FINDING-Food: Frequent Informational Nudges Directing Individuals to Needed Goods.

A Food Insecurity Intervention.

by

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ABSTRACT

Food insecurity is an economic and social condition involving limited or uncertain access to food. The problem of food insecurity in communities is influenced by economic conditions, food deserts, and barriers to accessing healthy food. Individuals experiencing food insecurity often endure concurrent problems of financial instability, hunger, and poor mental and physical health. Public and non-profit services in the U.S., such as the federally supported Supplemental Nutrition Assistance Program (SNAP) and community food banks, provide food-related assistance to individuals who are at a high risk of experiencing food insecurity. Unfortunately, many individuals who qualify for these services still experience food insecurity due to barriers preventing them from accessing food, which may include inadequate finances, transportation, skills, and information. Effective approaches for removing barriers that prevent individuals from accessing food are needed to mitigate the increased risk of hunger, nutritional deficiencies, and chronic disease among vulnerable populations. This dissertation tested a novel food insecurity intervention using informational nudges to promote food security through the elimination of information barriers to accessing food. The intervention used in this mixed-methods feasibility study consisted of informational nudges in the form of weekly text messages that were sent to food pantry clients experiencing food insecurity. The study aims were to test the efficacy and acceptability of the intervention by examining whether the informational nudges could enhance food pantry utilization, increase SNAP registration, and promote food security. Quantitative study results showed a lower prevalence of food insecurity in the intervention group than the control group. Qualitative findings revealed how the intervention group found the text messages to be helpful and informative. These study findings can enhance future food insecurity interventions aiming to eliminate barriers that prevent individuals who are food insecure from accessing healthy food.

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CHAPTER 1

INTRODUCTION

Food insecurity is an economic and social condition that involves individuals having limited or uncertain access to healthy food.[1] According to the United States Department of Agriculture (USDA), there are four ranges of food security, including high food security, marginal food security, low food security, and very low food security.[1] High food security involves no problems or limitations accessing food. Marginal food security entails minor concern over food insufficiency with minimal indication of altered food intake. Low food security consists of reduced quality and variety of diet with minimal indication of reduced food intake. Very low food security includes numerous indications of disrupted eating patterns that may involve diminished quality of diet, reduced food intake, and an increased risk of experiencing hunger. Individuals and households experiencing high food security or marginal food security are considered to be food secure, while those experiencing low food security or very low food security are identified as food insecure.[1]

The Economic Research Service (ERS) of the USDA began the process of identifying and measuring food security in the 1990's as a part of the U.S. Food Security Measurement Project.[2] This project was a product of the National Nutrition Monitoring and Related Research Act of 1990 (NNMRR),[3] which was passed by the 101st Congress of the United States to carry out three objectives: 1) create a National Nutrition Monitoring Advisory Council, 2) establish the National Nutrition Monitoring and Related Research Program, and 3) publish dietary guidelines for the U.S. general public that provide information and instruction concerning healthy foods and eating behaviors. The Ten-Year Comprehensive Plan that resulted from the NNMRR included a

recommendation to develop “a standardized mechanism and instrument(s) for defining and obtaining data on the prevalence of ‘food insecurity’ or ‘food insufficiency’ in the United States”.[3] After performing cognitive assessments and field tests of a conceptualized food security questionnaire, the U.S. Census Bureau then proceeded to administer the questionnaire as a supplement to the Current Population Survey of 1995.[4] A few years later in 1998, the ERS assumed responsibility for administering the Census Bureau’s food security survey and subsequently coordinating both the data analyses and reporting of study results for USDA research on food security and food security measurement.[5]

Since food security first started being measured among U.S. households in 1995, the prevalence of food insecurity in the U.S. was lowest in 1999[6] at 9.7 percent of households and highest in 2011[7] at 14.9 percent of households.[8] During the Great Recession, the largest ever single-year increase in household food insecurity prevalence was observed in the U.S., as the incidence of food insecurity swelled from 11.1 percent of households in 2007[9] to 14.6 percent of households in 2008.[8,10] After peaking in 2011, the prevalence of household food insecurity in the U.S. has declined during the past nine years for which data are available.[8] In 2021, 10.2 percent of U.S. households were food insecure.[11] Of these households, 3.9 percent experienced very low food security and endured an involuntary decrease in both the quality and quantity of food intake.[11]

Food insecurity is associated with a host of unhealthy behaviors and poor physical health outcomes. Given that food insecurity disrupts eating patterns, diet-related problems that are correlated with food insecurity can consist of nutritional deficiencies[12] and metabolic syndrome.[13] Food insecurity increased the odds of behaviors that are detrimental to physical health, which include disordered eating

behaviors,[14] physical inactivity,[15] smoking cigarettes,[16] risky sex,[17] and alcohol and drug abuse.[16-18] Physical ailments related to food insecurity can also involve poor sleep quality,[19] cognitive impairment,[20] obesity,[21] high blood pressure,[22] and inflammation.[23] Individuals experiencing food insecurity are also at an increased risk of developing various chronic diseases including type-2 diabetes,[24] cardiovascular disease,[25] and cancer.[26]

The health risks associated with food insecurity are multifaceted in posing health hazards that expand beyond the physiological realm. Individuals experiencing food insecurity are also at a greater risk of numerous mental health problems.[27] Food insecurity increases the likelihood of individuals experiencing high stress levels,[28] anxiety,[29] depression,[30] and suicidal behaviors.[27] Related markers of poor mental health that are linked to food insecurity involve poor coping skills,[31] social isolation,[28] stigma,[32] hopelessness,[33] and addiction.[34] Potentially unpreventable risk factors of poor mental health related to food insecurity include adverse childhood experiences,[35] generational poverty,[36] abuse (i.e., physical, psychological, sexual),[37,38] interpersonal violence,[39] trauma,[40] and the death of a loved one.[41] Certain preventable risk factors of poor mental health that are associated with food insecurity involve physical inactivity,[15] disordered eating behaviors,[14] and poor sleep quality.[19]

