ABSTRACT

Title of Thesis:	EXPLORING THE INTERPLAY OF FOOD INSECURITY AND CORRESPONDING COPING BEHAVIORS AMONG COLLEGE STUDENTS: IMPLICATIONS FOR INTERVENTION THROUGH RESOURCE MANAGEMENT BEHAVIORS
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Food insecurity affects 20 to 50% of US college students, which is significantly higher than the national average of 12.8%, with significant impacts on students' physical health, mental well-being, and academic performance. Despite its prevalence, key research gaps persist. Current USDA food security survey modules may inadequately capture college students' unique experiences, despite their widespread use in this population. Additionally, there is limited understanding of long-term effects among students, and a scarcity of evidence-based solutions and targeted policies to address campus food insecurity.

This study aims to address key gaps in literature by examining the coping strategies adopted by food-insecure college students, particularly how these strategies vary by food insecurity severity, and by exploring how resource management behaviors including food planning and shopping routines, food literacy and financial behavior, are associated with food security levels. Using a cross-sectional design, data were collected from 373 college students through an online self-administered questionnaire hosted on the Qualtrics platform. Participants were eligible if they were undergraduate students enrolled in a four-year college in Maryland. Descriptive

statistics, Kruskal-Wallis and ANOVA tests, and ordinal logistic regression were used to analyze the data.

Results indicated that as food insecurity worsened, students not only increased the frequency of their coping strategies but also progressed to more extreme measures. Initially, food-insecure groups relied on strategies such as asking friends and family for food or money to buy food, buying the cheapest food available, avoiding expensive foods such as fruit and vegetables, eating at places in which you pay what you can and eating as much as possible when food is available. However, as food insecurity worsens, students reported reliance on extreme coping strategies such as choosing between food and essential expenses (rent, utilities, medicine), implementing stricter food shopping budgets resulting in limited diet variety, selling personal possessions to buy food, and stretching food to last longer. Additionally, frequent use of these coping strategies significantly predicted very low food security. The present finding suggests that certain coping strategies employed specifically by very low food secure students could serve as more sensitive indicators for identifying students in urgent need, potentially offering greater precision than current USDA food insecurity assessment modules.

Also, financial behavior encompassing day-to-day money management and financial planning emerged as a significant predictor of food insecurity. Paradoxically, students who demonstrated stronger financial behaviors were more likely to experience higher levels of food insecurity. Our analysis also revealed that although not significant predictors in the ordinal logistic model, food insecure students were more likely to discard food based on date label expiration and demonstrated lower food literacy compared to their food secure counterparts.

Overall, this study fills an important research gap by mapping how coping strategies evolve across varying levels of food insecurity, offering insights for developing context-specific tools and

targeted interventions for college students. To our knowledge, this is also the first study to examine key aspects of the utilization dimension of food insecurity among college students concerning resource management—specifically food literacy, planning, shopping routines, and financial behaviors—to identify potential areas for intervention. Findings highlight the urgent need to address food insecurity in this population, with resource management emerging as a promising intervention point.

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Chapter 1: Introduction

1.1 Problem Statement and Rationale

Food insecurity, an economic and social condition of limited or uncertain access to adequate food, is a significant issue affecting many college students in the United States.[1,2] A recent scoping review found that the prevalence of food insecurity ranged from 9% to 52% among this population, with most studies reporting rates between 20% and 40%.[3] This issue significantly impacts students' academic performance, and physical and mental health. Academic consequences include lower grades and a higher risk of dropout, while health implications include depression, anxiety, obesity, and other chronic diseases.[3–5]

Food insecurity among college students has unique aspects as these students are mostly single and newly independent of their caregivers.[6] The level of family support also varies adding to their unique challenges.[7] Knowledge about food assistance programs also varies among college students adding to their unique challenge. While some students may know about food assistance programs from their lived experience, newly food-insecure students may be unfamiliar with important resources such as food assistance programs.[6,8]

Several studies have been conducted to understand the unique aspects of food insecurity in college students. However, significant gaps remain in our understanding and ability to address this unique issue effectively. These gaps include the lack of a validated survey tool designed specifically for this demographic to measure the magnitude and severity of college food insecurity, limited knowledge of its long-term effects on health and academic performance, and a need for evidence-based solutions and policies to prevent or meaningfully address food insecurity among college students. In particular, targeted interventions for college students facing food insecurity are relatively limited despite alarmingly high rates of food insecurity among college students. For

instance, campus-based interventions aimed at improving food literacy, which is knowledge, skills, and behaviors required to plan, manage, select, prepare, and eat food to meet needs and determine intake, along with food preparation skills, financial behavior and self-efficacy to address food insecurity have been less studied.[9–11]

1.2 Project Aims and Objectives

The overall objective of this study was to better understand food insecurity in college students. In order to achieve this objective, the study had two primary aims

Aim 1) To investigate the relationship between food coping strategies and varying levels of food insecurity, and to identify patterns in coping strategies that correspond to different degrees of food insecurity among college students

The purpose of the first aim was to understand the unique coping strategies adopted by food-insecure college students and whether these strategies differ based on the severity of their food insecurity. Understanding this relationship can lay the groundwork for developing a more tailored and context-specific measurement tool for college food insecurity and guide the development of targeted interventions in the future.

Aim 2) To examine the relationship between food insecurity and food planning and shopping routines, food literacy, and financial behavior by investigating how they correlate with the severity of food insecurity.

The purpose of this second aim was to examine the association between modifiable factors such as food planning and shopping routines, food literacy and financial behavior, and food

insecurity, while also exploring the potential role of these factors as part of future intervention strategies to address food insecurity in college students.

Chapter 2: Literature Review

2.1. Food Insecurity

Food insecurity, a household-level economic and social condition characterized by limited or uncertain access to adequate food, is a significant issue affecting communities across the United States.[2] According to USDA, 12.8% of US households experienced food insecurity in 2022, with racial and ethnic minorities and socioeconomically disadvantaged populations disproportionately affected.[12,13] This widespread issue has far-reaching consequences, significantly increasing the risk of multiple chronic health conditions, including diabetes, obesity, heart disease, and mental health disorders.[12]

2.2. Food Insecurity in College Students

Food insecurity has become a significant problem among college students in recent years. The estimation of food insecurity among college students is between 20-50%.[1,3,14] This rate is significantly higher than the national average of 12.8%, which shows the unique challenges faced by college students compared to the general population.

Despite multiple studies attempting to quantify the extent of food insecurity among college students, the true prevalence is yet unknown.[15,16] This is due to multiple reasons such as previous studies being conducted on individual campuses, making it difficult to generalize findings to the broader college student population. Additionally, the studies also varied in the instrument they used to measure food insecurity, and it is also unclear whether college students interpret food insecurity items in the same way as adults in the general population.[15] This highlights the need for reliable and valid data collection methods to measure the exact prevalence in college students.[16]

The prevalence of food insecurity among college students also varied significantly based on the type of institution. A systematic review highlighted this variation, showing a higher

prevalence rate among community college students (47%) compared to students at 4-year universities (36%).[3] Furthermore, a significant disparity exists between academic levels, with undergraduates experiencing a higher prevalence of food insecurity compared to their graduate counterparts.[17,18]

The prevalence of food insecurity across the college student population was further intensified during the COVID-19 pandemic. A study showed that the proportion of students worried about food running out increased from 25% to 35%, while those reporting food not lasting rose from 17% to 21%.[19] Additionally, students who had experienced food insecurity before the pandemic were at higher risk of food insecurity after its onset.[19] There is also regional variation in prevalence with the Midwest, South, and West experiencing significant increases in food insecurity status, while the Northeast showed no substantial change.[19]

These findings indicate the necessity of considering factors like institution type, academic level, and regional variations when addressing food insecurity among college students. The findings also indicate the vulnerability of this population to unpredictable crises such as the COVID-19 pandemic.

2.3. Factors Affecting Food Insecurity among College Students

Several factors contribute to food insecurity among college students. It is important to understand these factors to develop effective strategies to identify and address this significant issue.

2.3.1. Demographic Factors

Food insecurity is associated with various demographic factors, including race/ethnicity, gender, and sexual orientation. For instance, younger students and those with children have higher odds of experiencing food insecurity. Additionally, food insecurity is found to be higher among

students of color, particularly those identifying as Black or Hispanic/Latino.[1,20,21] Furthermore, single/separated/divorced students and transgender/non-binary/other gendered students have a higher risk of food insecurity.[17,22–24] These findings highlight the complex interplay of demographic factors in food insecurity among college students.

2.3.2. Socio-economic Status

Low socioeconomic status is one of the most significant determinants of food insecurity among college students. Various socioeconomic factors that contribute to this issue were identified. Students with one or more part-time jobs, lower income, homeless, and those receiving financial aid or enrolled in assistance programs like SNAP were more likely to experience food insecurity. Additionally, a history of being in foster care, receiving free or reduced lunch or experiencing food insecurity as a child was also associated with higher rates of food insecurity in college.[23,25,26]

The relationship that exists between past experiences of food insecurity and the chance of them being vulnerable is important to mention. Students who experienced food insecurity during childhood or before college were more likely to face it during their college years, showing the cyclical nature of this issue.[8,27] Students lacking familial financial support, relying on financial aid, and those burdened with loan repayments were more prone to experiencing food insecurity.[8,27–29]

In addition, the allocation of finances towards non-essential expenditures, such as dining out and entertainment, was also associated with a higher risk of food insecurity.[27] These findings indicate the association between financial management skills, various socioeconomic factors, and food security status among college students.

2.3.3. Other Factors Associated with Food Insecurity among College Students

Time of the year is another factor associated with food insecurity in college students. Food insecurity is more pronounced during the spring semester than during the fall. This variation is potentially due to increased resources available during fall, possibly from income earned over the summer break and schools requiring students to be on unlimited meal plans at the beginning of the year.[17] Moreover, first-generation college students exhibit significantly higher rates of food insecurity compared to their counterparts whose parents have attained higher education.[17]

Another factor associated with food insecurity is the effective utilization of available food resources such as food pantry utilization. While food-insecure students are more likely to use food pantries than their food-secure counterparts, it's important to note that most food-insecure students still do not utilize these resources.[21] This paradox highlights a significant gap in addressing food insecurity on college campuses. Despite being at higher risk and having a greater need for support, many food-insecure students are not accessing available food assistance programs. This underutilization may be due to inconvenient hours of operation, fear of stigma, or due to lack of awareness about the availability of such programs and eligibility requirements. For instance, some students thought that they were ineligible to use the services due to their international status.[6,30]

Limited access to cooking facilities in dormitories is another factor that can exacerbate food insecurity. Many students lack the space or equipment to prepare and store nutritious meals, leading to a reliance on expensive pre-prepared foods or unhealthy alternatives.[31]

Lack of transportation to grocery stores is another unique challenge for college students, particularly those living on campus without a personal vehicle. This can limit access to affordable and nutritious food options, forcing students to rely on more expensive on-campus dining or nearby convenience stores.[10,16,32]

2.4. Consequences and Outcomes of Food Insecurity in College Students

Food insecurity among college students has been associated with various negative consequences affecting mental health, physical well-being, and academic performance. This section explores the consequences of food insecurity in the college student population.

2.4.1. Mental Health

Food insecurity has been linked to significant mental health challenges among college students. Food-insecure students were more likely to experience symptoms of depression and anxiety compared to their food-secure peers.[5,25,32–34] The stress of not knowing where their next meal will come from can exacerbate existing mental health issues or trigger new ones.[5]

Moreover, food insecurity can significantly impact students' self-esteem and social relationships. A qualitative study conducted among university students in California revealed that food insecurity affected students' social interactions, with participants reporting feelings of exclusion from food-related social events and embarrassment due to their inability to afford meals, leading them to avoid social gatherings.[35] The resulting social isolation can further contribute to feelings of loneliness and depression, creating a cycle that is difficult to break.

The long-term psychological effects of food insecurity during college years are also a concern. Exposure to chronic stress during this critical developmental period may have lasting impacts on mental health and well-being well into adulthood.[32]

2.4.2. Physical Health

The physical health consequences of food insecurity among college students are equally concerning. Food-insecure students were more likely to engage in obesogenic behaviors such as eating unhealthy processed food high in fat and sugar, and lower consumption of fruit and vegetable intake.[1,36,37]

These poor dietary patterns can lead to an increased health risk. It is reported that poor health and overweight/obesity were more prevalent in food-insecure students than in food-secure students.[29] Additionally, students experiencing food insecurity were more likely to rate their health status lower compared to food-secure students.[31]

2.4.3. Academic Performance

The impact of food insecurity on academic performance is significant in the context of higher education. Several studies have demonstrated a negative correlation between food insecurity and academic achievement. Food insecurity affects energy levels and ability to concentrate, with food-insecure students more likely to report lower energy levels and difficulty concentrating.[38] This, in turn, affects the academic performance of college students as food-insecure students are more likely to report lower GPAs than their food-secure counterparts.[25,39–41]

College food insecurity was also found to be inversely related to college completion and educational attainment.[42] Another study found that college students facing unmet basic needs including food insecurity, housing insecurity, and lack of healthcare access are more likely to experience higher rates of attrition defined as dropping out, taking a leave of absence, or being at risk for academic probation.[43] These findings indicate the significant impact of food insecurity on the academic performance of college students.

