third of the study population experienced their food insecurity either persisting (15%), improving (16%), or worsening (5%) as a consequence of the pandemic.

Montana was severely impacted by the pandemic, with disruptions of supply chains and retail food as well as elevated food insecurity (Byker Shanks et al., 2022; Ebel et al., 2022; Ebel & Byker-Shanks, 2022; John-Henderson et al., 2022; Wolfson & Leung, 2020). The implementation of governmental mitigation measures, such as lockdown policies, in response to the COVID-19 pandemic had significant and unprecedented impacts on Montana's food systems (Chiwona-Karlton et al., 2021).

Applied Research Methods

Study Site

Montana State University (MSU) is a land-grant university established in 1893 in Bozeman. During the 2020 fall semester, when the study was conducted, the main campus had 16,249 enrolled students, 46% of whom designated Montana as their home state. MSU is characterized by a large undergraduate student population (88% of all students in fall 2020) with 80% of students 18 to 24 years old. In fall 2020, 77% of students enrolled were full-time (Montana State University, 2023a). The MSU Bozeman campus has two dining halls,

at least one of which is open throughout the year. The student capacity for MSU housing facilities was around 4,200 in 2020, and students living in MSU housing facilities were able to obtain discounts using the dining halls (Montana State University, 2023b).

Data Collection

A structured survey (see Appendix) was developed by the research team at MSU, including experts in the areas of food environments, food security, and sustainable food systems, and based on existing survey instruments (Ahmed et al., 2020). Before administering the survey, approval of obtaining human subjects to participate was obtained by the Institutional Review Board (IRB) at MSU (IRB Number: SA071320-EX). Informed consent was retrieved from all participants, following IRB guidelines, prior to taking the survey. The survey was disseminated as an online link to student email accounts using Qualtrics (SAP, Provo, UT) to a random sample of 2000 MSU students (about 12% of the student population) during the fall semester 2020.

Survey Instrument

The survey instrument included twenty questions grouped into three sections that solicited information on student (1) demographics, (2) food security and food environments in general, including a question eliciting participants to rank several ideas for enhancing food security on campus, and (3) effects of the COVID-19 pandemic on food access, availability, and security. Gender was not included in the survey questionnaire since our analysis focused on highlighting differences and/or similarities between housing situation and education level. The survey was pilot-tested with a group of students for field validity and refined based on user feedback in early fall 2020. The instrument consisted of 19 multiple-choice questions and one ranking activity. To measure participant food insecurity, two questions were included in the survey instrument using a two-question adaptation of the U.S. Adult Food Security Survey Module Six-Item Short Form (Gundersen et al., 2017; USDA ERS, 2012): (1) “I/we worried whether my/our food would run out before I/we got money to buy

more”; (2) “The food that I/we bought just didn’t last, and I/we didn’t have money to get more.” If a respondent answered “sometimes true” or “often true” to either question, they were classified as food insecure.

Data Analysis

Using STATA (StataCorp, College Station, TX), the survey was processed for descriptive statistics. Margins of error were calculated for a 95% confidence level. For multi-response questions, we determined a weighted sample proportion that used core demographic variables (age, race and ethnicity, student degree level, housing situation) to generate strata. The weighted sample proportion considers the different proportions of respondents in each stratum in order to provide a more accurate representation of the overall population (Pfeffermann et al., 1998). In addition, we examined individual probability of food insecurity based on both housing situation and degree level, using a logit-linear relationship to evaluate both factors and their contributions to the estimated probability (Stroud, 1994).

$$\text{Food insecurity} \sim \text{Bernoulli}(\pi_i)$$

$$\pi_i = \frac{e^{(\beta_0 + \beta_1 * \text{hou} + \beta_2 * \text{lev} + \beta_3 * \text{hou} * \text{lev})}}{1 + e^{(\beta_0 + \beta_1 * \text{hou} + \beta_2 * \text{lev} + \beta_3 * \text{hou} * \text{lev})}}$$

where *hou* represents housing situation (on/off campus) and *lev* represents student educational level (graduate/undergraduate).

Sample

A total of 443 responses were validated (21% response rate) but only 391 individuals responded to all survey questions. Table 1 summarizes the most significant sample demographics.

Findings

Food (In)security

Approximately one-third of student participants reported food insecurity (34%). For students living on campus, the share of food-insecure individuals was lower for undergraduate than for graduate students. Conversely, off-campus, undergraduate

Table 1. Core Sample Demographics and Overall Montana State University Student Population Indicators for 2020

Sample demographics parameter	Sample demographics numbers	Montana State University Enrollment Fall 2020
Population	443	16,249
Age	18–24 years (82%); 25–29 years (9%); 30–39 years (5%); 40+ years (4%)	18–24 years (80%); 25–29 years (10%); 30–39 years (6%); 40+ years (3%)
Ethnicity / race	White (89%); Asian (4%); American Indian or Alaska Native (4%); Black (2%); Hawaiian or Pacific Islander (1%); Hispanic or Latino (8%)	White (93%); Asian (4%); American Indian or Alaska Native (5%); Black (1%); Hawaiian or Pacific Islander (1%); Hispanic or Latino (5%)
On-campus students	32% (68% off-campus)	28% (72% off-campus)
Full-time students	77% (23% half-time)	77% (23% half-time)
Undergraduate students	88% (12% graduate)	88% (12% graduate)

Source: Montana State University, 2020

students were more food insecure than graduate students (Figure 1). We found that both housing and education levels equally contribute to the students' food insecurity ($p = 0.01$).