Adverse effects that food insecurity experiences impose on people can span far beyond the health spectrum. Myriad social factors contribute to or may be an outcome of the problem of food insecurity in the U.S. Socioeconomic factors that predict food insecurity involve various forms of financial hardship including unemployment,[42] earning a low-income, competing expenses,[43] high food prices,[42] and inflation.[42] Environmental factors that are associated with food insecurity involve the presence of food deserts,[44]

neighborhood safety and walkability,[45] housing instability,[46] and houselessness.[47] Sociocultural factors related to food insecurity include food procurement and preparation skill deficiencies,[48] a lack of information about how to obtain affordable food,[49-52] food waste practices,[53] low financial literacy,[54] unreliable transportation,[55] and low social support among family and friends.[56] Moreover, sociopolitical factors contributing to food insecurity include an insufficient breadth of food service programs[57] and other government policy shortcomings.[58] Overall, the aforementioned consequences of food insecurity concerning outcomes relating to physical health, mental health, and social wellbeing present vulnerable individuals with an array of additional burdens that exacerbate the cooccurring problems contributing to their food insecurity.

Not all people in the U.S. experience food insecurity the same way, as these experiences vary across people groups.[59] Stark age,[59] gender,[60] income,[59] and racial and ethnic[61] disparities exist regarding the prevalence and severity of food insecurity. Working-age middle adults (ages 35–64) encounter higher rates of food insecurity compared to young adults (ages 18–34) and older adults (ages 65+).[59] Females have a greater risk of experiencing food insecurity, as it is more common for females to be single parents[62] and they typically earn a lower income than men.[63] Income disparities are arguably the most pronounced since food insecurity experiences are often resultant of financial hardship which places individuals and households classified as low-income or below the poverty line among those most likely to be food insecure.[64] Racial and ethnic disparities also exist, as there has historically been a higher prevalence of food insecurity among individuals who are Black, Indigenous, and People of Color compared to their White counterparts.[65] Other disparities that persist concerning food insecurity in the U.S. include college students being at a greater risk than non-college students,[66]

immigrants being at a greater risk than non-immigrants,[65] and individuals who are houseless being at a greater risk than individuals with a home.[47] Given the many population-based disparities as it relates to food insecurity, there is an obvious lack of health equity as it relates to food insecurity and chronic disease across the various people groups within the U.S.[67]

Current government, non-profit, and grassroots programs in the U.S. that are aiming to promote food security operate with the purpose of reaching individuals experiencing food insecurity to provide them with necessary food assistance. A few relevant programs that have been designed and implemented to promote food security among adults with or without children include the Supplemental Nutrition Assistance Program (SNAP); the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC); The Emergency Food Assistance Program (TEFAP); food banks; and community gardens. SNAP, previously referred to as the Food Stamp Program, is a U.S. federal government program managed by the Food and Nutrition Service of the USDA that provides individuals and families with income-based food assistance.[68] People enrolled in SNAP receive monthly financial benefits through an electronic benefits transfer (EBT) card, which allows them to purchase select food and drink items from participating businesses.[69] SNAP recipients are permitted to purchase fruits, vegetables, meat, dairy products, breads, cereals, snacks, and even seeds and plants for to be cultivated for food production.[70] Obtaining regular access to SNAP benefits can yield meaningful food security improvements among vulnerable individuals by providing them with consistent access to a sufficient quantity and quality of food.[71]

Being eligible to receive SNAP benefits requires that a household's gross income be less than 130 percent of the federal poverty threshold for the household size with net

income being less than 100 percent of the poverty threshold.[72] Work requirements to qualify for SNAP benefits expect people aged 16 to 59 to work at least 30 hours a week with exceptions for students, caregivers, people living with disability, and people in drug rehabilitation.[72] Adults aged 18 to 49 who are not pregnant and do not have dependents under the age of 18 living in the household are required to work at least 80 hours per month.[72] Although, state governments may waive work requirements in high unemployment areas to increase access for individuals who need food assistance the most. Individuals who are ineligible for SNAP benefits but otherwise may need food assistance include full-time college students and undocumented immigrants, while non-citizen adults must have lived in the U.S. for at least five years or be receiving disability-related assistance.[73] A recent research report published during the COVID-19 pandemic highlighted an increased rate of food insecurity accompanied by stagnant SNAP participation among low-income U.S. households.[74] Authors of this report also admonished food assistance program representatives to facilitate SNAP participation among the most vulnerable populations.[74] Given the promising potential that SNAP benefits hold for promoting food security among vulnerable people, it is imperative that individuals who are food insecure and eligible for SNAP be identified and informed about their opportunity to obtain steady access to a sufficient amount of healthy food.

TEFAP is another program that provides critical support for people who are experiencing food insecurity.[75] Similar to SNAP, TEFAP is also a federal USDA program administered by the Food and Nutrition Service that provides emergency food assistance to promote food security and improve the diet of individuals and families who are suffering financial hardship. TEFAP is organized to have the federal government purchase food and then allocate it to state, tribal, and local entities based on the amount

of people who are unemployed and the number of people living under the poverty level.[76] The food assistance provided by the U.S. government is then apportioned to partnering agencies (i.e., food bank networks, community action groups), which then distribute the food to smaller local entities (i.e., food pantries, soup kitchens, non-profit organizations) that are located within or near low-income communities with high rates of food insecurity. Local agencies then engage in food security promotion efforts by providing critical food assistance to individuals and families experiencing food insecurity. TEFAP is essential for most food assistance entities to help people experiencing food insecurity, which is why the USDA committed up to $1 billion in 2021 for purchasing food and bolstering food bank infrastructure to prevent food insecurity in low-income communities.[77]