2.5. Coping Strategies

2.5.1. Modifying Food Acquisition, Preparation, and Consumption Habits

College students apply various coping strategies to manage challenges associated with food insecurity. Food-insecure students often make changes to their eating habits as a primary coping mechanism, engaging in behaviors that could contribute to a higher risk of obesity, such as consuming less healthy meals to eat larger quantities, overeating when food is plentiful, and

purchasing cheap processed foods like frozen pizza or ramen noodles.[37] Those experiencing very low food security often opt for unhealthy convenient foods due to rigorous schedules, the need for quick and easy options, storage limitations, and the cost of healthier alternatives.[44–46] Buying the cheapest available food was also found to be the most common coping strategy applied by students for food acquisition.[47]

Another common strategy used by food-insecure students was altering meal patterns. Food-insecure students frequently skip meals due to time constraints or to spread out their limited resources.[44,45,48] Additionally, some students save higher-quality food for consumption during finals to avoid feeling hungry during exams.[45] Some students resort to sleeping longer than usual to avoid eating.[45,48] Furthermore, students engage in consuming the same foods multiple times.[48,49]

2.5.2. Navigating and Prioritizing Available Resources and Support Systems

Students often look for opportunities to access free food as a coping strategy. A study found that students sought out campus events offering free food, attending primarily to eat.[48] Campus food pantries are another source, however, only two-thirds of students are aware of the campus food pantry and only one-third of them use them.[44] The underutilization of campus food pantries can be due to feelings of shame and stigma in some students while others abstained from using them due to fear of depriving more needy individuals of essential resources.[50] Additional barriers include a lack of knowledge about pantry operations, such as location and service hours, and a lack of availability of desired food items.[50]

To cope with food insecurity, many students seek additional sources of income. Some students logged extra hours to get more money to purchase food, while others resorted to quick money-making strategies such as selling personal items, donating bodily fluids like plasma or hair, or seeking assistance from family or friends.[45,48]

Food-insecure students often face difficult decisions in prioritizing their expenses. They prioritize rent payments before allocating money for food.[14] Additionally, students sometimes have to choose between purchasing textbooks for classes and buying food, often prioritizing feeding themselves.[46,48]

The severity of food insecurity influences the types and frequency of coping strategies employed. Very low food secure freshmen students were more likely to deny themselves preferred food items, limit their food intake at each meal, and skip meals to eat larger meals later compared to low food secure (LFS) freshmen students. Furthermore, students facing episodic food insecurity used coping strategies more frequently than food-secure students, while those experiencing persistent food insecurity employed these strategies at even higher rates .[47,51]

2.6. Proposed Strategies to Address Food Insecurity in College Students

Various research studies have explored proposed solutions for food insecurity among college students, with a majority focusing on institutional-level interventions. The majority of the students suggested on-campus food assistance programs; primarily through discounted or free meal plans and campus pantries as a way to address food insecurity among college students.[1,28,52]

Financial aid and financial coaching were suggested as another significant approach to addressing food insecurity among college students.[1,21] However, the effectiveness of existing financial aid programs in preventing food insecurity is questionable, as students with financial needs were not necessarily protected against food insecurity despite receiving grant funds.[53] Furthermore, studies showed an association between receiving the Pell Grant and a higher likelihood of experiencing food insecurity, showing that grant funds may not be enough to meet basic needs.[21,53,54]

Students also proposed increased job opportunities and improved finances as ways to address food insecurity.[52,55] Additionally, students suggested food scholarships and financial assistance for housing and other basic needs as a way to afford food and prioritize food security.[44] The students mentioned that having funds specifically for food prevents them from stretching the money for other needs such as rent and prioritizes food security.

Educational initiatives form another significant category of solutions. Students suggested education on nutrition and eating healthy, how to cook cheaply, budgeting, and accessing food assistance programs as a way to address food insecurity.[28,44,52] Additionally, students emphasized the importance of centralizing educational resources to improve accessibility, destigmatize food insecurity, and increase awareness of the issue on campus.[44]

Several studies have also suggested off-campus food assistance programs. For example, students advocated grocery store discounts specifically for students. Additionally, improving access to the Supplemental Nutrition Assistance Program (SNAP) for students has been a recurring suggestion. Students often encounter barriers to entry due to strict eligibility requirements, and among those who qualify many have insufficient information about SNAP enrollment processes. To overcome these challenges, providing education on SNAP eligibility, benefits and streamlined enrollment procedures are proposed.[1,28,44]

Fewer interventional studies were conducted to evaluate strategies to improve food insecurity in college students. One study assessed the effectiveness of grocery store gift cards and restaurant delivery service gift cards as interventions for students with marginal food insecurity, finding both methods to improve food security status after four months. However, neither of the interventions was significantly better than the other, though the majority of the students preferred grocery store gift cards.[56]

Despite the higher prevalence of food insecurity and its significant impact on the physical and mental health and academic performance of college students, limited intervention studies are addressing this issue and evaluating intervention programs' outcomes aimed at improving food security and access.[9,57] This shows the gap in this area and the need for further research to evaluate evidence-based intervention to address this significant issue.[58]

2.7. Food Insecurity and Food Literacy

Food literacy is the collection of interrelated knowledge, skills, and behaviors required to plan, manage, select, prepare, and eat food to meet needs and determine intake. This skill set empowers individuals, households, communities, or nations to protect diet quality through change and strengthen dietary resilience over time.[11] However, research indicates that food literacy is lacking in college students.[59–61]

Students identified college as an appropriate place to learn practical life skills and expressed their need for information on food planning, preparation, and budgeting.[62,63] They also expressed frustration with knowing the "right choice" but lacking the skills or resources to act on that knowledge.

Several studies have demonstrated the potential impact of food literacy on food security status. For instance, a study found that food procurement ability and the skills and access needed to shop for groceries on a budget mediated the relationship between financial strain and food insecurity among male college students.[64] In the same study, better access to cooking facilities mediated the relationship between financial strain and food insecurity in female college students. Additionally, very-low food-secure students had significantly lower cooking self-efficacy and food preparation behavior than food-secure students, further emphasizing the link between food literacy and food security status.[55]

Another study showed a negative relationship between food security and food literacy in college students. This suggests that limited food literacy, coupled with constraints in the availability and ability to prepare healthful foods may contribute to food insecurity in college students.[62] Additionally, some students mentioned the reasons for food insecurity were related to limited cooking skills, time to eat and cook, transportation, and limited funds and time to buy food.[65]

On the other hand, a study examined the impact of an 11-week food literacy-based curriculum on students' knowledge, food literacy-based self-efficacy, behaviors, and food security status. It found significant improvements in cooking skills and food preparation abilities. However, the study didn't find significant improvement in food insecurity indicators.[59] Another study indicated that an undergraduate nutrition course, incorporating a teaching kitchen lab, may help decrease food insecurity and possibly reduce stress levels among undergraduate students.[66] This indicates that further research is needed to test the association between food literacy and food insecurity among college students.

Chapter 3: Methodology

3.1. Study Overview

This research employed a cross-sectional online survey design to collect quantitative data on food insecurity among college students. It examined the relationship between coping strategies and levels of food insecurity, identifying patterns used by food-insecure students. Additionally, the study explored how food planning and shopping routines, food literacy, and financial behavior might mitigate food insecurity by analyzing its relationship with food insecurity levels in the college population.

Data was collected on 373 college students using an online self-administered questionnaire using the Qualtrics platform. Participants were eligible to participate in this study if they were undergraduate students in a 4-year college in the Maryland area and were at least 16 years old. Data collection took place in January 2025. All procedures for this study were reviewed and approved by the Institutional Review Board of the University of Maryland.

3.2. Study Setting

This research study was conducted across 4-year colleges in the Maryland area. The state encompasses 38 4-year colleges.[67] As of fall 2022, the total number of undergraduate students enrolled in these institutions was 159,584.[68]

These college student populations were selected due to the higher prevalence of food insecurity, yet there remain significant gaps in understanding long-term impacts and effective interventions and tailored measures to assess food insecurity in this group.[9,10] Our study focused on the Maryland area while maintaining a substantial sample size of 373 students, aiming to increase the study's statistical power while gaining insights that may apply to areas beyond

Maryland due to the diverse population in this area. Additionally, this area was selected due to the proximity of these institutions to our facility.

3.3. Subjects

This study collected data from a diverse sample of 373 college students across the Maryland area using an online survey platform, Qualtrics. Given that the primary aim of the proposed study is to explore coping strategies among food-insecure students and examine food literacy's potential to mitigate food insecurity, we oversampled food-insecure students to ensure adequate representation for analysis. To ensure that the sample has a sufficient number of food-insecure students for a more robust comparison between food-secure and food-insecure groups, participants were screened at the beginning of the survey using a two-item screener, the Hunger Vital Signs, to ensure that 60% of the sample consists of food insecure participants. Participants who answered 'often true' or 'sometimes true' to either or both of the following two statements were screened as being at risk for food insecurity. 1. We (I) worried whether our (my) food would run out before we (I) got money to buy more. (Often true, Sometimes true, Never true) 2. The food we (I) bought just didn't last and we (I) didn't have money to get more. (Often true, Sometimes true, Never true)

Qualtrics sent recruitment emails to potential participants, targeting students from 4-year colleges across Maryland. Participants were included in the study if they were undergraduate students enrolled in 4-year colleges in Maryland and were at least 16 years old. Qualtrics applied exclusion criteria such as category exclusions, participation frequency, and so on.

3.4. Measurement

The questionnaire included 94 items: 11 socio-demographic factor questions; USDA 10 items for the food insecurity survey questionnaire; 29 items for the food literacy questionnaire; 11

items for the food planning and shopping routines questionnaire; 23 coping strategy-related questions and 10 items financial behavior questionnaire.

3.4.1. Socio-demographics

The study collected comprehensive socio-demographic data. This information includes age, gender, marital status, race, current level of study, and employment status. Additionally, data was collected on factors that affect food insecurity in college students such as scholarship status (categorized as Pell Grant, need-based scholarship, or other), meal plan (categorized as yes, no or don't know), and current residency (categorized as on-campus, off-campus living with family, and off-campus living alone or with roommates).

3.4.2. Food Security Survey Module

The 10-item USDA Food Security Survey Module (FSSM) was used in this study to measure food insecurity in college students. Although this instrument has not been specifically validated for college students, it is widely recognized as the gold standard for assessing food insecurity.[15] The 10-item questionnaire was selected because it provides more reliable and comprehensive data than the 6-item survey, particularly for assessing severe levels of food insecurity while being less time-consuming for participants compared to the full 18-item version.[69] Additionally, the 10-item FSSM was identified as the most frequently used tool in studies of college student populations.[3] Responses are coded as affirmative for "yes," "often," "sometimes," "almost every month," and "some months but not every month." Based on the sum of affirmative responses (ranging from 0 to 10), participants were classified into four categories of food security: high food security (0), marginal food security (1-2), low food security (3-5), and very low food security (6-10).[69]

3.4.3. Food Literacy

To evaluate food literacy, the study utilized the 29-item Food Literacy Assessment Tool.[70] This comprehensive instrument is designed to assess three critical domains of food literacy. The first domain, Nutrition, and Safety, consists of 10 items that focus on an individual's ability to manage, prepare, and select food. The second domain, Cultural and Relational, comprises 8 items that examine how individuals maintain good relationships with food and share food with others. The third domain, Socio-ecological, includes 11 items that address issues of food sustainability and environmental considerations. This questionnaire is a reliable and valid measure of food literacy, with a Cronbach alpha value of 0.88, 0.71 and 0.73 for the first, second and third domain respectively indicating good internal consistency and content validity ratio (CVR) of greater than 0.54 for all the questions.[70]

3.4.4. Financial Behavior

Financial behavior was measured using a 10-item measure (α= 0.618).[71] The responses were rated using a 5-point frequency Likert scale ranging from “Always” to “Never”. To ensure consistency in coding, negatively worded items, such as “ *I tend to buy things even when I can’t really afford them”* were reverse coded (“Always” = 1 to “Never” = 5). All other items were positively worded and scored in the opposite direction (“Never” = 1 to “Always” = 5).

3.4.5 Food Planning/Shopping Routines

The food planning/shopping routines scale was measured using an 11-item measure comprising two subscales: meal preparation and utilization, and food waste subscale. The meal preparation and utilization subscale consisted of 8 items that focused on individuals' ability to plan and prepare meals and buy items in their budget. The food waste subscale consisted of 3 items which asked students if they threw away food if the date on the food label passed. The responses

were rated using a 5-point frequency Likert scale ranging from “Never” to “Always”. To ensure consistency in scoring, all items in the food waste subscale, which were negatively worded, were reverse coded (“Always” = 1 to “Never” = 5). All other items were positively worded and scored in the opposite direction (“Never” = 1 to “Always” = 5).