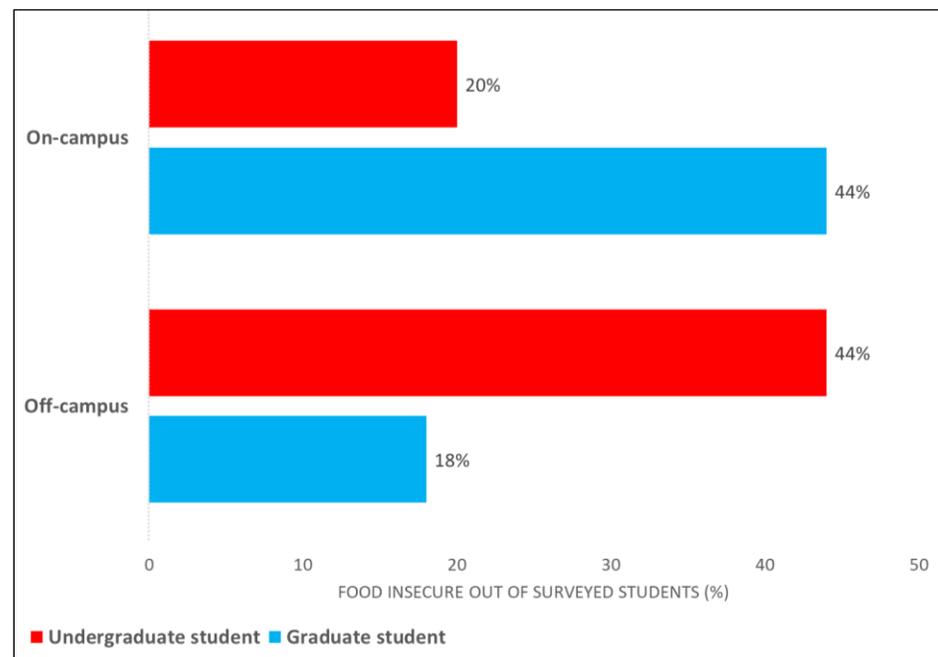
Types of Food Environments

Students responded to the question as to where they regularly obtained their food that they accessed food from diverse types of built food environments, with grocery stores the most prevalent (90% of respondents) and restaurants (67%) (Table 2). Several individuals also procured food from wild food environments (15%), specifically through hunting, fishing, and foraging. Eight percent of students grew food in their home gardens. Students prepared most of their meals at home or in their dorms, compared to campus dining halls or locations off-campus (Figure 2).

Food Access and Environments

Approximately one-third of participants (32%) shared that while being a student they had experienced a lack of access to adequate food. Students were also asked about specific attributes (which were not further explained in the questionnaire) of the food to which they had access. Most students claimed to have access to food that is affordable

Figure 1. Reported Food Insecurity Based on Students' Housing Situation and Degree Program Level: Percentage of Food Insecure Students out of Valid Responses ($n = 437$; margin of error: $\pm 1.6\%$)



(93%), while access to sustainable food was mentioned less frequently (66%) (Figure 3).

Furthermore, the participants provided feedback regarding their access to resources promoting food security (Figure 4): A significant proportion of student respondents (90%) reported adequate access to transportation for purchasing and gathering food. Nearly 90% also considered themselves equipped with cooking skills and knowledge of healthy diets.

A narrow third of the participants (32%) responded that they had experienced a lack of adequate food access while being a student. For this subset of students, the most prominent negative

Table 2. Food Environments where Students Regularly Access Food, Multiple Responses Possible, Weighted Percentage of Valid Responses (n = 443; margin of error: ±1.5%)

Food Environment	Weighted Sample Proportion
Grocery store	90%
Restaurants	67%
Campus dining halls	37%
Coffee shops / café	36%
Convenience stores	17%
Wild food environments	15%
Home garden	8%
Farmers market and/or campus farm stand	7%
Farm share or community supported agriculture share	3%
Foodbank and/or food pantry	3%
Other	3%

Figure 2. Locations Where Students Regularly Consume their Meals, Weighted Percentage of Valid Responses (n = 439; margin of error: ±1.5%)

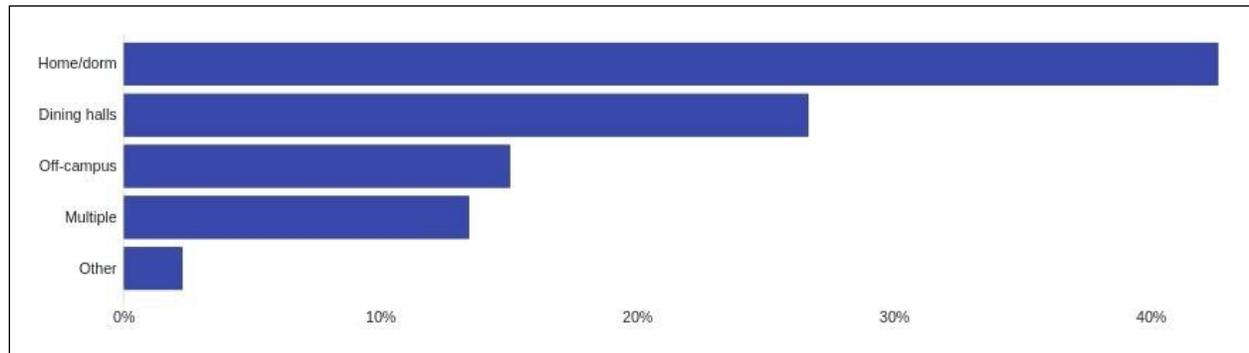


Figure 3. Student Access to Healthy Food (Student Perceptions of their Food Environments Based on Adapted Key Food Environment Elements), Weighted Percentage of Valid Responses (n = 432; margin of error: ±1.5%)