Food banks serve a critical purpose in facilitating the distribution of free food to individuals experiencing food insecurity who otherwise could not afford to purchase enough food to feed themselves or their families.[78] The world's first ever food bank to be established was St. Mary's Food Bank of Phoenix, Arizona.[79] St. Mary's Food Bank was established by John van Hengel in 1977 through a $3,000 loan provided by St. Mary's Basilica of Phoenix in response to a first-person testimony from a mother of 10 children who regularly visited the St. Vincent de Paul soup kitchen and reported that she had been depending on food from grocery store dumpsters to feed her children.[79,80] The concept of food banking was an instant success, as St. Mary's Food Bank distributed 275,000 pounds of food in its initial year.[81] This number has since been multiplied 401 times over, as St. Mary's Food Bank distributed 110,427,114 pounds of food in 2021.[82]

As the number of food banks in the U.S. increased, van Hengel established a national organization to create a network of food banks in 1979, which was originally

named Second Harvest and is now known as Feeding America.[81] As of 2022, Feeding America maintains a network of over 200 food banks that regularly distribute food to over 60,000 food pantries and meal programs across the U.S.[83] Food banks affiliated with Feeding America operate by using a warehouse model to collect and store donated food that is then distributed to intermediaries like food pantries, soup kitchens, and other non-profit organizations on the front line in low-income communities.[84] With the valuable financial support of TEFAP along with regular food donations made by food producers and retailers, and community members, food pantries have potential to play a big role in preventing food insecurity among the most vulnerable individuals and households.

The prevalence of food insecurity among food pantry clients in the U.S. is considerably higher than the general population.[85] Research evidence from studies among individuals experiencing food insecurity suggested that regularly accessing food pantries to obtain food can produce improvements in food security status.[86] Further study findings among individuals experiencing food insecurity have shown that the mere implementation of a food pantry can improve both food security and fruit and vegetable intake over time.[87] A limited variety of food pantry-based food insecurity interventions have been conducted across the U.S.[88] Common barriers to accessing food that individuals experiencing food insecurity encounter include having inadequate finances,[89] transportation,[90] skills,[48] and information.[51] Barriers to accessing food assistance can be categorized as either predisposing access barriers (e.g., skills, information) or enabling access barriers (e.g., finances, transportation).[91] Predisposing access barriers consist of personal characteristics (i.e., age, knowledge, values), while enabling access barriers pertain to financial income, resources, and policies.[91]

Most food pantry-based food insecurity interventions have aimed to eliminate predisposing access barriers to obtaining food by targeting nutrition education[92] and cooking skills.[93] Interventions aiming to improve food security by reducing these barriers have reported successes in alleviating food insecurity through provision of cooking classes,[94] meal recipes,[95] and educational sessions focused on diet and nutrition.[96] Research among individuals experiencing food insecurity has targeted income-related enabling access barriers to obtaining food and found that SNAP participation reduced the prevalence and severity of food insecurity.[97,98] Recent study findings highlighted food pantry use and food insecurity rates being markedly higher among SNAP participants compared to those who do not receive SNAP benefits.[99] People who are food insecure may encounter a separate enabling access barrier of transportation due to living in a food desert or having insufficient means of transport.[90,100,101] Little has been done to address the enabling access barrier of transportation, which can prevent individuals experiencing food insecurity from accessing readily available food.[55,90] One exception is the Meals-on-Wheels program for older adults in the U.S. that has been shown to improve the food security status of vulnerable individuals among the elderly population.[102]

A lack of information is another predisposing barrier to accessing food that individuals experiencing food insecurity may encounter.[51] Informational support is essential for people who are struggling to find and obtain resources to mitigate hardships involving their basic needs.[103] Effectively communicated information about accessible food assistance resources can play a pivotal role in preventing and alleviating food insecurity among vulnerable individuals.[104] People who are food insecure may have nearby access to local resources (i.e., food pantries) where they can obtain food while

not having adequate information about the food assistance that is readily available to them.[51] Study findings have suggested that individuals experiencing food insecurity report having insufficient information about the food pantry location, hours of operation, and whether or not they qualify for this form of food assistance.[52] Information that is vital for vulnerable individuals to access their basic needs can be conveyed by using informational nudges for communicating up-to-date details about beneficial resources.[105] The details that are communicated to individuals through the informational nudges can then guide their decision making so they can access needed goods and services.

The use of informational nudges to influence decision-making and behaviors is informed by nudge theory, a behavioral economics concept embedded in social psychology and behavioral sciences.[106] Nudging has been posited as a form of libertarian paternalism, which is a philosophy that involves guiding the behaviors of people in their best interest while ensuring complete freedom to make their own decisions.[107] In general, nudges are minor modifications in the environment that are easy, non-coercive, and feasible to implement.[108] Nudging has emerged as a popular and useful approach to apply in research interventions aiming to improve health outcomes among various populations.[109] Keeping in mind the nutritional consequences imposed upon people experiencing food insecurity, research interventions using nudges have been shown to improve dietary behaviors among adults.[110]

Informational nudges have been utilized in a recent basic needs insecurity intervention study among college students that used emails to communicate the address and available services at a campus-based resource center.[105] Findings from the study highlighted how services accessed at the resource center (e.g., food pantry, clothing closet, textbook lending) were considerably higher among college students who received

the nudges compared to those who did not.[105] Another recent basic needs insecurity intervention study tested whether informational nudges via text messages communicating available financial support services could increase emergency aid utilization.[111] Study outcomes indicated that the informational nudges contributed to higher emergency aid application rates among individuals who received the text messages compared to those who were not nudged.[111] These findings lend credence to examining the extent to which informational nudges can be leveraged by food pantries to promote food security through communicating relevant details about food pantry operations and food assistance opportunities to vulnerable individuals who are at risk of experiencing food insecurity.