3.4.6. Coping Strategies

To assess the coping strategies employed by college students in response to food insecurity, three scales including hunger coping strategies, food acquisition, and management practice scales were used. The first scale, measuring hunger coping strategies, has 12 items and is reliable and valid with a Cronbach alpha value of 0.85. Additionally, construct and content validity were tested using Spearman correlation and the questions showed significant correlations.[72] The food acquisition practice and food management practice scales have 6 and 4 questions respectively and a reliable tools with a Cronbach alpha value ranging between 0.74 and 0.85.[47]

3.5. Data Analysis

The data collection tools in this research evaluated college students’ food insecurity status, food coping strategies they applied, and their level of financial literacy to assess the relationship between these factors. The findings aim to explain how coping strategies varied across the different levels of food insecurity and to explain the relationship between food literacy, food planning/shopping routines, and financial behavior and food insecurity. Evaluation and analysis of these measures are summarized below and described in more detail in Chapter 4 (paper 1, page 33), and Chapter 5 (paper 2, page 52)

3.5.1 Analysis of Coping Strategies

The data were analyzed using the IBM SPSS, version 29. Descriptive statistics were used to summarize the baseline characteristics of the sample. To assess the group differences in the

frequency of coping strategies applied (food secure, low food secure, and very low food secure), a non-parametric test (Kruskal Wallis test) was used since the assumption of normality was not met. The test revealed significant differences, as a result, post-hoc analysis (pairwise comparison) was conducted.

3.5.2. Analysis of Association Between Food Insecurity and Food Literacy, Food Planning/Shopping Routines and Financial Behavior

The data were analyzed using IBM SPSS, version 29, and RStudio version 2024.12.1 Build 563. Descriptive statistics were used to assess baseline demographics. To determine the association between socio-demographic factors and food insecurity levels, a Chi-square test of independence was conducted. To assess the relationship between the level of food security and food literacy, food planning and shopping, and financial behavior, Kruskal-Wallis, ANOVA, and Welch's test were conducted. Furthermore, ordinal logistic regression was used to identify statistically significant predictors of levels of food insecurity.

Chapter 4 (Paper 1): Mapping Food Insecurity Gradients to Coping Response Behaviors Among College Students

4.1. Introduction

Food insecurity is a pressing issue on college campuses, impacting 20 to 40% of college students, a rate significantly higher than the national average of 13.5%.[2,3,13] This indicates the unique challenges faced by college students, who are mostly single and newly independent of their caregivers. Varying levels of family support or limited awareness of available resources make college students vulnerable to food insecurity.[6–8] This issue is further exacerbated by rising tuition, insufficient financial aid, and high living expenses.[25,26] Students of color, particularly those identifying as Black and Hispanic/Latino individuals, as well as those from low-income backgrounds, working part-time jobs, experiencing house insecurity, receiving financial aid, or having a history of childhood food insecurity, face significantly higher odds of being food insecure during college.[1,20,21,23,25,26]

Consequently, inadequate access to food has various consequences on students' physical, mental health and academic performance. Furthermore, food insecurity is linked to increased anxiety, depression, higher obesity risk, and lower GPAs among college students.[29,33,34,39–41]

Students facing food insecurity often resort to a range of coping strategies to manage their resources. Previous studies have identified various coping strategies adopted by food-insecure college students including changing their eating habits such as consuming less healthy meals to eat larger quantities, overeating when food is plentiful, and purchasing cheap processed foods like frozen pizza or ramen noodles.[37,44–47] Food insecure students also tend to skip meals, log extra hours, or sell personal items and donate bodily fluids like plasma or hair to gain extra money to

purchase food.[45,48] Some are also forced to prioritize between paying for food and other expenses such as rent and textbooks.[46,48]

Various solutions have been proposed to address food insecurity, with a majority focusing on institutional-level interventions, such as discounted or free meal plans and campus pantries.[1,28,52] Other suggestions were financial aid and financial coaching, food scholarships, increased job opportunities, and education on nutrition and eating healthy.[1,21,28,44,52,55] Off-campus food assistance programs, such as grocery store discounts specifically for students and improved access to the Supplemental Nutrition Assistance Program (SNAP) have been suggested as potential strategies.[1,28,44] However, limited intervention studies have evaluated the effectiveness of intervention programs in improving food security and access.[9,57,58]

Addressing food insecurity on college campuses demands urgent research across multiple dimensions. For instance, critical gaps include the absence of validated measurement tools specific to college populations, insufficient understanding of its long-term effects on health and academic outcomes, and limited evidence-based interventions despite alarmingly high prevalence rates.[9,10] In this context, understanding coping behaviors among the most vulnerable food-insecure students represents a crucial first step toward developing effective interventions, creating more sensitive food insecurity indicators for this population, and establishing specific, actionable strategies to address this growing crisis.

This study aims to address a portion of these gaps by focusing on understanding the unique coping strategies adopted by food-insecure college students and whether these strategies differ based on the severity of their food insecurity. Understanding this relationship will lay the groundwork for developing a more tailored and context-specific measurement tool for college food insecurity and guide the development of targeted interventions in the future.

4.2. Methods

4.2.1. Study Setting and Participant Recruitment

This research study was conducted on undergraduate students enrolled in 4-year colleges in the Maryland area. The state comprises 38 four-year colleges, with a total undergraduate enrollment of 159,584 as of fall 2022.[67,68] Data were collected from a diverse sample of 373 college students across the Maryland area using an online survey platform, Qualtrics. To ensure that the sample has a sufficient number of food-insecure students, the food-insecure group was slightly oversampled. This methodological approach was used to detect meaningful differences in coping behaviors according to food security levels and capture sufficient variation to understand the diversity of coping behaviors.

Potential participants were screened at the beginning of the survey using a two-item screener, the Hunger Vital Signs. Participants who answered 'often true' or 'sometimes true' to either or both of the following two statements were screened as being at risk for food insecurity. 1. We (I) worried whether our (my) food would run out before we (I) got money to buy more. (Often true, Sometimes true, Never true) 2. The food we (I) bought just didn't last and we (I) didn't have money to get more. (Often true, Sometimes true, Never true)

Qualtrics sent recruitment emails to potential participants, targeting students from 4-year colleges across Maryland. Participants were included in the study if they were undergraduate students enrolled in a 4-year college in Maryland and were at least 16 years old. Qualtrics applied exclusion criteria such as category exclusions, participation frequency, and so on.

This research was approved by the Institutional Review Board at the University of Maryland and all 373 responses were used for data analysis.

4.2.2 Measures

Socio-demographics such as age, gender, marital status, race, current level of study, parent's level of education, and employment status were assessed. Additionally, data was collected on factors that affect food insecurity in college students such as scholarship status (categorized as Pell Grant, need-based scholarship, or other), meal plan (categorized as yes, no or don't know), current residency (categorized as on-campus, off-campus living with family, and off-campus living alone or with roommates), and living arrangement (categorized as I live alone, I live with my parents, with roommates or friends, with husband/wife or partner/significant other, my children, or other).

Level of Food Security was measured using the 10-item USDA Food Security Survey Module (FSSM).[69] Although this instrument has not been specifically validated for college students, it is widely recognized as the gold standard for assessing food insecurity.[15] Responses are coded as affirmative for "yes," "often," "sometimes," "almost every month," and "some months but not every month." Based on the sum of affirmative responses (ranging from 0 to 10), participants were classified into four categories of food security: high food security (0), marginal food security (1-2), low food security (3-5), and very low food security (6-10).[69]

Coping strategies employed by college students were assessed using three scales including hunger coping strategies, food acquisition practice, and food management practice scales. The first scale, measuring hunger coping strategies (α= 0.85), has 12 items and includes questions such as "*Have you ever had to choose between paying for food and paying for rent?*". The responses were rated using a 5-point frequency Likert scale ("Never" = 1 to "Always= 5"). The construct and content validity of the scale were tested using Spearman correlation and the questions showed significant correlations.[72] The second scale, measuring food acquisition practice (α= 0.74), is a 6-

item scale and includes questions such as " *Over the past 12 months, how frequently have you attended functions in which there was free food*?". The responses were rated using a 3-point frequency Likert scale ("Never" = 1 to "Often" = 3). The third scale, measuring food management practice (α= 0.85), has 4 items including questions such as "*Over the past 12 months, how frequently have you eaten as much as possible when food is available"*.[47] The responses were rated using a 3-point frequency Likert scale ("Never" = 1 to "Often" = 3). To confirm reliability in the current sample, Cronbach's alpha was calculated, resulting in values of 0.93, 0.76 and 0.75 for the hunger-coping strategies, food acquisition and food management practice scales respectively, indicating good reliability.

4.2.3 Data Analysis

The data were analyzed using IBM SPSS, version 29. Descriptive statistics were used to assess baseline demographics. To determine the association between socio-demographic factors and the level of food security, a chi- square test of independence was conducted. For variables with an observed cell count less than 5, Fisher's exact test was used.

To examine group differences in the frequency of coping strategies applied across food security levels, the Kruskal-Wallis's test was used. Post-hoc pairwise comparisons were conducted using Dunn's method with a Bonferroni correction to identify specific group differences in the pairwise comparisons.

Kruskal-Wallis's test was used because the assumption of normality was not met. Kolmogorov-Smirnov was conducted to determine whether each coping strategy is normally distributed. The test was selected because it is appropriate for large sample sizes ($n > 50$).[73] The results indicate that the null hypothesis of normality must be rejected for all coping strategies ($p < .001$) and conclude that the data is not normally distributed. Additionally, the normality Q-Q plots

demonstrated that data points were not close to the diagonal line, further concluding that data was not normally distributed.

4.3. Results

4.3.1. Sample Socio-Demographics across Levels of Food Security

The study sample (n=373) consisted of 52.8% female and 51.2% white students, with a mean age of 21 ± 2.05 years. Most participants (73.7%) resided off-campus either alone or with family and friends. Regarding employment status, 40.3% of the participants reported being unemployed. Financial assistance was received by 47.9% of the participants through at least one source, such as Pell grant, or need-based scholarships, with 11.9% receiving multiple forms of financial assistance. Additionally, 88.2% were single, and 43.4% identified as first-generation college students.

To ensure that the sample has a sufficient number of food-insecure students, the food-insecure group was slightly oversampled. As a result, 59.2% of our participants were food insecure, with 65.2% of this group classified as having very low food security. Sociodemographic factors varied significantly across the different levels of food security. A series of chi-square tests of independence were conducted, and the level of food security was found to be statistically significantly associated with gender, ethnicity, race, first-generation college status, employment status, campus residence, and financial aid status (p <0.05).

Food insecurity was higher among female participants compared to male participants (66.5% vs. 50.3%), and all non-binary/transgender participants were classified as food insecure (p = 0.006). Additionally, food insecurity rates showed significant racial disparities in this sample, with 77.3% of Black or African American students experiencing food insecurity, while 45.5% of White students were food insecure (p < 0.001). Compared to 57.8% of non-first-generation

students, only 18.9% of first-generation college students experienced food security ($p < 0.001$). Similarly, food insecurity was higher in full-time employed students (82.5%) compared to unemployed students ($p < 0.001$). Financial aid recipients were also more vulnerable, with 68.1% experiencing food insecurity, compared to 46% of students who did not receive financial aid ($p < 0.001$).

However, age, marital status, and level of study were not significantly associated with food security status ($p > 0.05$). Detailed socio-demographic characteristics of the participants are listed in Table 4.1 below.

Table 4.1. Socio-demographic Characteristics of Participants Across Levels of Food Security

		Food security levels, N (%)		
	Total (n= 373)	**Secure (n= 152)**	**Low secure (n=77)**	**Very low secure (n = 144)**
Mean Age and Standard Deviation (Range of 18 to 24)	20.98 ± 2.05	20.67 ± 2.09	20.7 ± 1.97	21.5 ± 1.96
Gender**				
Female	197 (52.8%)	66 (33.5%)	48 (24.4%)	83 (42.1%)
Male	173 (46.4%)	86 (49.7%)	28 (16.2%)	59 (34.1%)
Other	3 (0.8%)	0 (0%)	1 (33.3%)	2 (66.7%)
Marital Status				
Single or never married	329 (88.2%)	140 (42.6%)	68 (20.7%)	121 (36.8%)
Married or domestic partner	39 (10.5%)	12 (30.8%)	6 (15.4%)	21 (53.8%)
Separated/Divorced	5 (1.3%)	0 (0%)	3 (60%)	2 (40%)
Ethnicity***				
Hispanic	49 (13.1%)	8 (16.3%)	12 (24.5%)	29 (59.2%)
Non-Hispanic	324 (86.9%)	144 (44.4%)	65 (20.1%)	115 (35.5%)
Race***				
White	191 (51.2%)	104 (54.5%)	36 (18.8%)	51 (26.7%)
Black or African American	149 (39.9%)	34 (22.8%)	32 (21.5%)	83 (55.8%)
Asian	15 (4%)	8 (53.3%)	4 (26.7%)	3 (20%)
Other	18 (5%)	6 (33.3%)	5 (27.8%)	7 (38.9%)
Level of Study				
Freshman	71 (19%)	22 (30.9%)	21 (29.6%)	28 (39.4%)
Sophomore	68 (18.2%)	25 (36.8%)	13 (19.1%)	30 (44.1%)
Junior	95 (25.5%)	42 (44.2%)	19 (20%)	34 (35.8%)
Senior	139 (37.3%)	63 (45.3%)	24 (17.3%)	52 (37.4%)
First-generation college student***				
Yes	162 (43.4%)	30 (18.5%)	36 (22.2%)	96 (59.3%)
No	211 (56.6%)	122 (57.8%)	41 (19.4%)	48 (22.7%)
Employment status***				
Employed full-time	86 (23.1%)	15 (17.4%)	15 (17.4%)	56 (65.1%)
Employed part-time	135 (36.2%)	47 (34.8%)	39 (28.9%)	49 (36.3%)
Unemployed	150 (40.3%)	90 (60%)	22 (14.7%)	38 (25.3%)
Other	2 (0.3)	0 (0%)	1 (50%)	1 (50%)
Residence*				
On-campus (dormitory)	98 (26.3%)	32 (32.7%)	25 (25.5%)	41 (41.8%)

Off-campus with family	151 (40.2%)	57 (37.7%)	35 (23.2%)	59 (39.1%)
Off-campus alone	88 (23.6%)	49 (55.7%)	9 (10.2%)	30 (34.1%)
Off-campus with roommates or friends	36 (9.7%)	14 (38.9%)	8 (22.2%)	14 (38.9%)
Campus meal plan				
Yes	165 (44.2%)	63 (38.2%)	37 (22.4%)	65 (39.4%)
No	201 (53.9%)	87 (43.3%)	38 (18.9%)	76 (37.8%)
Financial Assistance* **				
Receiving one or more aid	223 (59.8%)	71 (31.8%)	54 (24.2%)	98 (43.9%)
Not receiving financial aid	150 (40.2%)	81 (54.0%)	23 (15.3%)	46 (30.7%)
*<.05, **<.01, ***<.001				

4.3.2 Patterns of Coping Strategies Across Food Security Levels

Table 4.2. presents the mean composite and subscale scores of coping strategies across levels of food security, including hunger coping strategies, food acquisition practices, and food management. Additionally, mean frequency scores for individual items were computed between groups. Students experiencing very low food security applied all coping strategies significantly more frequently than those with low food security, who in turn applied these strategies more frequently than food secure students. Kruskal-Wallis H-test was conducted and revealed a statistically significant difference in the distributions of coping strategies among the groups ($p < 0.001$).