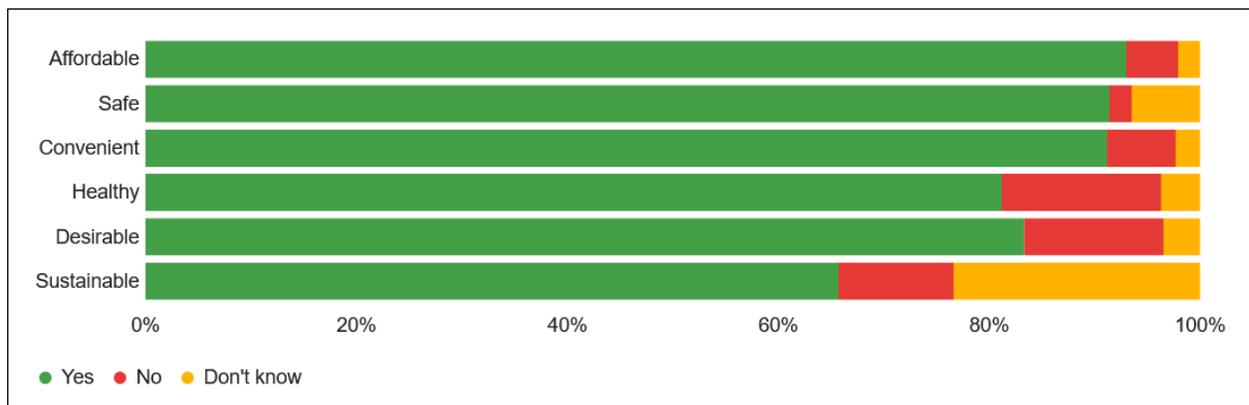
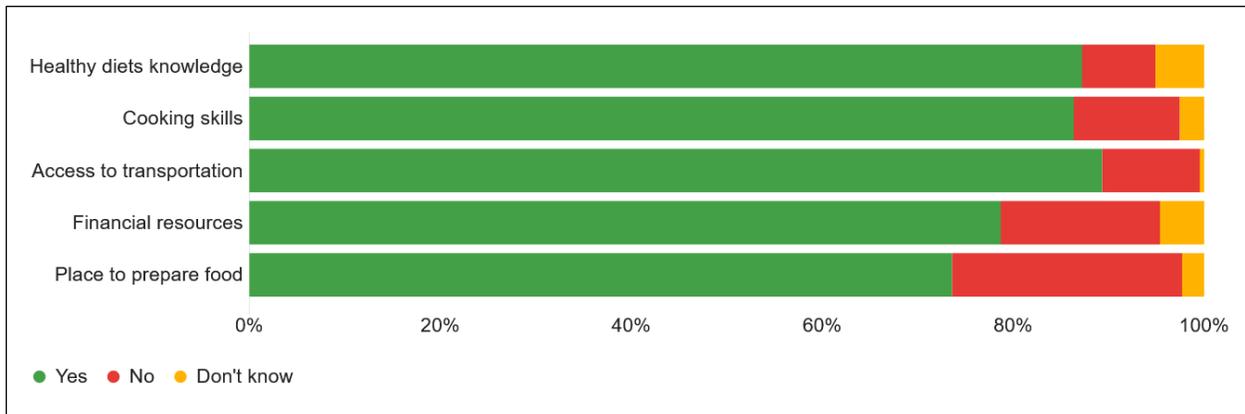


Figure 4. Individual Skills and Access to Resources to Support Students' Diet, Weighted Percentage of Valid Responses (n = 431; margin of error: ±1.5%)



impact of this circumstance was on dietary quality (83%) followed by impacts on their physical (63%) and mental (62%) health, as well as on their overall wellbeing (64%) (Figure 5).

Impact of the Pandemic

This section examines the impact of the early stage of the COVID-19 pandemic (year 2020) and related regulatory measures on students' food access and security. While over half of the students (55%) perceived no significant effect on their food access, 44% reported experiencing a worsened situation. Students residing off-campus faced slightly greater challenges (Table 3). Our findings highlight, in addition, that the participants encountered trade-offs between allocating funds for food and meeting various other expenses essential for their livelihoods and educational pursuits, including housing and educational expenses (Table 4).