Despite the essential support that food assistance entities (i.e., food pantries) provide to vulnerable populations, systemic improvements are needed to better serve people groups who are at an increased risk of experiencing food insecurity. The purpose of this research study is to identify a feasible and efficacious approach for reducing food insecurity among vulnerable individuals using an informational nudging approach. A primary objective of this study is to test whether informational nudges via text messages can improve the food security status of first-time food pantry clients. The means through which we intend to improve food security will include increasing both food pantry utilization and SNAP registration rates. Therefore, this dissertation will pursue the following study aims: 1) Identify whether food pantry utilization is greater among participants receiving informational nudges; 2) Determine if informational nudges increase SNAP registration rates; and 3) Test the extent to which informational nudges improve food security. Study hypotheses in the same order will include the following: 1) Informational nudges will increase food pantry utilization; 2) Informational nudges will

raise SNAP registration rates; and 3) Informational nudges will improve food security status.

This study will make essential contributions to the nascent knowledge base of food insecurity prevention. Findings derived from this food insecurity intervention study will provide critical insights to be integrated with the evolving approaches being used to promote widespread food security. The impact this research has on the field of food insecurity will occur on multiple levels. A critical knowledge gap will be addressed by lending evidence regarding the use of informational nudges to promote food security. Confirming that this research intervention can improve food security status would generate an opportunity to explore the replication of findings in a scaled intervention by expanding collaboration with organizations that serve individuals experiencing food insecurity. If successful, widespread application of this intervention could result in community-wide improvements in food security by informing adults experiencing food insecurity about when, where, and how they can obtain much-needed food.

CHAPTER 2

REVIEW OF LITERATURE

2.1. Food Insecurity Trends in the United States

The prevalence of food insecurity in the U.S. has varied year-by-year since the USDA began tracking food security. Starting in 1995, when the first USDA report on food security in the U.S. was released, it was estimated that 10.3 percent of households were experiencing food insecurity.[112] As the 1990s progressed from 1995 to 1998, very little change occurred in the prevalence of food insecurity as the rate decreased less than one percent from 10.3 percent of households in 1995 to 10.2 percent of households in 1998.[112] Before the turn of the century in 1999, the prevalence of food insecurity in the U.S. remained practically unchanged at 10.1 percent of households.[6]

Dramatic shifts in the prevalence of food insecurity among U.S. households occurred in the first decade of the 2000s. At the beginning of the new millennium, the prevalence of food insecurity among U.S. households remained stable with a minor increase from 10.1 percent in 1999 to 10.5 percent in 2000.[113] This upward trajectory of increasing food insecurity prevalence continued until 2004 when it was reported that 11.9 percent of households were food insecure.[114] From 2004 to 2006, the rates of household food insecurity in the U.S. steadily decreased from 11.9 percent to 10.9 percent.[115] In 2007, a minimal increase was reported with 11.1 percent of households experiencing food insecurity,[9] which preceded the largest ever single year increase in food insecurity prevalence among U.S. households.

The Great Recession in the U.S. prompted an economic downturn that contributed to a major spike in food insecurity prevalence, as the rates of food insecurity among households increased exponentially by 3.5 percent from 11.1 percent in 2007 to

14.6 percent in 2008.[10] Up until that point in time, the historic and momentous uptick in food insecurity from 2007 to 2008 produced the highest recorded prevalence of food insecure U.S. households. Food insecurity remained pervasive as rates were consistently above 14 percent from 2008 into the 2010s where food insecurity in the U.S. reached its highest ever rate of 14.9 percent in 2011.[7] From the record-breaking year of 2011, the prevalence of household food insecurity made small and gradual decreases while remaining at-or-above 14 percent through 2014.[116-118]

Household food insecurity rates in the U.S. progressively decreased from 2011 to 2019.[8] The steepest one-year decline on record for the prevalence of household food insecurity occurred from 2014 to 2015.[8] This desirable outcome involved a precipitous 1.3 percent decrease in food insecurity that went from 14.0 percent of households in 2014 to 12.7 percent of households in 2015.[119] The rates of household food insecurity remained under 13 percent from 2015 through 2016,[120] and then subsequently dropped below 12 percent from 2017 through 2018.[121,122] As this downward trajectory continued, the prevalence of food insecurity then fell to pre-Great Recession levels in 2019 with 10.5 percent of households being food insecure.[123] The prevalence of food insecurity remained essentially unchanged at 10.2 percent in 2021,[11] which is the most recently reported USDA data for food insecurity among U.S. households.

2.2. Food Insecurity Measurement

In 1992, the USDA began the process of creating an instrument to measure food insecurity by reviewing and compiling existing literature on the subject.[5] Two years later in 1994, the USDA's Food and Nutrition Service convened with the U.S. Department of Health and Human Services' National Center for Health Statistics and held a National Conference on Food Security Measurement and Research.[5] As a result, participating

academics, researchers, and Federal agency staff members established a conceptual foundation to inform the design of a nationally generalizable food insecurity measure. Shortly after in 1995, a food insecurity measure was finalized as a survey questionnaire and then integrated as a supplement to the Current Population Survey (CPS).[5] Survey items from the food insecurity questionnaire that supplemented the CPS in 1995 are the same 18 items within the USDA's U.S. Household Food Security Survey Module (FSSM) that has been ubiquitously utilized in food insecurity research studies to this day.[124] Since 1995, the process of including the 18-item Household FSSM as a supplement to the CPS has continued on an annual basis,[5] which has been a major contributor to the FSSM being considered as a gold-standard for measuring food security in the U.S.[125]