The most frequently used hunger coping strategies across all three levels of food security were ‘bought the cheapest food available’, and ‘avoided buying expensive foods like fruits and vegetables.’ In particular, mean frequency scores indicated that students in both low and very-low food-secure groups used these strategies ‘sometimes’ to ‘often’. Furthermore, the very-low food secure group reported using nearly all hunger coping strategy items at least ‘sometimes’.

Table 4.2. Mean frequency scores of coping strategies by food security level

	Sum or Mean Frequency ± SD			p-value
	Food secure (n=152)	Low food secure(n=77)	Very low food secure(n=144)	
Coping strategies				
Mean composite scores (22 items) (Standardized)	38.38 ± 12.78	52.70 ± 11.95	60.53 ± 10.87	<.001
Subscale- hunger coping strategies				
Mean subscale score (12 items)	23.04 ± 10.15	33.49 ± 9.31	38.65 ± 9.35	<.001
Choose between paying for food and paying for rent	1.63 ± 1.08	2.36 ± 1.12	2.90 ± 1.24	<.001
Choose between paying for food and paying for utilities	1.67 ± 1.06	2.60 ± 1.29	3.03 ± 1.17	<.001
Choose between paying for food and paying for textbooks and tuition or other education expenses	1.78 ± 1.07	2.65 ± 1.31	3.07 ± 1.25	<.001
Choose between paying for food and paying for transportation	1.91 ± 1.18	2.53 ± 1.22	3.14 ± 1.29	<.001
Choose between paying for food and paying for medicine	1.92 ± 1.22	2.62 ± 1.44	3.17 ± 1.21	<.001
Asked friends and family for food or money for food	2.07 ± 1.21	2.96 ± 1.28	3.19 ± 1.24	<.001
Skipped paying bills to buy food	1.70 ± 1.02	2.68 ± 1.36	3.11 ± 1.29	<.001
Bought the cheapest food available	2.32 ± 1.19	3.18 ± 1.07	3.53 ± 1.24	<.001
Avoided buying expensive foods like FVs	2.36 ± 1.24	3.49 ± 1.12	3.50 ± 1.17	<.001
Log extra hours at work to afford food	1.95 ± 1.21	2.82 ± 1.33	3.35 ± 1.26	<.001
Employed strict budgets for food shopping, resulting in diets with limited variety?	1.85 ± 1.09	2.69 ± 1.14	3.31 ± 1.19	<.001
Resorted to sleeping as a strategy to avoid feelings of hunger	1.89 ± 1.09	2.91 ± 1.21	3.35 ± 1.08	<.001
Subscale- Food acquisition practice				
Mean subscale score (6 items)	9.06 ± 2.50	11.25 ± 2.94	12.68 ± 2.59	<.001
Attended functions in which there was free food	1.83 ± 0.72	2.06 ± 0.73	2.27 ± 0.72	<.001
Obtained food from food bank or pantry	1.49 ± 0.67	1.83 ± 0.82	2.01 ± 0.68	<.001

Participated in food assistance program (SNAP, WIC)	1.49 ± 0.66	1.75 ± 0.81	2.06 ± 0.75	<.001
Ate meals at places in which you pay what you can	1.43 ± 0.63	2.08 ± 0.81	2.17 ± 0.76	<.001
Took fewer classes to have more money for food	1.43 ± 0.63	1.79 ± 0.75	2.05 ± 0.72	<.001
Sold personal possession to buy food	1.39 ± 0.61	1.73 ± 0.79	2.12 ± 0.75	<.001
Sub-scale- food management scale				
Mean subscale score (4 items)	6.27 ± 1.95	7.96 ± 2.09	9.19 ± 1.68	<.001
Eaten as much as possible when food is available	1.63 ± 0.69	2.09 ± 0.73	2.28 ± 0.67	<.001
Ate less healthy meals to eat more food	1.55 ± 0.61	2.00 ± 0.79	2.25 ± 0.68	<.001
Stretched food to last longer	1.60 ± 0.69	1.94 ± 0.69	2.40 ± 0.62	<.001
Avoid having guests to avoid serving food	1.51 ± 0.67	1.94 ± 0.75	2.26 ± 0.67	<.001

Hunger coping strategy :(1=never, 2=rarely, 3=sometimes, 4=often, 5=always)
Food acquisition, Food management: (1= never, 2 = sometimes, 3= often)

4.3.3 Food Insecurity Coping Response Strategies: Post Hoc Analysis

Our post hoc analysis (Table 4.3.) revealed specific coping behaviors that differentiate between food security groups. The findings demonstrated that students exhibited a distinct progression of coping strategies in response to worsening food insecurity, transitioning from early-stage to more intensive late-stage behaviors.

Early-stage coping strategies: Several behaviors differentiated food-secure students from those experiencing any level of food insecurity, while no significant differences emerged between the low and very low food-secure groups. This pattern of significant differences between food-secure and food-insecure groups, coupled with the absence of distinctions between varying levels of food insecurity, suggests these behaviors represent early adaptive strategies that emerge at the onset of food insecurity.

Initially, food-insecure groups (both low and very low) begin to cope with hunger by 'asking friends and family for food or money to buy food', 'buying the cheapest food available', and 'avoiding expensive foods such as fruits and vegetables'. For food acquisition and food management, they tended to 'eat at places in which you pay what you can' and 'eat as much as possible when food is available' in the early stages.

Late-stage coping strategies: Other coping behaviors differed significantly between low and very low food secure groups, indicating these strategies emerge as food insecurity intensifies to a more severe level. Students with very low food security reported significantly higher frequencies of difficult trade-offs, more often choosing between food and rent (p=.019), utilities (p=.043), transportation (p=.008), or medicine (p=.008). Additionally, these students were more likely to work extra hours to afford food (p=.027), implement stricter food shopping budgets resulting in limited diet variety (p=.005), or use sleep as a hunger coping strategy. These findings reveal a clear progression of coping mechanisms as food insecurity severity increases, with more extreme trade-offs occurring at the highest level of food insecurity.

Additionally, post-hoc analysis revealed that, among the food acquisition and food management practices examined, strategies like participating in SNAP or WIC (p=.008), taking fewer classes to have more money for food (p= .039), selling personal possessions to buy food (p=.001), eating less healthy meals to eat more food (p= .048) and stretching food to last longer (p< .001) were significantly more likely to be applied by very low food-secure students compared to low food secure students. These findings indicate the increasing financial, social, academic, and health-related challenges college students face as their food security status worsens.

Table 4.3. Pairwise comparison of coping strategies across levels of food security

	H- statistics (p-value)

	Secure vs. Low secure	Secure vs. Very low secure	Low secure vs. Very low secure
Hunger coping at an early stage			
Choose between paying for food and paying for textbooks and tuition or other education expenses	-71.076 (<.001)	-104.084 (<.001)	-33.008 (NS)
Asked friends and family for food or money for food	-72.533 (<.001)	-89.485 (<.001)	-16.952 (NS)
Skipped paying bills to buy food	-75.939 (<.001)	-110.499 (<.001)	-34.559 (NS)
Bought the cheapest food available	-68.491 (<.001)	-96.954 (<.001)	-28.463 (NS)
Avoided buying expensive foods like FVs	-90.746 (<.001)	-91.050 (<.001)	.304 (NS)
Hunger coping at a late stage			
Choose between paying for food and paying for rent	-68.621 (<.001)	-108.439 (<.001	-39.819 (.019)
Choose between paying for food and paying for utilities	-78.509 (<.001)	-114.535 (<.001)	-36.027 (.043)
Choose between paying for food and paying for transportation	-52.138 (.001)	-96.727 (<.001)	-44.589 (.008)
Choose between paying for food and paying for medicine	-53.926 (.001)	-98.233 (<.001)	-44.307 (.008)
Log extra hours at work to afford food	-67.342 (<.001)	-106.098 (<.001)	-38.756 (.027)
Employed strict budgets for food shopping, resulting in diets with limited variety?	-70.397 (<.001)	-117.288 (<.001)	-46.891 (.005)
Resorted to sleeping as a strategy to avoid feelings of hunger	-85.657 (<.001)	-122.080 (<.001)	-36.423 (.042)
Food Acquisition at an early stage			
Attended functions in which there was free food	-31.71 (NS)	-59.66(<.001***)	-27.95(NS)
Obtained food from food bank or pantry	-45.171 (.004)	-73.996 (<.001)	-28.825 (NS)
Ate meals at places in which you pay what you can	-82.414 (<.001)	-94.272 (<.001)	-11.858 (NS)
Food Acquisition at a late-stage			
Participated in food assistance program (SNAP, WIC)	-33.195 (NS)	-75.500 (<.001)	-42.305 (.008)

Took fewer classes to have more money for food	-48.958 (.001)	-83.916 (<.001)	-34.959 (.039)
Sold personal possession to buy food	-42.565 (.007)	-93.904 (<.001)	-51.339 (.001)
Food management at an early stage			
Eaten as much as possible when food is available	-62.727 (<.001)	-88.772 (<.001)	-26.046 (NS)
Food management at a late stage			
Ate less healthy meals to eat more food	-60.295 (<.001)	-94.521 (<.001)	-34.226 (.048)
Stretched food to last longer	-45.222 (.004)	-107.539 (<.001)	-62.317 (<.001)
Avoid having guests to avoid serving food	-57.662 (<.001)	-100.462 (<.001)	-42.800 (.008)

4.4 Discussion

The purpose of this study was to investigate the relationship between coping strategies and varying levels of food security and to identify patterns in coping strategies that correspond to different levels of food security among college students. It examined the frequency and type of coping strategies applied across the different levels of food security, providing insight into how coping strategies progressed as food insecurity worsened, laying the foundation for the development of tailored measurement tools and intervention strategies to address food insecurity.

This study found that students experiencing very low food security applied all coping strategies significantly more frequently than those with low food security, who in turn used these strategies more frequently than food-secure students. These statistically significant differences demonstrate distinctly different coping response behaviors that align with food insecurity gradients. This pattern aligns with previous studies, though not all research shows identical results. Multiple studies found that very low food-secure students more frequently employed strategies like denying preferred food items and limiting meal portions, indicating that as food security status worsens use of coping strategies increases.[51,74,75] Another study comparing students experiencing

episodic and persistent food insecurity identified increasingly frequent coping strategy use as food insecurity becomes persistent.[47] Differently, one analysis revealed that students with marginal and very low food security utilized a significantly higher total number of coping strategies compared to those with low or high food security.[76]

A key contribution of this study is the identification of progression from basic to more severe coping mechanisms as food insecurity worsened, indicating how students adjust their behaviors over time and transition from early-stage strategies to more intensive late-stage behaviors. For instance, students experiencing any level of food insecurity initially reported choosing between food and non-essential expenses such as textbooks. As food insecurity worsened, this progressed to making difficult choices between food and more essential expenses such as rent, utilities, transportation, and even medicine. Working extra hours, following strict food budgets, or even resorting to sleep were distinct hunger-coping strategies sometimes or often used by students experiencing very low food security to afford food or avoid hunger. This finding suggests that certain coping strategies employed specifically by very low food secure students could serve as more sensitive indicators for identifying students in urgent need, potentially offering greater precision than current USDA food insecurity assessment modules.

These findings may shed light on developing a food security assessment tool more tailored to college students that could better identify and prioritize very low food secure students than existing USDA food security survey instruments. Specifically, questions about choosing between food and essential expenses (rent, transportation, or medicine), selling personal possession to buy food, stretching the food budget to last longer, or avoiding having guests to serve food may serve as sensitive indicators in this demographic. These items could not only screen food-insecure students but also identify those experiencing very low food insecurity who require immediate

intervention. Furthermore, these identified coping indicators could inform the development of tangible, targeted intervention strategies for college students, including financial literacy education to effectively stretch limited budgets and nutrition interventions to enable healthier food choices within financial constraints.