Figure 5. Attributes Perceived to be Affected by Lack of Access to Adequate Food While Being a Student (Only Students who Reported Lack of Access to Adequate Food), Weighted Percentage of Valid Responses (n = 128; margin of error: ±2.8%)

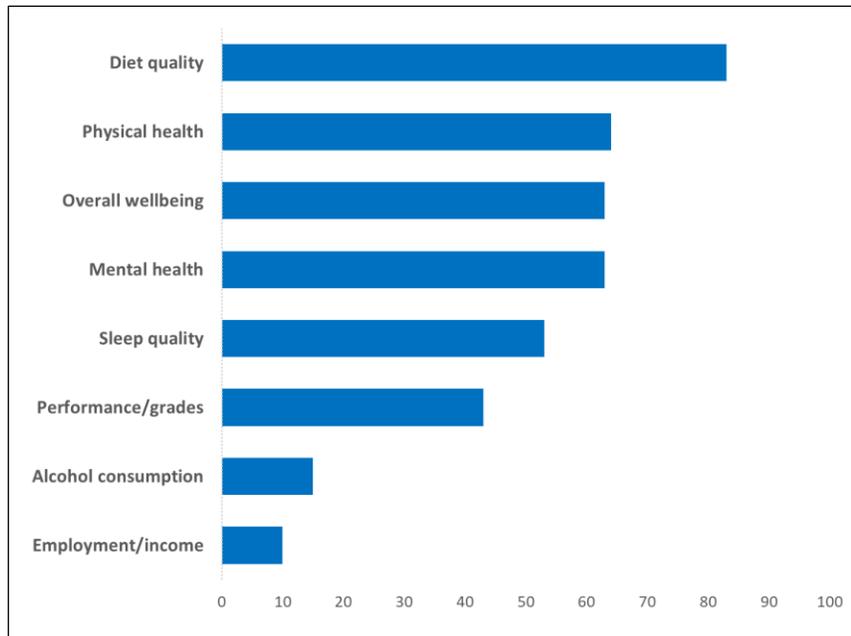


Table 3. Impact of COVID-19 on the Facility of Food Access, Conditional On/Off Campus Housing, Percentage of Valid Responses (n = 425; margin of error: ±1.5%)

Housing location	About the same as before	Easier	Harder
On campus	59%	1%	40%
Off-campus	52%	1%	47%

Students further reported how COVID-19 impacted features of their lifestyle. Of note, the students living off campus perceived a greater impact on their lifestyle than those residing in student housing (Figure 6). They reported in our survey that before the pandemic they were highly engaged in a range of food-related practices and recreational activities, and that most were severely affected by COVID-19 (Figure 7).

Recommendations for Enhancing Food Access

Ideas we presented for enhancing food access on campus were perceived positively by most survey respondents. The idea to develop a program to “swipe” meals at campus dining halls, from

advantaged students with an abundant meal plan to students in need of a meal, was especially popular (Figure 8).

Discussion

Food (In)security

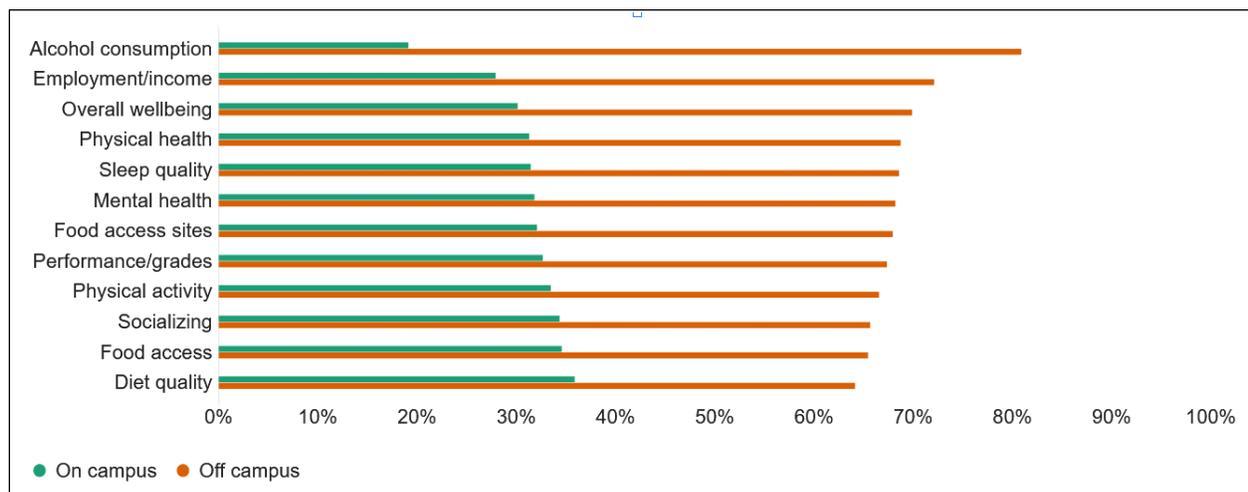
Although food insecurity is a pressing issue among U.S. college students, limited research has focused on the topic (Berry, 2020; Willis, 2021). Contrary to the perception of a protected college environment, studies indicate that students are particularly vulnerable to food insecurity, with higher rates in colleges and universities compared to the general population (Nazmi et al., 2019; Willis, 2021). With over 20 million individuals in higher education, addressing student food security is a growing public health concern (Nazmi et al., 2019). Economic stressors, such as rising college costs and increasing enrollment of low-income and first-generation students, contribute to food insecurity among this population (Greaney et al., 2009; Kolowich, 2015).