The U.S. Household FSSM is a subjective, experience-based measure asking adult respondents to self-report answers to 10 questions about their own food security experiences and eight questions concerning the food security of any children within their household.[124] Items included in the Household FSSM focus on the following experiences relating to food security: food running out, inability to purchase food, inability to afford healthy food, involuntary food restriction, involuntary fasting, and child hunger.[126] Once a respondent has completed the Household FSSM, each item is graded to produce a total survey score. Total scores on the Household FSSM determine whether the respondent is characterized as experiencing either high food security, marginal food security, low food security, or very low food security.[127]

Variations of the U.S. Household FSSM have been produced by the USDA for purposes involving improved measurement accuracy and reduced respondent burden.[128] The U.S. Adult FSSM is at 10-item adaptation of the Household FSSM that is widely used in research studies measuring food security exclusively among adults.[129] One

advantage of the Adult FSSM includes reduced respondent burden by reducing the survey from 18 items to 10 items through removal of questions pertaining to child food security. A second advantage of the Adult FSSM involves more accurate representation and comparison of food insecurity experiences among adults with and without children. The Six-Item FSSM Short Form is another adaptation of the Household FSSM that is even briefer than the Adult FSSM.[130] Similar to the Adult FSSM, the Six-Item FSSM introduces minimal respondent burden to those completing the survey. A notable downside of the Six-Item FSSM is the decreased measurement precision and reliability since it does not measure the most severe levels of food insecurity.

Few other validated measures of food security exist outside of the USDA's ERS. Another food security measure that is sometimes used in place of the USDA FSSM is the Household Food Insecurity Access Scale (HFIAS),[131] which was a product of the U.S. Agency of International Development's now completed Food and Nutrition Technical Assistance III Project.[132] The HFIAS is an 18-item survey that was created with the intention of being a broadly generalizable measure of food security with capabilities of distinguishing food insecure households from food secure households across various cultures.[133] Items included in the HFIAS focus on the following experiences relating to food security: food running out, inability to obtain food, limited variety of food, involuntary food restriction, involuntary fasting, and hunger.[131] The HFIAS primarily measures the access component of household food insecurity.

A separate lesser known food security measure is the Food Insecurity Experience Scale (FIES).[134] Similar to the FSSM and HFIAS, the FIES is also an experience-based measure of food security. This food security measure was developed by the Food and Agriculture Organization (FAO) of the United Nations in 2014 as a part

of the Gallup World Poll, which is an annual survey among adults from nearly 150 countries.[135] The FIES contains eight questions, which cover the following experiences relating to food insecurity: food running out, inability to afford healthy food, limited variety of food, involuntary food restriction, involuntary fasting, and hunger.[136] In comprising only eight items, the FIES poses minimal respondent burden. Items in the FIES are sequenced to have questions earlier in the survey cover food insecurity of lower severity and questions later in the survey pertain to food insecurity of greater severity.[137] A primary reason that the FAO uses the FIES to measure food security across various countries is to foster valid, reliable, and comparable estimates of the prevalence of food insecurity that are generalizable on a global scale.[135] The FSSM is most frequently used to measure food security among participants sampled from the U.S., which is appropriate given that this measure was designed and validated for the U.S. population.

2.3. Disparities in Food Insecurity among U.S. Adults

2.3.1. Age

Throughout the U.S., disparities in food insecurity prevalence and severity among adults exist across age, sex, and racial/ethnic population groups.[59] Research findings among adults ages 20–65 years old (n = 4,393) suggested that food security status significantly differs by age ($p = 0.007$), as the average age of adults who were food insecure ($M = 39.3$, $SD = 0.7$) was lower than the average age of those who were food secure ($M = 40.7$, $SD = 0.8$).[138] Among nationally representative samples in the U.S., research findings from a study among U.S. adults (n = 287,836) indicated that individuals who were 65 years of age and older were less likely to experience food insecurity compared to those who were ages 20–39 years old or 40–64 years old ($p < 0.0001$), as adults 65 years of age and older were reported to be 39 percent less likely

(OR = 0.61, 95% CI = 0.57, 0.65) to experience food insecurity compared to those between the age of 18–34 years.[59] Another study among a national sample of U.S. adults (n = 74,413) during the COVID-19 pandemic yielded findings that demonstrated an inverse relationship between age and food insecurity (B = -0.004, SE = 0.0001; 95% CI = -0.005, -0.004).[139] These outcomes are supported by separate research among adults across the U.S. (n = 10,368) during the COVID-19 pandemic that found the odds of experiencing food insecurity decrease as people age (OR = 0.98; 95% CI = 0.97, 0.99).[140]

Research findings that highlight the relationship between food insecurity and age in nationally representative samples of U.S. adults have been supported by studies conducted among U.S. adults who are classified as being low-income, as income is a strong predictor of food insecurity. Among a sample of low-income adults in the U.S. (n = 17,866), study findings indicated that very low food security rates were highest among middle age adults ages 35–49 (10.3%) and late-middle age adults ages 50–64 (13%) compared to older adults ages 65–84 (5.1%).[141] Similar evidence from another study among low-income adults in the U.S. (n = 1,478) indicated that the prevalence of low- and very low food security differed across adults who were 18–39 years old (22% low, 33% very low), 40–59 years old (14% low, 30% very low), and 60 years old and older (13% low, 15% very low) ($p < 0.001$).[142]