An interesting food acquisition pattern observed in our study was that food-insecure students reported that they 'never' or 'sometimes' obtained food from food banks or pantries. No significant difference emerged between low and very low food-secure students in this regard, consistent with previous studies.[47] The underutilization of these resources despite having a greater need in very low food-secure group may stem from stigma concerns, inconvenient hours of operation, lack of awareness about the program availability, and confusion about eligibility requirements.[6,30] To address these barriers, institutions could create greater awareness about available resources and healthy eating options, modify pantry operations to better accommodate student schedules, and ensure these services effectively reach the most vulnerable student populations.

Diet quality among food-insecure students is also another important aspect that warrants further attention. A well-established adverse association exists between food insecurity and dietary patterns and quality, and it appears to be partly explained by the coping strategies frequently adopted by food-insecure students. Similar to previous studies, our study found that the most frequently applied coping strategies by food-insecure college students are buying the cheapest food available and avoiding buying expensive foods like fruits and vegetables.[47,72,75,76] Additionally, as food insecurity worsened, students tended to implement stricter food shopping budgets, eat less variety and less healthy meals, and stretch food to last longer, indicating a shift from temporary adjustment to chronic food restriction. These strategies may compromise diet quality leading to

increased health risks such as obesity which is reported to be higher in food-insecure students.[1,29,31,36] The financial strain these students are experiencing and their lower diet quality leads to nutrient deficiency leading to low energy levels, difficulty concentrating, and ultimately poorer academic performance among food-insecure college students.[25,38–41]

This study also revealed significant associations between food insecurity and multiple demographic factors -race, ethnicity, gender, first-generation college status, and employment status- findings consistent with previous studies.[1,17,20–24] Food insecurity was higher among female participants and all non-binary/transgender participants were classified as food insecure. Additionally, similar to previous studies, Black or African American or Hispanic/Latino students, first-generation college students, and those with full-time employment experienced higher food insecurity rates than their counterparts.[17,23,25,26] Unlike previous studies, we found no significant association between food security status and age, marital status, or having a campus meal plan. [1,17,20] Understanding these socio-demographic disparities is also crucial when developing targeted interventions to address food insecurity. By identifying the groups most affected, institutions and policymakers can implement tailored support strategies to mitigate food insecurity among vulnerable student populations.

This study has several limitations. The study was conducted on undergraduate students in 4-year colleges in the Maryland area. As a result, findings from this study may not be generalizable to other university students and graduate students. Additionally, with the use of self-reported data, there might be social desirability bias with students underreporting the severity of food security status or the extent of the coping strategy used. Lastly, there is a selection bias in this study as food insecure college students were oversampled to allow robust comparison between food secure and insecure groups. As a result, the prevalence of food insecurity identified in this study may not

reflect the prevalence of food insecurity in the general college student population and caution should be used when generalizing these findings.

While acknowledging certain methodological limitations, this research offers a roadmap for institutions seeking to implement more responsive and tailored support systems for vulnerable student populations. Overall, this study addresses a significant gap in literature by mapping the progression of coping strategies across different levels of food insecurity, providing insights for developing more precise measurement tools and targeted interventions. By examining the spectrum of food insecurity rather than using a binary secure/insecure comparison, we revealed how students' adaptive behaviors evolve as their circumstances change. The findings illuminate important distinctions in both the frequency and nature of coping mechanisms employed as food insecurity intensifies. These patterns could serve as the foundation for creating more context-specific assessment instruments for measuring food insecurity among college populations. Understanding these nuanced responses is essential for designing effective support strategies that address the specific challenges faced at each level of food security.

Chapter 5 (Paper 2): Exploring Resource Management Behaviors Across Food Security Levels to Identify Drivers of Food Insecurity in College Students

5.1. Introduction

Food insecurity, limited or uncertain access to sufficient nutritious food, affects college students at significantly higher rates than the general population.[1–3,14] This pressing issue needs immediate attention, as it negatively impacts academic performance, physical and mental health, and overall well-being.[25,32,36,41] Previous studies show that food-insecure college students frequently adopt cost-saving strategies—such as meal skipping, buying cheaper or less nutritious food, and limiting food variety—compared to their food-secure peers.[37,44,45,47,48] Understanding how these various strategies address specific aspects of food insecurity can clarify the relationship between students' coping mechanisms, resource management-related behaviors, and their experiences of food insecurity.

Food security encompasses four main dimensions- availability, access, utilization, and stability. Availability refers to the food supply, while access involves the ability to obtain nutritious food, which is dependent on market access and financial resources. Utilization refers to the effective use of food and water households have access to and their ability to absorb and metabolize nutrients. It depends on the way food is prepared, stored, and processed. Stability ensures consistent and reliable maintenance of the other three pillars of food security.[77–80]

Among these dimensions, food utilization holds particular promise as a modifiable factor to alleviate food insecurity. Examining how utilization-related behaviors connect to food insecurity among college students could reveal potential intervention points. For instance, by focusing on utilization strategies, institutions might develop effective approaches to address food insecurity within the college student population without requiring substantial resource investment

or systemic change. In general, organized food management behaviors including meal planning, shopping strategies, and food preparation have been shown to be protective against food insecurity in the general population.[81,82] Conversely, food waste, a customer-driven behavior where food fit for human consumption is intentionally discarded, significantly compromises food security worldwide [83,84] Despite this close connection, studies examining how college students manage food and what approaches effectively help them do so remain scarce. Given that inadequate food management behaviors may contribute to increased food insecurity, addressing this research gap is crucial for mitigating food insecurity in this population.

Beyond food management behaviors, few studies have explored the potential associations between relevant resource management constructs such as food literacy, financial behavior, and food insecurity among college students. Food literacy encompasses the knowledge, skills, and behaviors required to plan, manage, select, prepare, and eat food to meet needs and determine intake.[11] One study found significant improvements in cooking skills and food preparation abilities following an 11-week intervention using a food literacy-based curriculum, though no significant improvement in food insecurity indicators was observed.[59] Another study indicated that an undergraduate nutrition course incorporating a teaching kitchen lab may reduce food insecurity among undergraduate students.[66] While these studies have found that students with higher food literacy skills better manage limited food resources and demonstrate improved cooking skills and meal planning abilities, the relationship between food literacy and food insecurity remains understudied, highlighting a significant need for more robust, evidence-based research.

Additionally, college students face the novel challenge of managing their own finances upon entering college. Financial behavior involves day-to-day money management, financial planning, and dealing with financial difficulties.[71] Studies in the general population have found

that higher financial literacy or management skills correlate with lower odds of experiencing food insecurity.[85,86] However, there remains a limited understanding of how these financial behaviors interrelate with food insecurity and whether specific gaps in planning, budgeting, or money management skills exist among college students.

Given the urgency of addressing food insecurity among college students, this study examines how general resource management behaviors including food management, food literacy, and financial behavior are associated with food security levels. By doing so, the study aims to provide meaningful insight for identifying targeted interventions to mitigate food security issues.

5.2. Methods

5.2.1. Study Setting and Participant Recruitment

This research study was conducted on undergraduate students enrolled in 4-year colleges in the Maryland area. The state comprises 38 four-year colleges, with a total undergraduate enrollment of 159,584 as of fall 2022.[67,68] Data were collected from a diverse sample of 370 college students across the Maryland area using an online survey platform, Qualtrics. To ensure that the sample has a sufficient number of food-insecure students, the food-insecure group was slightly oversampled. This methodological approach was used to detect meaningful differences in coping behaviors according to food security levels and capture sufficient variation to understand the diversity of coping behaviors.

Potential participants were screened at the beginning of the survey using a two-item screener, the Hunger Vital Signs. Participants who answered ‘often true’ or ‘sometimes true’ to either or both of the following two statements were screened as being at risk for food insecurity. 1. We (I) worried whether our (my) food would run out before we (I) got money to buy more.

(Often true, Sometimes true, Never true) 2. The food we (I) bought just didn't last and we (I) didn't have money to get more. (Often true, Sometimes true, Never true)

Qualtrics sent recruitment emails to potential participants, targeting students from 4-year colleges across Maryland. Participants were included in the study if they were undergraduate students enrolled in a 4-year college in Maryland and were at least 16 years old. Qualtrics applied exclusion criteria such as category exclusions, participation frequency, and so on.

This research was approved by the Institutional Review Board at the University of Maryland and all 370 responses were used for data analysis.

5.2.2 Measures

Socio-demographics such as age, gender, marital status, race, current level of study, parent's level of education, and employment status were assessed. Additionally, data was collected on factors that affect food insecurity in college students such as scholarship status (categorized as Pell Grant, need-based scholarship, or other), meal plan (categorized as yes, no or don't know), current residency (categorized as on-campus, off-campus living with family, and off-campus living alone or with roommates), and living arrangement (categorized as I live alone, I live with my parents, with roommates or friends, with husband/wife or partner/significant other, my children, or other).

Level of food insecurity was measured using the 10-item USDA Food Security Survey Module (FSSM).[69] Although this instrument has not been specifically validated for college students, it is widely recognized as the gold standard for assessing food insecurity.[15] Responses are coded as affirmative for "yes," "often," "sometimes," "almost every month," and "some months but not every month." Based on the sum of affirmative responses (ranging from 0 to 10),

participants were classified into four categories of food security: high food security (0), marginal food security (1-2), low food security (3-5), and very low food security (6-10).[69]

Food literacy was measured using 29 items adopted from the Food Literacy Assessment Tool (α= 0.73).[70] This comprehensive instrument is designed to assess three critical domains of food literacy. The first domain, Nutrition, and Safety consists of 10 items that focus on an individual's ability to manage, prepare, and select food and include items such as " *I know about the various food groups that make up nutritionally balanced meals*". The second domain, Cultural and Relational, comprises 8 items that examine how individuals maintain good relationships with food and share food with others and include questions such as "*Cooking is enjoyable*". The third domain, Socio-ecological, includes 11 items that address issues of food sustainability and environmental considerations and includes questions such as "*I know why choosing seasonal food is good for the environment*". The responses for all items were rated using a 5-point frequency Likert scale ("Strongly Disagree" = 1 to "Strongly Agree = 5"). Factor analysis, specifically principal component analysis, was conducted and two items were removed: " *I check cleanliness of restaurants when dining out* " and " *I check the country of origin when purchasing food* ". As a result, only 29 of the 33 items were included in the data analysis (α= 0.955).

Financial behavior was measured using a 10-item measure (α= 0.618).[71] It included questions such as *"I always begin saving well in advance for Big events such as Christmas, Eid, etc".* The responses were rated using a 5-point frequency Likert scale ranging from "Always" to "Never". To ensure consistency in coding, negatively worded items, such as " *I tend to buy things even when I can't really afford them* " were reverse coded ("Always" = 1 to "Never" = 5). All other items were positively worded and scored in the opposite direction ("Never" = 1 to "Always"

= 5). The reliability of this questionnaire was measured in this study and had a Cronbach's alpha value of 0.869.

Food planning/shopping routines were measured using an 11-item measure comprising two subscales: meal preparation and utilization, and food waste subscale. The meal preparation and utilization subscale included items such as "*How frequently do you plan and prepare meals ahead?*" and the food waste subscale, included questions such as "*How frequently do you throw away foods if 'Best by' date on the food label passes?"*. The responses were rated using a 5-point frequency Likert scale ranging from "Never" to "Always". To ensure consistency in scoring, all items in the food waste subscale, which were negatively worded, were reverse coded ("Always" = 1 to "Never" = 5). All other items were positively worded and scored in the opposite direction ("Never" = 1 to "Always" = 5). The reliability of this questionnaire was measured in this study and had a Cronbach's alpha value of 0.890.

Coping strategies employed by college students in response to food insecurity were assessed using two scales including hunger coping strategies, food acquisition and management practice scales. The first scale, measuring hunger coping strategies (α= 0.85), has 12 items and includes questions such as "*Have you ever had to choose between paying for food and paying for rent?*". The responses were rated using a 5-point frequency Likert scale ("Never" = 1 to "Always= 5"). The construct and content validity of the scale were tested using Spearman correlation and the questions showed significant correlations.[71] The second scale, measuring food acquisition and management practice, is a 10-item scale and includes questions such as " *Over the past 12 months, how frequently have you attended functions in which there was free food*?". The responses were rated using a 3-point frequency Likert scale ("Never" = 1 to "Often" = 3).[49] The reliability of this questionnaire was measured in this study and had a Cronbach's alpha of 0.93, 0.76 and 0.75 for

the hunger-coping strategies, food acquisition and food management practice scales respectively, indicating a good reliability.

5.2.3 Data Analysis

The data were analyzed using IBM SPSS, version 29, and RStudio version 2024.12.1 Build 563. Descriptive statistics were used to assess baseline demographics. To determine the association between socio-demographic factors and food insecurity levels, a Chi-square test of independence was conducted.