Existing research on college student food insecurity has primarily focused on demographic and economic aspects, with limited attention given to other risk factors such as place of residence and specific food environ-

Table 4. Expenses Affecting Students’ Food Budget (Single Choice Question), Weighted Percentage of Valid Responses (n = 125, only students who reported lack of access to adequate food; margin of error: ±2.8%)

Attribute	Weighted Sample Proportion
Housing	16%
Educational expenses	14%
Transportation	13%
Household utilities	12%
Medical care or medical expenses	7%
Debts and other expenses	15%

Figure 6. Features Perceived to be Affected by the COVID-19 Pandemic by Housing Situation, Weighted Percentage of Valid Responses (n = 420; margin of error: ±1.5%)



Note: our questionnaire asked for lifestyle changes, not exclusively for the negative impacts of the pandemic.

ments (Bruening et al., 2016; Martinez et al., 2018). Furthermore, most studies were conducted before the COVID-19 pandemic further disrupted food

security (Boyacı-Gündüz et al., 2021; Rogers et al., 2021). To address this research gap, our study at Montana State University comprehensively

Figure 7. Food-Related Behavior and Practices of Surveyed Students Prior to and Since the Onset of the COVID-19 Pandemic, Weighted Percentage of Valid Responses (n = 407; margin of error: ±1.6%)

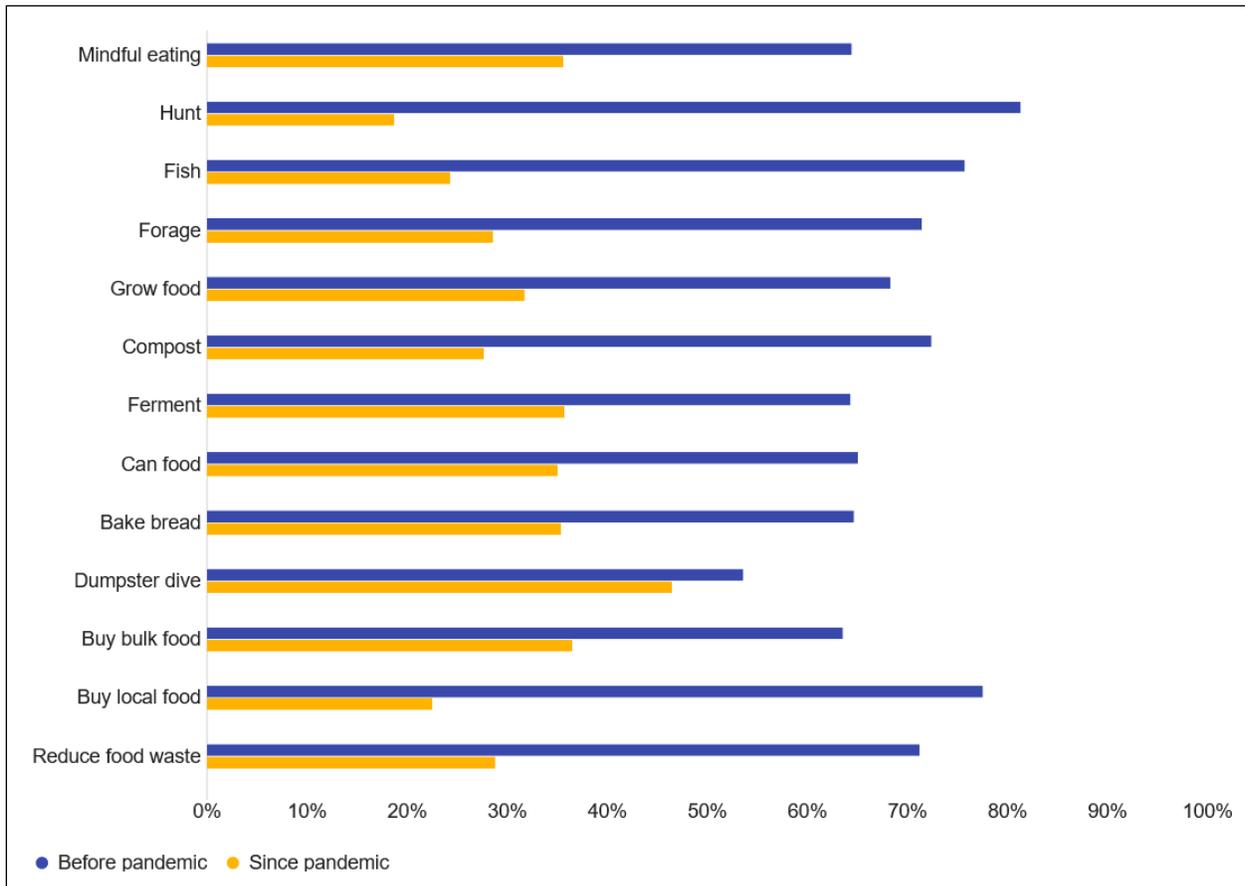
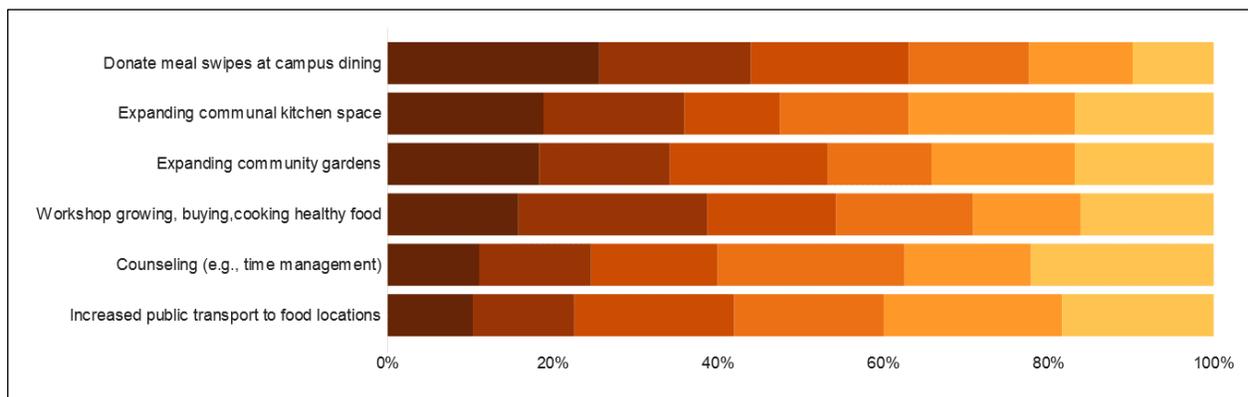