The inverse relationship between food insecurity and age have been shown to be consistent across regions of the U.S. Outcomes from a study among adults in the southeastern U.S. (n = 366) suggested that middle age adults had a greater likelihood of experiencing food insecurity when compared with older adults (B = 0.68, SE = 0.21; $p < 0.001$).[143] Research among adults in the northeastern U.S. (n = 11,599) yielded results

indicating that the odds of experiencing food insecurity were higher among individuals who were 40–59 years old (OR = 1.23; 95% CI = 1.01, 1.49) and lower among individuals who were either 60–74 years old (OR = 0.49; 95% CI = 0.40, 0.62) or 75 years old or older (OR = 0.20; 95% CI = 0.14, 0.28) in comparison to those who are 18–39 years old.[144] Findings from a study conducted among adults in the southern U.S. (n = 1,803) indicated that the odds of experiencing food insecurity were lower among individuals who were 40–59 years old (OR = 0.60; 95% CI = 0.42, 0.84) and individuals who were 60 years old or older (OR = 0.24; 95% CI = 0.16, 0.36) compared to those who were 18–39 years old.[145] Research among adults in the western U.S. (n = 22,596) yielded results showing that the prevalence of food insecurity was highest among individuals who were 31–44 years old (51%) or 45–65 years old (47%) in comparison to those who were 66 years old or older (20%) ($p < 0.0001$).[24] Contrary to the trend of food insecurity prevalence lessening with age, a study among adults in the southwestern U.S. (n = 425) found that the risk of experiencing food insecurity was greatest among individuals who were 35–44 years old (RR = 1.61; 95% CI = 1.16, 2.24) and 45 years old or older (RR = 1.80; 95% CI = 1.31, 2.47) when compared with those who were younger than 25 years old,[146] which may be explained by the younger individuals still being considered dependents. It has been posited that the reason food insecurity rates in the U.S. are typically lowest among older adults is due to larger quantity of food assistance programs available to the elderly population in comparison to those who are young adults and middle age adults.[59]

2.3.2. Gender

Gender disparities also exist concerning food insecurity experiences among U.S. adults. Findings from a study among adults throughout the U.S. (n = 287,836) indicated

that females had a 23 percent greater odds of being food insecure (OR = 1.23; 95% CI = 1.19, 1.27) in comparison to males.[59] This evidence is supported by separate research among young adults aged 24–34 years old (n = 10,886) determined that there was a higher prevalence of females (13.9%) experiencing food insecurity than males (9.6) ($p < 0.001$).[147] However, discordant findings from a recent study that was conducted among a national sample of U.S. adults (n = 10,368) during the COVID-19 pandemic revealed the odds of experiencing food insecurity were lower among females (OR = 0.80; 95% CI = 0.72, 0.88) in comparison to males.[140]

Across various geographic regions in the U.S., research evidence largely suggests that female adults are at a greater risk of experiencing food insecurity than their male counterparts. A study among households in the midwestern U.S. (n = 2,095) determined that female head of households (39.6%) were more likely to be food insecure when compared with male head of households (30.6%) ($p = 0.025$).[148] Additional research among adults in the midwestern U.S. (n = 2,146) found that females who are Black (OR = 4.25; 95% CI = 2.28, 7.94) or White (OR = 1.93; 95% CI = 1.04, 3.60) had higher odds of experiencing food insecurity compared to males who are White.[149] Results from research among adults in the western U.S. (n = 35,747) indicated that the prevalence of food insecurity was greater among females (38.5%) than males (36.2%) ($p < 0.05$).[150] Factors that have contributed to food insecurity rates in the U.S. being higher among females than males include the greater proportion of single parents being female[62] and the average annual income being lower among females than males.[63]

2.3.3. Race and Ethnicity

The most recent USDA food security data available from 2021 illustrate substantial racial and ethnic disparities in food insecurity, as Black households (20%) and Hispanic households (16%) had a much higher prevalence of household food insecurity compared to White households (7%).[8] Research findings among a national sample of U.S. adults (n = 4,393) suggested that food insecurity significantly varies across racial and ethnic groups including Asians (13.3%), Blacks (33.4%), Hispanics (36%), and Whites (31.7%) ($p < 0.001$).[138] Further results from separate research among a national sample of U.S. adults (n = 287,836) indicated that individuals who are Black (OR = 1.69; CI = 1.62, 1.76) or Hispanic (OR = 1.24; 95% CI = 1.18, 1.30) were at an increased odds of experiencing food insecurity when compared with those who are White.[59] A study among households across the U.S. (n = ~50,000) produced results indicating that the odds of being food insecure is greater among Black (OR = 1.5; 95% CI = 1.4, 1.6) and Hispanic households (OR = 1.5; 95% CI = 1.4, 1.5) in comparison to White households.[151] A recent study conducted among adults throughout the U.S. (n = 10,368) during the COVID-19 pandemic revealed that the odds of experiencing food insecurity were greater among individuals who are Black (OR = 1.8; 95% CI = 1.5, 2.0), Hispanic (OR = 1.3; 95% CI = 1.2, 1.5), or Native American (OR = 1.9; 95% CI = 1.1, 3.4) in comparison to those who are White.[140] These research findings, which were produced among several national samples of U.S. adults, highlight the increased risk of experiencing food insecurity among individuals who are Black or Hispanic in comparison to those who are Asian or White.

The racial and ethnic disparities in food insecurity remain consistent across age groups among U.S. adults. A study among young adults and middle adults in the U.S. (n = 19,990) determined that the prevalence of food insecurity was highest among Black

females (35%) and males (34%) and Hispanic females (30%) and males (26%) in comparison to White females (24%) and males (23%) ($p < 0.05$).[152] Separate research findings among middle adults and older adults in the U.S. (n = 3,871) found similar differences in the prevalence of food insecurity across races and ethnicities ($p < 0.001$), with rates of low food security differing among Hispanic Mexican Americans (25.0%), Hispanic non-Mexican Americans (25.5%), non-Hispanic Blacks (17.8%), non-Hispanic Asians (7.0%), and non-Hispanic Whites (6.3%).[153] Results from a study carried out among a national sample of young adults ages 24–34 in the U.S. (n = 10,886) indicated that individuals who are Black (18.9%) had a greater likelihood of experiencing food insecurity in comparison to those who are Hispanic (10%) or White (10.4%) ($p < 0.001$).[147] Whether it is among U.S. adults who are young or old, the evidence is clear in highlighting how Black and Hispanic individuals are at an elevated risk of food insecurity.