To examine whether scores of food literacy, food planning and shopping, and financial behavior differed significantly across levels of food security, Kruskal-Wallis and ANOVA tests were used. Before conducting ANOVA, Levene's test was used to assess if the assumption of homogeneity of variance was met. In cases when the assumption of homogeneity of variances was not met, Welch's test was used. Spearman's correlation was also used before conducting ordinal logistic regression to assess the direction and strength of association between food security levels and each independent variable, as well as to assess potential correlations among the independent variables.

Furthermore, ordinal logistic regression was used to identify statistically significant predictors of levels of food insecurity. The following variables were considered in the initial model: gender, race, first-generation college student status, employment status, financial aid, frequency of application of coping strategies- hunger coping and food acquisition and management practices, financial behavior, food literacy, and food planning and shopping routines. Backward stepwise selection was applied and the variable with the least significant p-value was eliminated to identify the variables for the final model. Models were assessed using the Akaike information

criterion (AIC). The model with the smallest AIC was considered a better model. Multicollinearity, the proportional odds assumption, and model fitting were also assessed.

5.3. Results

5.3.1. Sample Characteristics

The study sample (n=370) included 53.2% female and 51.1% white students, with a mean age of 21 ± 2.04 years. Most participants (73.8%) resided off-campus either alone or with family and friends. Regarding employment status, 41.1% of the participants reported being unemployed. Financial assistance was received by 47.3% of the participants through at least one source, such as a Pell-grant, or need-based scholarship, with 10.8% receiving more than one financial assistance. More than half of the students (55.4%) didn't have a campus meal plan. 37.6% of the participants were senior undergraduate college students. Additionally, 89.7% of them were single, and 43.0% of the participants identified as first-generation college students. Detailed socio-demographic characteristics of the participants are listed across food security levels in Table 5.1. below.

To ensure that the sample has a sufficient number of food-insecure students, the food-insecure group was slightly oversampled. As a result, 58.9% of our participants were food insecure, and among this food insecure group, more than half (65.1%) were classified as having very low food security. Sociodemographic factors varied significantly across the different levels of food security. A series of Chi-square test of independence was conducted, and the level of food security was found to be statistically significantly associated with gender, ethnicity, race, first-generation college status, employment status, campus residence, and financial aid status (p <0.05).

Food insecurity was higher among female participants compared to male participants (66.5% vs. 50.3%). Additionally, food insecurity rates showed significant racial disparities in this sample, with 77.2% of Black or African American students experiencing food insecurity, while

45.0% of White students were food insecure ($p < 0.001$). Compared to 42.2% of non-first-generation students, 81.1% of first-generation college students experienced food insecurity ($p < 0.001$). Similarly, food insecurity was higher in full-time employed students, with 82.3% of them experiencing food insecurity, compared to 40.8% of unemployed students ($p < 0.001$). Financial aid recipients were also more vulnerable, with 67.8% experiencing food insecurity, compared to 45.7% of students who did not receive financial aid ($p < 0.001$).

However, age, marital status, and level of study were not significantly associated with food security levels ($p > 0.05$).

Table 5.1. Socio-demographic Characteristics of Participants

	Total (n= 370)	Food security levels, N (%)		
		Secure (n= 152)	Low secure (n=76)	Very low secure (n = 142)
Mean Age and Standard Deviation (Range of 18 to 24)	20.97 ± 2.04	20.67 ± 2.09	20.65 ± 1.94	21.45 ± 1.95
Gender**				
Female	197 (53.2%)	66 (33.5%)	48 (24.4%)	83 (42.1%)
Male	173 (46.8%)	86 (49.7%)	28 (16.2%)	59 (34.1%)
Marital Status				
Single	332 (89.7%)	140 (42.2%)	71 (21.4%)	121 (36.4%)
Married or domestic partner	38 (10.3%)	12 (31.6%)	5 (13.2%)	21 (55.3%)
Ethnicity***				
Hispanic	48 (13.0%)	8 (16.7%)	12 (25.0%)	28 (58.3%)
Non-Hispanic	322 (87.0%)	144 (44.7%)	64 (19.9%)	114 (35.4%)
Race***				
White or other	221 (59.7%)	118 (53.4%)	44 (19.9%)	59 (26.7%)
Black or African American	149 (40.3%)	34 (22.8%)	32 (21.5%)	83 (55.7%)
Level of Study				
Freshman	70 (18.9%)	22 (31.4%)	21 (30.0%)	27 (38.6%)
Sophomore	66 (17.8%)	25 (37.9%)	12 (18.2%)	29 (43.9%)
Junior	95 (25.7%)	42 (44.2%)	19 (20%)	34 (35.8%)
Senior	139 (37.6%)	63 (45.3%)	24 (17.3%)	52 (37.4%)
First-generation college student***				
Yes	159 (43.0%)	30 (18.9%)	35 (22.0%)	94 (59.1%)
No	211 (57.0%)	122 (57.8%)	41 (19.4%)	48 (22.7%)
Employment status***				
Employed full-time	85 (23.0%)	15 (17.6%)	15 (17.6%)	55 (64.7%)
Employed part-time	133 (35.9%)	47 (35.3%)	38 (28.6%)	48 (36.1%)
Unemployed	152 (41.1%)	90 (59.2%)	23 (15.1%)	39 (25.7%)
Residence*				
On-campus (dormitory)	97 (26.2%)	32 (33.0%)	25 (25.8%)	40 (41.2%)
Off-campus with family	150 (40.5%)	57 (38.0%)	35 (23.2%)	58 (38.7%)
Off-campus alone	88 (23.8%)	49 (55.7%)	9 (10.2%)	30 (34.1%)
Off-campus with roommates or friends	35 (9.5%)	14 (40.0%)	7 (20.0%)	14 (40.0%)
Campus meal plan				
Yes	165 (44.6%)	63 (38.2%)	37 (22.4%)	65 (39.4%)

No	205 (55.4%)	89 (43.4%)	39 (19.0%)	77 (37.6%)
Financial Assistance* **				
Receiving one or more financial assistance	221 (59.7%)	71 (32.1%)	54 (24.4%)	96 (43.4%)
Not-receiving financial assistance	149 (40.3%)	81 (54.4%)	22 (14.8%)	46 (30.9%)
*<.05, **<.01, ***<.001				

5.3.2. Food Literacy, Food planning and shopping routines and Financial behavior Across Levels of Food Security

The mean food literacy scores varied across food security levels, with food secure participants having the highest mean food literacy score of 109.1 ±23.4, followed by low food secure students (105.4 ±20.2), and very low food secure students (102.4 ± 24.2). The difference in mean food literacy score between these groups was statistically significant ($F(2, 367) = [3.118]$, $p = 0.045$). Tukey's HSD Test for multiple comparisons found that the mean food literacy score was significantly different between very low food secure and food secure college students ($p = 0.035$, 95% C.I. = (-13.04, -0.37)). There was no statistically significant difference between food secure and low food secure students, nor between low food secure and very low food secure students ($p > 0.05$).

Among the three domains of food literacy only nutrition and food safety scores showed statistically significant differences across food security levels ($F(2, 367) = [4.231]$, $p= 0.015$), with food secure participants having the highest mean nutrition and safety score of 38.2 ±8.5), followed by low food secure students (36.8 ± 8.4), and very low food secure students (35.2± 9.3). Tukey's HSD Test for multiple comparisons found significant differences between very low food secure and food secure college students ($p = 0.011$, 95% C.I. = (0.57, 5.39)). There was no statistically

significant difference between food secure and low food secure students, nor between low food secure and very low food secure students ($p > 0.05$).

Regarding food planning and shopping routines, very low food insecure and low food secure students showed higher scores across meal preparation and utilization subscales, indicating the frequent application of strategies such as 'planning and preparing meals ahead', 'shopping with a grocery list', 'using leftovers to create another meal' and 'buying cost-effective meat' options compared to food secure students.

On the contrary, food insecure students were also more likely to throw away food based if "best by," "sell by," and "use by" dates on the food label passes, resulting in lower scores within the food waste domain of food management behavior. Kruskal-Wallis's test was conducted to examine if these differences were significant across levels of food security, as Kolmogorov-Smirnov test indicated non-normality of the data ($p < .001$). The test indicated a significant difference in food planning and shopping scores across the levels of food security ($p < .001$). Post-hoc pairwise comparison (Dunn's test with Bonferroni correction) revealed a significant difference between food secure and low food secure and between food secure and very low food secure groups ($p < .05$). However, there was no significant difference between low food secure and very low food secure groups ($p > 0.05$).

Mean financial behavior scores were also higher among very low food secure (32.96, SD = 6.0) and low food secure students (32.25, SD = 6.8) compared to food secure students (27.84, SD = 8.4). Welch's test was conducted to examine if these differences were significant across levels of food security, as Levene's test for homogeneity of variance was violated ($F(2,367) = 16.24$, $p < .001$. The test revealed that there was a statistically significant difference in mean score between these groups ($F (2, 198.97) = [18.95]$, $p < .001$). Post-hoc pairwise comparison revealed

significant differences between food secure and low food secure and between food secure and very low food secure groups ($p < .05$). However, there was no significant difference between low food secure and very low food secure groups ($p > 0.05$).

Table 5.2. Comparison of food literacy, food planning and shopping routines, and financial behavior by levels of food security

Food Literacy, mean ± SD	Food Secure (n= 152)	Low Secure (n=76)	Very Low Secure (n = 142)	F test ($df_{between}$, df_{within}) (ANOVA)	P-value
Composite score	109.1 ± 23.4	105.4 ± 20.2	102.4 ± 24.2	3.12 (2, 367)	.045
Nutrition and Safety	38.2 ± 8.5	36.8 ± 8.4	35.2 ± 9.3	4.23 (2, 367)	.015
Cultural and Relational	30.2 ± 6.9	29.6 ± 6.0	28.5 ± 7.2	2.27 (2, 367)	.105
Socio-ecological	40.8 ± 9.2	39.0 ± 7.8	38.8 ± 9.2	2.18 (2, 367)	.114
Food planning & shopping routines, mean ± SD	Food Secure (n= 152)	Low Secure (n=76)	Very Low Secure (n = 142)	H-statistics (Kruskal-Wallis test)	P-value
Meal preparation, and utilization	22.5 ± 8.1	27.9 ± 5.4	28.9 ± 5.2	48.43	<.001
Food waste	9.4 ± 3.5	7.9 ± 2.5	7.4 ± 2.5	30.46	<.001
Financial behavior, mean ± SD	Food Secure (n= 152)	Low Secure (n=76)	Very Low Secure (n = 142)	F-test (df_1, df_2) (Welch's test)	P-value
Composite Score	27.8 ± 8.4	32.3 ± 6.8	33.0 ± 6.0	18.95 (2, 198.97)	<.001

5.3.4. Bivariate Correlation

Table 5.3 presents the bivariate correlation between the level of food security, food literacy, coping strategies (hunger coping strategy and food acquisition and management practice), food planning and shopping routines, and financial behavior. There was a significant association between the level of food security (1= food secure, 2= low food secure, and 3= very low food secure) and food literacy, hunger coping strategies, food acquisition and management practice, financial behavior, and food planning and shopping routines ($p < 0.05$).

Specifically, the level of food security had a positive correlation with the frequency of application of all coping strategies- hunger coping ($\rho = 0.589$, $p < 0.05$), and food acquisition and management practice ($\rho = 0.592$, $p < 0.05$). This indicates that students who frequently apply coping strategies such as buying the cheapest available food, skipping bills to pay for food, selling personal possessions to buy food, and stretching food to last longer are more likely to experience very low food security.

The level of food security also showed a positive correlation with financial behavior ($\rho = 0.280$, $p < 0.05$) suggesting that students with very low food security are more likely to engage in behaviors such as saving in advance, avoiding overspending, comparing items before buying, and avoiding buying products that they really can't afford.

A positive correlation between food security levels and meal preparation and utilization behavior ($\rho = 0.345$, $p < 0.05$) indicates that students with very low food security are more likely to shop with a grocery list, buy foods in season to save money and use leftovers to create another meal.

In contrast, the level of food security was negatively correlated with food literacy ($\rho = -0.178$, $p < 0.05$) and food waste ($\rho = -0.284$, $p < 0.05$) indicating that students experiencing very low food security tended to have lower food literacy scores and were more likely to discard food based on date labeling.

Financial behavior, on the other hand, had a significant positive correlation with meal preparation and utilization ($\rho = 0.503$, $p < 0.05$) and a significant negative relationship with food waste ($\rho = -0.369$, $p < 0.05$). This indicates that students with higher financial behavior scores are

more likely to shop with a grocery list, buy foods in season to save money and discard food based on date labeling.

Table 5.3. Bivariate Spearman's Correlation

S.No.	Variable	1	2	3	4	5	6	7
1.	Food Security Status	1						
2.	Food Literacy Score	-.178**	1					
3.	Hunger Coping Strategy	.589**	-.016	1				
4.	Food Acquisition and Management Practice	.592**	-.215**	.630**	1			
5.	Financial behavior	.280**	.082	.178**	.256**	1		
6.	Meal preparation & utilization	.345**	.086	.298**	.395**	.503**	1	
7.	Food waste	-.284**	-.007	-.249**	-.339**	-.369**	-.542**	1

**Correlation is significant at $\alpha < 0.01$ level (2-tail)
*Correlation is significant at $\alpha < 0.05$ level (2-tail)

5.3.5. Ordinal Logistic Regression

In this study, an ordinal logistic regression was conducted to assess the association between the level of food security (1= food secure, 2= low food secure, and 3= very low food secure) and multiple predictor variables. The initial model included gender, race, first-generation college student status, employment status, financial aid, coping strategy use- (hunger coping and food acquisition and management practices), financial behavior, food literacy, and food planning and shopping routines.