Figure 8. Heatmap of Ranking of Student-Generated Ideas for Enhancing Food Access on Campus (Dark Red = Indicates Ideas Perceived Most Beneficial, Yellow = Ideas Perceived Least Beneficial), Percentage of Valid Responses (n = 396; margin of error: ±1.6%)



assessed risk factors for student food insecurity by considering both graduate and undergraduate students, their living arrangements, and the impact of the early stage of the COVID-19 pandemic. The results showed that 34% of surveyed MSU students experienced food insecurity, aligning with the range found in similar previous studies (Chaparro, 2007; Freudenberg et al., 2011; Gaines et al., 2014; Patton-López et al., 2014; Kolowich, 2015; Morris et al., 2016; Payne-Sturges et al., 2017; Martinez et al., 2018; Willis, 2021).

Most food security research deals with adults, adolescents, and school children. Accordingly, low food security has been shown to affect student academic achievement, attention, health, wellness, and behavior (Cady, 2014; Howard, 2011; Jyoti et al., 2005). What is known for the college level is that food-insecure students sacrifice food for educational expenses, are unlikely to regularly eat breakfast and homecooked meals, tend to have unhealthy eating habits in general, face higher odds of depression and other mental health issues, and are more susceptible to alcohol abuse compared to their food-secure peers (Bruening et al., 2016; Cady, 2014; Martinez et al., 2018). Correspondingly, food-insecure MSU students claimed that limited access to healthy food had a negative impact on their overall well-being and their physical and mental health.

In addition, our study explored the association between food insecurity and students' place of residence. We found that undergraduate students living off-campus had a higher prevalence of food insecurity (40%) than those living on campus (20%), consistent with previous findings (Martinez et al., 2018). This discrepancy may be influenced by the prevalence of pre-paid meal plans among undergraduate students in campus dining halls. This is supported by a study that contrasted food insecurity between undergraduates in on- and off-campus living situations; a higher proportion of students participating in a meal plan resided on-campus compared to those residing off-campus (El Zein et al., 2019). Glantsman et al. (2022) also found that students who lived on campus before the pandemic were significantly less likely to be at risk of food insecurity during the pandemic compared to students who lived off campus before the

pandemic. In contrast to MSU undergraduates, graduate students living on-campus faced higher food insecurity (44%) than those living off-campus (18%). While this requires further investigation, this phenomenon may be related to a tight housing market and expensive rental costs in Bozeman that force several students to share apartments, potentially decreasing food expenses. Future research efforts should explore the relationship between food insecurity and living on- and off-campus, paired with social determinants of health as well as the local circumstances.

Food Access and Environments

Many U.S. students purchase inexpensive foods of poor nutritional quality, not only because of financial limitations but also due to limited access to both affordable quality food markets and facilities for storing and preparing foods (Martinez et al., 2018). At MSU, most food-insecure and food-secure students reported getting food from a grocery store or supermarket (90% of surveyed students), restaurants (67%), the campus dining halls (37%), and coffee shops or cafés (36%). Compared to a 2018 study at different University of California campuses (undergraduate students only), MSU students buy food more frequently in grocery stores and restaurants but less at university facilities such as dining halls (Martinez et al., 2018). While dining halls at MSU were operational during fall 2020, ongoing challenges with staff shortages or students' potential health concerns may have affected the desirability of utilizing the dining halls during this period.

Over 90% of MSU students stated that they had access to affordable, safe, and convenient food. In addition, over 75% claimed to have knowledge of healthy diets and cooking as well as a place to prepare food. Nevertheless, a third of students reported being food insecure. We conclude that access to food in a college town like Bozeman does not seem to be the most limiting factor for student food security, nor food preparation knowledge or cooking infrastructure at home. Hence, other factors rather than food access must contribute to the students' food insecurity. These factors may involve excessive expenses for other needs such as tuition and housing that absorb money in

an expensive place like Bozeman, and a college agenda that does not leave students much time to purchase and prepare their food. Further research is crucial to understand the underlying reasons for the paradoxical situation that a considerable segment of college students experiences food insecurity despite seemingly accessible food options. It is essential to dig deeper into the specific factors contributing to this issue.