The racial and ethnic disparities in food insecurity that persist in the U.S. are also consistent across specific regions of the country. Results from a study among households in the southern U.S. (n = 367) during the COVID-19 pandemic found that the odds of being food insecure was greater among Black and/or Hispanic households (OR = 4.15; 95% CI = 1.63, 10.53) when compared with White households.[154] Comparable findings were detected among adults in the northeastern U.S. (n = 1,741), which revealed that the prevalence of food insecurity was higher among individuals who are Black (40%) compared to those who are White (31.8%) ($p < 0.005$).[155] A study among households in the midwestern U.S. (n = 2,095) discovered similar differences in the prevalence of food insecurity, as White head of households (29.1%) reported food insecurity less frequently than those who are Black (38.2%), Hispanic (36.7%), Native American (50%) ($p < 0.001$).[148] Likewise, outcomes from research among adults in the

western U.S. (n = 22,596) indicated that the prevalence of food insecurity was greatest among Black females (42%) and males (46%) and Hispanic females (46%) and males (42%) compared to White females (35%) and males (36%) ($p < 0.0001$).[24] The consensus of this amassed evidence for the connection between food insecurity and race/ethnicity is that U.S. adults who are black, indigenous, or people of color (BIPOC) are at the greatest risk of experiencing food insecurity.

Given that the extant literature widely reports food insecurity rates being highest among U.S. adults who are BIPOC and lowest among those who are Asian or White, study findings among adults in the northeastern U.S. (n = 11,599) yielded results indicating that the odds of experiencing food insecurity were lower among individuals who are Asian (OR = 0.39; 95% CI = 0.21, 0.72) when compared with those who are White.[144] The disparity in food insecurity across the racial and ethnic groups of U.S. adults depicts ongoing injustice that has been perpetrated toward people groups who have historically been affected by the negative impacts of systemic racism, income inequality and the resulting economic hardship that brings about food insecurity.

2.3.4. Income

Income disparities may be most evident when it comes to the prevalence and severity of food insecurity. Research among a national sample of U.S. adults who were not experiencing poverty (n = 4,393) yielded results indicating that the prevalence of food security significantly differed by income level ($p < 0.001$), as the group of food insecure participants in the full study sample (n = 1,404) mostly consisted of individuals who had a poverty income ratio of 0–50 percent (16.2%), 50.1–100 percent (29.6%), or 100.1–150% (24.4%) of the federal poverty level compared to those with a poverty income ratio of 150.1–200 percent (11.2%), 200.1–250 percent (7.7%), or 250.1–300%

(4.9%) of the federal poverty level.[138] These differences are reflected in other findings from research among a national sample of U.S. adults (n = 287,836) that detected an inverse relationship between income and food insecurity ($p < 0.0001$) with rates of food insecurity being highest among those with a ratio of income to poverty of <1.00 (41.49%), 1.00–1.99 (33.76%), 2.00–2.99 (20.25%), and lowest among those with a ratio of income to poverty of ≥4.00.[59] Results derived from a study among households across the U.S. (n = ~50,000) that were above or below the poverty level produced results indicating that the odds of experiencing food insecurity were greatest among households below 185 percent of the poverty level (OR = 3.8; 95% CI = 3.7, 3.9) when compared with households above 185 percent of the poverty level.[151] The evidence is overwhelming in accentuating that economic circumstances are a chief predictor of food insecurity.

The 2023 poverty guidelines for the U.S. have varying income thresholds for determining if a household is considered to be low-income, and the threshold increases as the household size grows from one ($14,580), two ($19,720), three ($24,860), four ($30,000), five ($35,140), six ($40,280), seven ($45,420), eight ($50,560), and an extra $5,140 for each additional person.[156] Outcomes from a study among low-income adults in the U.S. (n = 1,874) showed that, among individuals experiencing food insecurity, the prevalence of those who were earning an annual income of $20,000 or less (63%) was greater than those earning $21,000–$40,000 (26%) or ≥$41,000 (11%) ($p < 0.0001$).[157] Separate research conducted among households across all 50 U.S. states (n = 74,413) during the COVID-19 pandemic also detected a positive relationship between low-income household status and food insecurity (B = 0.039, SE = 0.018; 95% CI = 0.003, 0.075).[139] Results from another study among a national sample of U.S. adults (n =

10,368) during the COVID-19 pandemic revealed that the odds of being food insecure were highest among individuals with an annual income of less than $25,000 (OR = 3.0; 95% CI = 2.4, 3.7), $25,000–$35,000 (OR = 2.3; 95% CI = 1.8, 30), or $35,000–$50,000 (OR = 1.9; 95% CI = 1.5, 2.4) in comparison to those with an annual income of $150,000 or greater.[140] Among many individuals who are low-income, food becomes a competing cost in a limited budget, thus contributing to the cumulative burden that accompanies economic hardship.