The final model was adjusted for the following variables based on the analytical process described in the methods section, gender, race, first-generation college student status, employment status, frequency of application of hunger coping strategies and food acquisition and management practices, and financial behavior.

Gender, race, first-generation status, employment status, hunger coping strategies, food acquisition and management practice, and financial behavior were identified as significant predictors of the level of food security. The odds of being in the higher category of food insecurity (very low food secure) are more than 2 times higher for female students (AOR = 2.361; 95% CI = 1.410, 4.009), Black or African American students (AOR = 2.363; 95% CI = 1.430, 3.924) and first-generation college students (AOR = 2.101; 95% CI =1.280, 3.451). Additionally, compared to unemployed college students, those employed full-time have 4 times higher odds of experiencing very low food security (AOR = 3.994; 95% CI = 2.030, 8.009).

Also, a one-unit increase in the frequency of hunger coping strategy use was associated with 8% increase in the odds of being in a more severe low food security. Similarly, for every one-unit increase in the frequency of application of food acquisition and management practice, the odds of experiencing very low food security increased by 20.3%. Additionally, a 5 unit increase in

financial behavior was associated with a 30.3% increase in the odds of being in a more severe low food security, adjusting for other factors in the model.

However, receiving financial aid, food literacy, meal planning, shopping, utilization and saving, and food labeling-related waste were not significant predictors of the level of food security ($p > 0.05$).

Table 5.4. Ordinal logistic regression

Predictors	**Regression Coefficient**	**Standard Error**	**Odds Ratio (95% CI)**	**P- value**
Gender- Male as reference				
Female	.859	.266	2.361 (1.410, 4.009)	.001**
Race- White and Other as reference				
Black or African American	.860	.257	2.363 (1.430, 3.924)	<.001***
First-generation status- Non-First-generation Students as reference				
First-generation students	.742	.252	2.101 (1.280, 3.451)	.003**
Employment status- Unemployed as reference				
Employed full-time	1.385	.349	3.994 (2.030, 8.009)	<.001***
Employed part-time	.517	.282	1.676 (.967, 2.926)	.07*
Hunger coping strategies	.078	.013	1.081 (1.053, 1.111)	<.001***
Food acquisition and management practice	.185	.032	1.203 (1.130, 1.284)	<.001***
Financial behavior (5-point increase)	.265	.095	1.303 (1.082, 1.570)	.004**

Compared to the null model, which is the baseline model with no predictor variables (AIC: 787.01), the initial model, comprising gender, race, first-generation college student status, employment status, financial aid, coping strategy use (hunger coping and food acquisition/management), financial behavior, food literacy, and food planning/shopping routines, provided a significantly better fit (AIC: 534.74, χ^2= 276.27, $p < 0.001$).

A backward stepwise selection procedure was then applied, in which variables with non-significant p-values and those that increased or didn't improve the AIC value were removed step by step. The final model included gender, race, first-generation college student status, employment status, frequency of hunger coping strategies, food acquisition and management practices, and financial behavior. This model demonstrated an improved fit (AIC = 530.25; χ^2 = 272.75, $p < 0.001$). Nagelkerke's $R^2 = 0.596$ suggested that the final model explained 59.6% of the variance in the outcome variable, the remaining were accounted for by possible error terms and other factors.

Multicollinearity was assessed using Variance Inflation Factors (VIFs). All predictor variables had VIF values less than 2, indicating that multicollinearity was not a concern in the model. The proportional odds assumption was also tested using the Brant test and findings indicated that the assumption was met ($\chi^2(8) = 6.46$, $p = 0.6$).

	Nagelkerke R squared	Cox & Snell R squared	McFadden R squared
Variance explained by predictor variables	0.596	0.524	0.351

5.4. Discussion

This study examines the relationship between resource management behaviors, specifically food management, food literacy, and financial behaviors- and food security levels among college students. By investigating these modifiable factors, we aim to identify key drivers of food insecurity in this population and inform targeted intervention strategies. This study aligns with student-proposed solutions, such as education on healthy eating, cooking economically, and budgeting along with assistance with job opportunities and affordable meal plans as potential interventions.[28,44,52] By focusing on modifiable factors and student-suggested solutions, we hope to provide valuable insights that can guide institutions, policymakers, and educators in their efforts to ensure food security for all college students.

This study revealed that being female, Black or African American, first-generation college student, and working full time was associated with higher odds of experiencing lower food security- findings consistent with previous studies.[1,17,20–26] Unlike previous studies, this study found that receiving financial aid is not a significant predictor of the level of food security in the ordinal logistic regression model.[8,27–29] Given a chi-square test of independence did reveal a significant association between financial aid receipt and food insecurity, indicating that a higher proportion of students receiving financial aid experienced food insecurity, this discrepancy may be attributed to the distribution of financial aid status across the food security categories, which resulted in low cell counts within certain combinations of variables (very low food security among non-recipients), making it difficult for the model to determine the contribution of financial aid status in predicting food security level.

A key contribution of this study is the assessment of the relationship between level of food security and modifiable factors such as food planning and shopping routines, food literacy and

financial behavior, which is an area poorly understood in the college student population. Financial behavior, defined as managing money day to day, financial planning, and dealing with financial difficulties, was found to be a significant predictor of food insecurity, with students exhibiting higher financial behavior scores more likely to experience higher levels of food insecurity.[71] This finding contradicts studies in the general population which associate higher financial literacy with lower food insecurity risk.[85,86] This unexpected finding may be due to the fact that our study's focus on immediate financial management, such as day-to-day budgeting and coping with financial emergencies, may not capture the long-term financial planning skills assessed in studies focusing on financial literacy, which often included complex concepts like inflation and investment returns.[85] It is also possible that the unique financial pressures faced by college students, such as high tuition costs and limited income, may lead to distinct financial behaviors compared to the general population. Additionally, this financial strain may have led these students to develop these adaptive strategies. Future research should consider incorporating more detailed measures of financial literacy and exploring the contextual factors that influence financial behavior in this population.

Food planning and shopping routines were hypothesized to be inversely related to food insecurity, consistent with findings in the general population.[81,82] However, contrary to our hypothesis and previous research, a moderate positive correlation was observed between food management behavior and food security, and these behaviors did not significantly predict food security levels. This unexpected finding may indicate that food-insecure college students, facing daily resource constraints, have developed adaptive food management strategies. These strategies, while potentially effective in mitigating immediate hunger, might not fully address the underlying causes of food insecurity, such as financial limitations or access barriers. Further investigation is

needed to determine the relationship between food management behavior and food security in this population, accounting for potential confounding factors and the specific context of college life.

This study also looked at food waste. Students were asked questions if they threw away food if 'best by', 'sell by', and 'use by' date passed. This study found a moderately weak negative correlation between these behaviors and food security levels. This indicates that college students who frequently throw away food if the 'sell by', 'use by', and 'best by' date passes are more likely to experience food insecurity. This finding is similar to previous studies in the general population which found food waste as a significant concern compromising food security worldwide.[83,84] This finding indicates that a lack of understanding regarding food label interpretation may contribute to food waste among college students, potentially exacerbating their food insecurity. Further study is required to assess this relationship as this might be a potential intervention area to address the highly prevalent food insecurity in college students.

Additionally, this study found a weak negative correlation between food literacy and the level of food security among college students. Food literacy was also not a significant predictor of the level of food insecurity in the ordinal logistic regression model. This finding correlates with previous research findings which found significant improvements in cooking skills and food preparation abilities didn't show significant improvement in food insecurity indicator.[59]

Frequent use of all coping strategies- hunger coping strategies and food acquisition and food management practices was also found to be associated with higher odds of experiencing very lower food security. This pattern aligns with previous studies, though not all research shows identical results. Multiple studies found that very low food-secure students more frequently employed strategies like denying preferred food items and limiting meal portions, indicating that as food security status worsens use of coping strategies increases.[51,72,73] Another study comparing

students experiencing episodic and persistent food insecurity identified increasingly frequent coping strategy use as food insecurity becomes persistent.[47] Differently, one analysis revealed that students with marginal and very low food security utilized a significantly higher total number of coping strategies compared to those with low or high food security.[74]

This study has several limitations that should be considered when interpreting the results. First, the study was conducted on undergraduate students in 4-year colleges in the Maryland area. As a result, findings from this study may not be generalizable to other university students and graduate students. Additionally, this study is a cross-sectional study and a causal relationship can't be established between the examined variables and the level of food security.

Furthermore, the study's ordinal logistic regression model encountered challenges due to sparse data in some categories, particularly for demographics such as race, employment status and financial aid recipient status. To address this challenge, we consolidated categories for certain variables such as race, to ensure adequate cell sizes for robust ordinal logistic regression. While this approach enhanced model stability, it potentially masked meaningful differences between original subcategories, limiting our ability to detect nuanced relationships, among these demographic factors and food security outcomes. However, we chose not to merge categories for employment status (e.g., full-time, part-time, unemployed) because preliminary analysis showed that these groups experienced food insecurity differently. Additionally, combining full-time and part-time employed categories did not make any change to model fit or meet the proportional odds assumption, and thus were not justified statistically.

Even if there was no significant multicollinearity, the overlap between coping strategies and food planning and shopping routines might have affected the interpretability of individual predictor effects.

While acknowledging certain methodological limitations, this research offers a roadmap for institutions seeking to implement more responsive and tailored support systems. These findings offer a framework for strengthening resource management skills, knowledge, and practices among vulnerable student populations, ultimately addressing food insecurity through evidence-based interventions. Overall, this study addresses a significant gap in literature by looking at the relationship between food security and modifiable factors such as financial behavior, food planning and shopping routines, and financial literacy, providing insights for developing more targeted interventions. Future research should consider integrating qualitative methods to better understand the contextual factors influencing financial behavior and food planning and shopping routines within the unique setting of college life. Given the association between food waste and food insecurity, future interventional studies focusing on food waste to address food insecurity in college students should be conducted. Future interventions should focus on not only the utilization aspect of food security but also access to resources when conducting programs targeting students experiencing food insecurity.

Chapter 6: Discussion

6.1. Summary of Findings

Food insecurity affects 20 to 50% of US college students, which is significantly higher than the national average of 12.8%, with significant impacts on students' physical health, mental well-being, and academic performance.[3–5,13] Despite its prevalence, several important research gaps remain unaddressed. For instance, some studies suggest current USDA household food security survey modules may not fully capture the unique and nuanced experiences of college students, although it has been widely used with college students. Additionally, depending on which version of the USDA survey modules is used, food insecurity estimates can vary more widely, ranging from 10% to 75%.[3] Furthermore, there is limited understanding of the long-term effects of food insecurity in this population, as well as a lack of evidence-based solutions and targeted policies to address it.[9,10]

Tackling food insecurity on college campuses requires urgent, multi-faceted research efforts. One of the key starting points is gaining a deeper understanding of the coping behaviors used by the most vulnerable food-secure students. Additionally, identifying modifiable gaps in population-specific knowledge, skills, budgeting, and management practices related to food insecurity is essential for effectively addressing this growing issue.

This study aimed to address key gaps in literature by examining the coping strategies adopted by food-insecure college students, particularly how these strategies vary by food insecurity severity- and by exploring how general resource management behaviors including food planning and shopping routines, food literacy and financial behavior, are associated with food security levels.

In this study, we found that students experiencing very low food security applied all coping strategies significantly more frequently than those with low food security, who in turn used these strategies more frequently than food-secure students. This pattern aligns with previous studies.[51,74,75] As food insecurity worsened, students not only increased the frequency of their coping strategies but also progressed to more extreme measures. Initially, food-insecure groups relied on strategies such as asking friends and family for food or money to buy food, buying the cheapest food available, avoiding expensive foods such as fruit and vegetables, eating at places in which you pay what you can and eating as much as possible when food is available. However, as food insecurity worsens, students reported reliance on extreme coping strategies such as choosing between food and essential expenses (rent, utilities, medicine), implementing stricter food shopping budgets resulting in limited diet variety, selling personal possessions to buy food, and stretching food to last longer. The present finding suggests that certain coping strategies employed specifically by very low food secure students could serve as more sensitive indicators for identifying students in urgent need, potentially offering greater precision than current USDA food insecurity assessment modules.

These coping strategies may compromise diet quality leading to increased health risks such as obesity which is reported to be higher in food-insecure students.[1,29,31,36] The financial strain these students are experiencing, along with their lower diet quality, can also lead to reduced energy levels and difficulty concentrating, ultimately impacting their academic performance among food-insecure college students.[25,38–41] Understanding these behaviors can aid in identifying students experiencing very low food security who are most in need of immediate support, laying the groundwork for developing a food security assessment tool more tailored to college students that

could better identify and prioritize very low food secure students than existing USDA food security survey instruments.

In the present study, food-insecure students were significantly more likely to obtain food from food banks or pantries compared to their food-secure counterparts. Although these food assistance resources were more frequently utilized by food-insecure groups, the findings suggest these critical support systems remain underutilized among food-insecure students overall, consistent with previous studies.[47] Understanding potential barriers and designing interventional studies to improve the accessibility and utilization of food pantries and food banks is a potential area of addressing food insecurity among college students.