In our study, we discovered that 43% of MSU students identified inadequate access to food as negatively affecting their academic performance. This highlights the severity of the problem and emphasizes the urgent need for targeted interventions and support systems to address student food insecurity and its impact on educational outcomes. MSU students demand creative and inexpensive solutions to improve the food access of a significant part of their population. A program allowing students with a meal plan to “swipe” their meals at campus dining halls and redirect them to students in need of a meal was assessed especially positively in our survey. Organizations such as Swipe Out Hunger, which has served over two million meals in the U.S. and Canada with its “Swipe Drives” and campus pantries (Swipe Out Hunger, 2023), have already impacted numerous students. Other well-regarded strategies to address the unique food security needs of students include communal kitchen space, community gardens, and workshops.

Impact of the Pandemic

During the lockdown phase in Montana and the following months of 2020, 55% of MSU students perceived no effect of the COVID-19 pandemic on their food access, while 44% suffered from more limited access than before the pandemic. These numbers are slightly below those of the overall U.S. population during the first months of the pandemic (Niles et al., 2020). The MSU data shows that despite a campus infrastructure providing students with appropriate food access during the pandemic, 44% of students living off-campus (which made up for two thirds of our sample) faced limited food access during the survey period. Among the students facing limited food access, a considerable 67% reported experiencing challenges in their academic activities.

Separating the specific impact of limited food access on academic performance from other factors proves challenging. The pandemic-induced isolation, which affected most students whether on- or off-campus, certainly had a profound influence on their overall well-being, subsequently leading to negative consequences for academic performance. Our study findings demonstrate that 81% of students experienced social isolation, 71% encountered mental health issues, 60% reduced physical activity, and 45% a decline in sleep quality. These four factors often co-occur with food insecurity and may exacerbate it. Strategies utilizing university and governmental resources to support student mental health and physical activity, and promote financial assistance, food aid, and access to health information are essential to increase the resilience of this vulnerable population to a shock like COVID-19.

Conclusions

Food insecurity among U.S. college students is a significant and growing concern. Despite the common perception that students live in a protected environment, research shows that food insecurity among students is higher than for the overall population. Food insecurity among college students has far-reaching implications, affecting academic achievement, attention, health, wellness, and behavior. Notably, the transition to college often comes with economic stressors, such as the rising costs of education. College students are facing the challenge of balancing educational expenses with basic needs like food, and many are unaware of how and where to find support.

Previous research on college student food insecurity has primarily focused on demographic and economic factors, with limited attention given to other risk factors such as place of residence or specific food environments. Most studies were conducted before the COVID-19 pandemic, which has further disrupted food security. In our study at MSU, we aimed to comprehensively assess the risk factors for student food insecurity, considering graduate and undergraduate students, their place of living, food access, and food environment. Our findings reveal that 34% of surveyed MSU students reported being food insecure, which aligns with

studies at other higher education institutions over the past decades. Our study confirmed that food-insecure students at MSU faced challenges in maintaining a healthy diet, experienced negative impacts on overall well-being, and reported lower academic performance. Moreover, our assessment of the relationship between food insecurity and students' food environments highlighted that off-campus undergraduate students experienced higher food insecurity rates than those living on campus. Remarkably, on-campus graduate students faced higher food insecurity than their off-campus peers. Further research is needed to understand the underlying reasons for these discrepancies. Access to affordable, safe, and convenient food was not the only factor limiting student food security at MSU. Other factors, such as housing situation and housing expenses, seem to be equally significant. Since our study was conducted in 2020, we have also examined the impact of the COVID-19 pandemic on student food security, food access, and food-related practices. We found that the pandemic influenced food habits, resulting in changes in student purchasing and preparation behaviors.

Addressing college student food insecurity requires comprehensive strategies that go beyond

providing access to affordable food. It necessitates comprehending the underlying economic challenges, raising awareness about available resources, and implementing supportive policies and interventions on college campuses. Future research should explore the unique circumstances contributing to food insecurity among college students and evaluate the effectiveness of interventions to mitigate this problem. Addressing food insecurity among college students is crucial for their overall well-being, academic success, and the promotion of a healthier society. By recognizing the unique challenges faced by this population and implementing targeted interventions, we can work toward creating a supportive environment that ensures all students have access to nutritious and affordable food throughout their college years. 

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Appendix: Survey Questionnaire

Part 1: Student Profile

This part of the survey will ask you three questions regarding your degree program, housing, and enrollment.

1. What type of degree program are you in?
 - a. Undergraduate
 - b. Masters
 - c. Doctoral
2. Do you live on or off campus?
 - a. On campus
 - b. Off campus
3. Are you a full-time or part-time student?
 - a. Full-time student
 - b. Part-time student

Part 2: Food Access

This part of the survey will ask you five questions regarding food access including where you get your food from and food resources.