In this study, financial behavior such as day-to-day money management, and financial planning was found to be a significant predictor of food insecurity, with students exhibiting higher financial behavior scores more likely to experience higher levels of food insecurity. This finding contradicts studies in the general population which associate higher financial literacy with lower food insecurity risk.[85,86] This may be due to the fact that our study's focus on immediate financial management, such as day-to-day budgeting and coping with financial emergencies, may not capture the long-term financial planning skills assessed in studies focusing on financial literacy, which often included complex concepts like inflation and investment returns.[85] It is also possible that the unique financial pressures faced by college students, such as high tuition costs and limited income, may lead to distinct financial behaviors compared to the general population. Future research should consider incorporating more detailed measures of financial literacy and explore the contextual factors that influence financial behavior in this population as it can be a potential area of intervention to address food insecurity among college students.

This study also revealed that very low food secure students demonstrated higher food planning and shopping routines, contradicting both our initial hypothesis and patterns observed in the general population.[81,82] This unexpected finding may indicate that food-insecure college students, facing daily resource constraints, have developed adaptive food management strategies to maximize limited resources. These strategies, while potentially effective in mitigating immediate hunger, might not fully address the underlying causes of food insecurity, such as financial limitations or access barriers. Considering that it is a potential area of intervention, further investigation is needed to determine the relationship between food planning and shopping routines and food security in this population, accounting for potential confounding factors and the specific context of college life.

Furthermore, this study revealed that food insecure students were also more likely to throw away food based on "best by," "sell by," and "use by" dates on the food label passes. This finding is similar to previous studies in the general population which found food waste as a significant concern compromising food security worldwide.[83,84] The association between food waste and food insecurity was observed in our bivariate analysis, suggesting that misinterpreted date labeling may contribute to food waste that worsens food insecurity. However, when incorporated into our ordinal logistic regression model, food waste did not emerge as a significant predictor of food security levels, indicating a more complex relationship that warrants further investigation.

Additionally, this study found an inverse relationship between food literacy and food security levels among college students. Food literacy did not emerge as a significant predictor of food insecurity in our ordinal logistic regression model. This finding aligns with previous research findings demonstrating that significant improvements in cooking skills and food preparation abilities didn't translate to meaningful improvement in food insecurity indicator.[59]

6.2. Limitations and Strengths of the Study

This research has several limitations. First, this study was conducted on undergraduate students in 4-year colleges in the Maryland area. As a result, findings from this study may not be generalizable to graduate students or students in other regions, who may experience food insecurity differently due to socio-demographic and campus resources and so on.

Secondly, this study is a cross-sectional study, and causal relationships can't be established. Even if we observe certain associations between financial behavior, food waste, food planning and shopping routines, we cannot determine the direction of this relationship and whether there is a causal relationship.

Thirdly, there is a selection bias in this study as food insecure college students were oversampled to allow robust comparison between food secure and insecure groups. As a result, the prevalence of food insecurity identified in this study may not reflect the prevalence of food insecurity in the general college student population and caution should be used when generalizing these findings.

Fourthly, the study's ordinal logistic regression model encountered challenges due to sparse data in some categories, particularly for demographics such as race, employment status, and financial aid recipient status. To overcome this challenge, we had to merge categories for certain variables such as race to ensure adequate cell sizes for ordinal logistic regression. While this approach helped stabilize the model, it may have obscured differences between subcategories. However, we chose not to merge categories for employment status (e.g., full-time, part-time, unemployed) because preliminary analysis showed that these groups experienced food insecurity differently. Additionally, combining full-time and part-time employed categories did not make any

change to model fit or meet the proportional odds assumption, and thus were not justified statistically.

Lastly, even if there was no significant multicollinearity, there may have been conceptual overlaps between coping strategies and food planning and shopping routines. This overlap might have affected the interpretability of individual predictor effects.

However, this research also has many strengths. It addresses a significant gap in the literature by mapping the progression of coping strategies across different levels of food insecurity, providing insights for developing more context-specific measurement tools to capture the nuanced experiences of college students such as their unique food access challenges, or coping strategies and targeted interventions. By examining the spectrum of food insecurity rather than using a binary secure/insecure comparison, we revealed how students' adaptive behaviors evolve as their circumstances change.

To the best of our knowledge, this is also the first study to focus on examining the utilization dimension of food insecurity among college students as a potential area of intervention. We simultaneously examined the relationship between food literacy, food planning and shopping routines, and financial behavior which are interrelated concepts but usually studied separately. By doing so the study tried to identify potential areas of intervention to address food insecurity among college students.

6.3. Conclusion

In conclusion, this study found that food insecurity is a concerning issue among college students. College students tend to apply coping strategies more frequently and apply more extreme coping strategies such as making trade-offs between paying for food and other expenses and stretching food to last longer as food insecurity worsens. Our study also tried to address significant

knowledge gaps by looking at the association between food security and financial behavior, food literacy, and food planning/shopping routines.

Future research should focus on developing a tailored assessment tool to measure the specific magnitude and severity of food insecurity among college students. Studies should also focus on the evaluation of interventions targeting food management practice, food literacy, and food waste reduction as strategies to address campus food insecurity. Additionally, qualitative research is needed to explore the contextual factors influencing financial behavior and food planning and shopping routines within the unique college environment, potentially revealing new intervention opportunities for addressing student food insecurity.

Appendix

Appendix 1: Questionnaire

A. Demographic Survey

A.1. What is your age?

A.2. What is your gender?
- a. Female
- b. Male
- c. Other (specify) _____
- d. Rather not say

A.3. What is your marital status?
- a. Single or never married
- b. Married or domestic partner
- c. Separated
- d. Divorced
- e. Other (specify)_____

A.4. What is your ethnicity?
- a. Hispanic
- b. Non-hispanic

A.5. What is your race?
- a. White
- b. Black or African American
- c. Asian
- d. Native American or American Indian
- e. Other (specify)_____

A.6. What is your current level of study?
- a. Freshman
- b. Sophomore
- c. Junior
- d. Senior

A.7. Are you a first generation college student?
- a. Yes
- b. No

A.8. What is your current employment status?
- a. Employed full-time
- b. Employed part-time

c. Unemployed
d. Other (specify) _____

A.9. Where do you currently reside during the academic year?
a. On-campus (dormitory)
b. Off-campus with family
c. Off-campus alone / with roommates
d. Other specify _____

A.10. Do you have a campus meal plan?
a. Yes
b. No
c. Don't know

A.11. Are you currently receiving any of the following forms of financial assistance? (Select all that apply)
a. Pell grant
b. Need-based scholarships
c. Other financial aid, specify _____
d. I am not receiving any financial assistance

B. 10-item Food Insecurity Survey Questionnaire

B.1. In the last 12 months, (I/We) worried whether (my/our) food would run out before (I/we) got money to buy more.
a. Often true
b. Sometimes true
c. Never true
d. Don't know or refuse

B.2. In the last 12 months, the food that (I/we) bought just didn't last, and (I/we) didn't have money to get more.
a. Often true
b. Sometimes true
c. Never true
d. Don't know or refuse

B.3. In the last 12 months, (I/we) couldn't afford to eat balanced meals.
a. Often true
b. Sometimes true
c. Never true
d. Don't know or refuse

B.4. In the last 12 months, since last (name of current month), did (you/you or other adults in your household) ever cut the size of your meals or skip meals because there wasn't enough money for food?

a. Yes
b. No
c. Don’t know

B.5. If yes to the above questions, how often did this happen?
a. Almost every month
b. Some months but not every month
c. Only 1 or 2 months
d. Don’t know or refuse

B.6. In the last 12 months, have you ever eat less than you felt you should because there wasn't enough money for food?
a. Yes
b. No
c. Don’t know or refuse

B.7. In the last 12 months, were you ever hungry but didn't eat because there wasn't enough money for food?
a. Yes
b. No
c. Don’t know or refuse

B.8. In the last 12 months, did you lose weight because there wasn't enough money for food?
a. Yes
b. No
c. Don’t know or refuse

B.9. In the last 12 months, have (you or other adults in your household) ever not eat for a whole day because there wasn't enough money for food?
a. Yes
b. No
c. Don’t know or refuse

B.10. If yes to the above question, how often did this happen?
a. Almost every month
b. Some months but not every month
c. In only 1 or 2 months?
d. Don’t know or refuse

C. Food Literacy

Food Literacy Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

C.1. I make a list of items I need to buy before grocery shopping					
C.2. I can understand the food labeling in packages of processed foods					
C.3. When purchasing processed food, I check food information (ingredients, nutrition facts).					
C.4. I check the country of origin when purchasing food					
C.5. I know how to separate and store ingredients that I cannot consume immediately.					
C.6. I can follow a simple recipe.					
C.7. I can prepare a meal without difficulty.					
C.8. I wash my hands thoroughly before cooking.					
C.9. I know how to store food in a refrigerator, or at room temperature which can affect freshness and safety.					
C.10. I check the cleanliness of restaurants when eating out.					
C.11. I can understand information related to food safety issues in the media.					
C.12. I can judge critically about the food advertisement content, especially the health claims.					
C.13. Cooking is enjoyable.					
C.14. When eating, I fully concentrate on eating.					
C.15. When eating, I savor various senses such as visual beauty, aroma, taste, and texture.					

C.16. I am grateful for the process that has allowed the food to come to the table.					
C.17. I like to eat or share food with my family, friends, and neighbors.					
C.18. I enjoy talking about food with people around me.					
C.19. I am interested in food from various cultures.					
C.20. Enjoying traditional food can help protect our cultural identity.					
C.21. I know why choosing seasonal food is good for the environment.					
C.22. I think food that is directly traded with producers is more reliable.					
C.23. I think choosing organic products is important for environmental conservation.					
C.24. I think rural farmers are important for a sustainable society.					
C.25. I am interested in urban agriculture (such as city gardening, weekend farming, etc.).					
C.26. It is important to consider animal welfare when purchasing meat and eggs.					
C.27. I know why it is better to choose fair-trade products.					
C.28. I believe that reducing meat and promoting vegetarianism helps slow climate change.					
C.29. I try to reduce food waste.					
C.30. I try to reduce food packaging waste (take-out drinks, delivery foods, etc.).					

C.31. I think everyone should have access to quality food regardless of economic circumstances.					

D. Food Management Behavior

Please tell us which of the following you usually do:	Every time	Very often	Sometimes	Rarely	Never
D.1. Plan and prepare meals ahead?					
D.2. Shop with a grocery list?					
D.3. Compare prices before you buy food?					
D.4. Buy food in season to save money?					
D.5. Buy cheaper cuts of meat to save money?					
D.6. Buy larger quantities of food products than needed before your next shop (bulk buying) (e.g. rice, flour, pasta, etc…)					
D.7. Use leftovers to create another meal?					
D.8. Throw away food if 'Best by' date on the food label passes?					
D.9. Throw away food if 'Use by' date on the food label passes?					
D.10. Throw away food if 'Sell by' date on the food label passes?					
D.11. Balance meals based on nutrition advice on what is healthy?					

E. Coping Strategies

Hunger Coping Strategies - Trade-offs and Financial Coping Strategies

Have you ever…	Never	Rarely	Sometimes	Often	Always
E.1. Choose between paying for food and paying for rent					
E.2. Choose between paying for food and paying for utilities					
E.3. Choose between paying for food and paying for textbooks and tuition or other education expenses					
E.4. Choose between paying for food and paying for transportation					
E.5. Choose between paying for food and paying for medicine					
E.6. Asked friends and family for food or money for food					
E.7. Skipped paying bills to buy food					
E.8. Bought the cheapest food available					
E.9. Avoided buying expensive foods like FVs					
E.10. Log extra hours at work to afford food					
E.11. Employed strict budgets for food shopping, resulting in diets with limited variety? (McGuire et al 2023)					
E.12. Resorted to sleeping as a strategy to avoid feelings of hunger					

Food Acquisition and Food Management Practice Subscale

Over the past 12 months, how frequently have you applied the following	Often	Sometimes	Never
Food acquisition practice subscale			
E.13. Attended functions in which there was free food			
E.14. Obtained food from food bank or pantry			
E.15. Participated in a food assistance program (eg, SNAP, WIC)			
E.16. Ate meals at places in which you pay what you can			
E.17. Took fewer classes to have more money for food			
E.18. Sold personal possession to buy food			
Food management practice subscale			
E.19. Eaten as much as possible when food is available			
E.20. Ate less healthy meals to eat more food			
E.21. Stretched food to last longer			
E.22. Avoided having guests to avoid serving food			

F. Financial Behaviour

Have you ever…	Always	Most of the times	Sometimes	Hardly ever	Never
F.1. I tend to buy things even when I can't really afford them					
F.2. I always begin saving well in advance for Big event such as Christmas, Eid, etc					
F.3. I avoid spending more money than I have					
F.4. I save money for a rainy day					
F.5. I have little or no difficulty managing my money					
F.6. I have a weekly (or monthly) budget that I follow					
F.7. I regularly set aside money each month for savings					
F.8. I read to increase my financial knowledge					
F.9. Before decided to buy, I collect information about different products/services in more than one company, in order to compare them					
F.10. I make complaint if I had been sold a product that was clearly unsuitable for my needs.					

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