4. Where are all the places where you get food?
 - a. Campus dining halls
 - b. Campus farm stand
 - c. Coffee shop / cafe
 - d. Farm share / Community Supported Agriculture (CSA)
 - e. Farmers market
 - f. Food bank and / or food pantry
 - g. Gas station
 - h. Grocery store
 - i. Home garden
 - j. Restaurants
 - k. Wild foods environments (places for fishing, hunting, foraging)
 - l. Other (please specify)
5. **Where do you mostly get your meals?** (Select the one that best describes you)
 - a. I mostly get food from the dining halls
 - b. I mostly prepare food in my dorm or at home
 - c. I mostly purchase food from off campus
 - d. I tend to get food from multiple sources
 - Other (please specify)
6. Please select how often the following statements were true for you/your household in the past 12 months. (answer options include never true, sometimes true, often true)
 - a. "I/we worried whether my/our food would run out before I/we got money to buy more."
 - b. "The food that I/we bought just didn't last, and I/we didn't have money to get more."
7. Do you have adequate access to foods with the following attributes? (yes, no, do not know)
 - a. Affordable food
 - b. Desirable food that meets preferences
 - c. Food that is convenient to prepare and consume
 - d. Healthy food
 - e. Safe food
 - f. Sustainable food
8. Do you have adequate access to the following resources to support your diet?

(answer options: yes, no, do not know)

- a. Cooking skills and knowledge
- b. Financial resources
- c. Knowledge of healthy diets
- d. Place to cook / prepare food
- e. Transportation

Part 3: Challenges and Opportunities

This part of the survey will ask 6 questions regarding challenges and opportunities pertaining to food access while you have been a student at MSU or Gallatin College.

9. If you have experienced a lack of access to adequate food while you have been a student, do you think it has impacted any of the following? (select all that apply)
 - a. I have not experienced a lack of access to adequate food while being a student
 - b. Grades
 - c. Mental health (e.g., anxiety, depression, preexisting trauma, OCD, etc.)
 - d. Overall academic performance
 - e. Overall wellbeing
 - f. Physical health

10. In the last 12 months, did you ever have to choose between paying for any of the following expenses versus paying for food? (select all that apply)
 - a. Educational expenses
 - b. Housing
 - c. Household utilities
 - d. Medical care or medical expenses
 - e. Transportation
 - f. Other debts or expenses

11. Do you find it easier, harder, or about the same as before the COVID-19 pandemic to get food overall?
 - a. About the same as before
 - b. Easier
 - c. Harder

12. Did the COVID-19 pandemic impact any of the following? (select all that apply)
 - a. Academic performance / Grades
 - b. Alcohol consumption
 - c. Diet
 - d. Employment
 - e. Food access
 - f. Household income
 - g. Mental health (e.g., anxiety, depression, preexisting trauma, OCD, etc.)
 - h. Overall lifestyle
 - i. Overall wellbeing
 - j. Physical activity
 - k. Physical health
 - l. Places where you get food
 - m. Sleep quality
 - n. Socializing

13. Do you carry out any of the following food practices? (select all that apply)

- a. Baking bread
- b. Buying in food in bulk
- c. Buying local food
- d. Canning
- e. Composting
- f. Cooking
- g. Cooking meals together with friends and / or family
- h. Dumpster diving
- i. Fermenting
- j. Fishing
- k. Foraging
- l. Gardening
- m. Gleaning
- n. Growing food
- o. Hunting
- p. Keeping a sourdough starter
- q. Mindful eating
- r. Sharing recipes with friends and/or family
- s. Trying to reduce food waste

14. Below are some student-generated ideas for enhancing food access on campus. Which ideas do you think would be the most beneficial to implement? Please drag and drop the statements below to rate them from most beneficial (1) to least beneficial (9).

- a. Community garden space for growing food
- b. Cooking workshop on preparing affordable meals
- c. Counseling on managing personal finances
- d. Guidance on applying for nutrition assistance programs
- e. Increased public transportation access to food locations
- f. Kitchen spaces
- g. Program where students can donate meal swipes at campus dining halls
- h. Workshop on growing food
- i. Workshop on basics of a healthy diet

Part 4: Demographic Information

The last part of the survey will ask five demographic questions regarding your background.

15. How old are you?

- a. 18–24 years
- b. 25–29 years
- c. 30–39 years
- d. 40 or older

16. What racial background and ethnicity do you identify as? (Check all that apply, ordered alphabetically below)

- a. American Indian or Alaska Native (Tribal affiliation: _____)
- b. Asian
- c. Black or African American
- d. Hispanic or Latino
- e. Native Hawaiian or Pacific Islander
- f. White
- g. Other
- h. Prefer not to answer

17. Do you care for a dependent(s)?

- a. No
- b. Yes

18. Do you (or your dependents) receive any form of nutrition assistance?

Examples of nutrition assistance include food pantry, Food Distribution Program on (American) Indian Reservations (FDPIR), Supplemental Nutrition Assistance Program (SNAP), Summer Lunch Program

- a. No
- b. Yes

19. Are you receiving care for any of the following health factors?

- a. Autoimmune disease(s)
- b. Chronic lung condition (e.g., asthma, Chronic obstructive pulmonary disease, etc.)
- c. Diabetes (type 1 or type 2)
- d. Heart disease (e.g., coronary heart disease, congestive heart failure, hypertension, etc.)
- e. Liver disease (including hepatitis B or C)
- f. Mental health conditions (e.g., anxiety, depression, preexisting trauma, OCD, etc.)
- g. Obesity
- h. None of the above

Do you have any additional comments you wish to share on food access for students?