The inverse relationship between income and food insecurity can vary by geographic region depending on the availability of resources, the cost of living, and the built environment.[158] Results from a study among adults in the northeastern U.S. (n = 11,599) yielded results indicating that the odds of experiencing food insecurity are greater among individuals whose annual income is at 150–200 percent (OR = 2.56; 95% CI = 2.02, 3.23), 100–150 percent (OR = 2.70; 95% CI = 2.16, 3.38), and less than 100 percent (OR = 3.76; 95% CI = 3.03, 4.66) of the federal poverty level when compared with those whose annual income is greater than 200 percent of the federal poverty level.[144] Research among households in the midwestern U.S. (n = 2,095) highlighted that a majority of households earning an annual income of less than $20,000 were food insecure (55.4%), while a majority of households earning $20,000–$34,999 (56.1%), $35,000–$49,999 (65.3%), $50,000–$74,999 (80.4%), or $\geq$$75,000 were food secure ($p < 0.001$).[148]

Another regionally-based study among adults in the midwestern U.S. (n = 2,947) yielded results showing that, among participants with an income of less than 200 percent of the federal poverty level, a significantly higher prevalence were food insecure (60.1%) than food secure (25.5%) ($p < 0.001$).[159] Research conducted among adults in the

southern U.S. (n = 1,803) produced findings indicating that the odds of experiencing food insecurity were greater among individuals who were low-income (OR = 3.57; 95% CI = 2.52, 5.08) compared to those who were not.[145] Further findings from a study among adults in the western U.S. (n = 22,596) depicted the inverse relationship between income and food insecurity through showing that the prevalence of food insecurity was greatest among households with an income less than 50 percent above the federal poverty level (51%), and the prevalence of food insecurity being consistently lower across groups with incomes of 50.1–100 percent (48%), 100.1–130 percent (41%), and >130 percent of the federal poverty level ($p < 0.0001$).[24] With food insecurity largely being an economic issue, this income-related evidence illustrates how individuals in the U.S. who are classified as low-income are at a greater risk of food insecurity.

2.4. Food Insecurity and Health Outcomes among U.S. Adults

2.4.1. Fruit and Vegetable Intake

The USDA's 2020-2025 Dietary Guidelines for Americans recommends that adults consume at least two and one-half cups of vegetables and two cups of fruit per day.[160] A report by the Centers for Disease Control and Prevention has suggested that only one in 10 U.S. adults meet the recommendations for daily fruit and vegetable intake.[161] Research has suggested that the healthy foods which individuals experiencing food insecurity lack access to largely consist of fruits and vegetables,[162] which places these already vulnerable individuals at a greater risk for not meeting daily fruit and vegetable intake recommendations. An inverse relationship between food insecurity and fruit and vegetable access was detected in a study among low-income households in the western U.S. (n = 274), which indicated that food insecurity was associated with lower access to both fruits ($r = -0.36$, $p < 0.001$) and vegetables ($r = -0.29$, $p < 0.001$).[163]

Results from a separate study conducted among adults in the northeastern U.S. (n = 11,599) highlight how a higher proportion of individuals experiencing food insecurity reported that accessing fruits and vegetables was very difficult (7.8%) compared with those who were food secure (1.6%) ($p < 0.001$).[144] The barrier of insufficient access to fruits and vegetables begets the problem of low fruit and vegetable intake.

With an inverse relationship existing between fruit and vegetable access and food insecurity, there is also a similar problem concerning the consumption of fruits and vegetables among individuals experiencing food insecurity. A study among a national sample of U.S. adults (n = 8,129) detected an inverse relationship between food security and vegetable intake ($p < 0.0001$), as vegetable intake was lower among individuals with low food security (RD = 0.94; 95% CI = 0.91, 0.97) and very low food security (RD = 0.88; 95% CI = 0.85, 0.91) in comparison to those with high food security.[164] These findings are reinforced by results from a separate study among adults in the midwestern U.S. (n = 302) that suggest an inverse relationship existed between food insecurity and fruit and vegetable intake ($\beta = -1.22$, SE = 0.43; $p < 0.01$).[165] Comparisons of daily fruit and vegetable servings were made in a study among households in the midwestern U.S. (n = 2,095), which determined that individuals who were food secure consumed more servings of fruits and vegetables per day (M = 3.8, SD = 2.0) than those who were food insecure (M = 3.5, SD = 2.0) ($p < 0.001$),[148] and separate research among adult females in the western U.S. who were experiencing food insecurity (n = 226) produced results indicating that daily servings of fruit and vegetable were lower among individuals who reported hunger (M = 2.86, SE = 2.13) compared to those who reported no hunger (M = 3.77, SE = 2.55) ($p < 0.0001$).[166] These outcomes illustrate how individuals experiencing

food insecurity not only struggle obtaining an adequate quantity of food, but they also face barriers accessing an adequate quality of food in health fruits and vegetables.

Inequity in the quantity of daily fruit and vegetable servings poses diet-related health risks. Evidence from research conducted among food pantry clients in the northeastern U.S. (n = 212) found that the odds of consuming a sufficient amount of fruits and vegetables were greater among individuals who were food secure (OR = 2.3, 95% CI = 1.1, 5.2) compared to those who were food insecure.[167] Related study findings from research among adults in the southern U.S. (n = 1,607) suggest that individuals experiencing food insecurity reported lower vegetable intake (M = 4.36, SE = 0.19) than those who were food secure (M = 5.64, SE = 0.11) (p = 0.02).[168] Separate research among adults in the southern U.S. (n = 5,870) yielded findings that suggested the odds of consuming less than five servings of fruits and vegetables per day was greater among individuals who are food insecure (OR = 1.50; 95% CI = 1.5, 2.15) in comparison to those who are food secure.[169] The only known longitudinal study that has examined the relationship between food insecurity and fruit and vegetable intake was conducted during the COVID-19 pandemic among adults in the midwestern U.S. (n = 484) and determined that the odds of consuming fruits and vegetables decreased among individuals experiencing food insecurity (OR = 0.33; 95% CI = 0.22, 0.50).[170] This cumulative evidence detailing the relationship between food insecurity and fruit and vegetable intake illustrates that individuals who are food insecure not only consume less fruits and vegetables, but they are also more likely to not meet the recommended daily intake of these healthy foods, thus placing them at an increased risk of poor health outcomes.

2.4.2. Disordered Eating Behaviors

Food insecurity experiences have further been found to be associated with unhealthy disordered eating behaviors (DEBs) that include, but are not limited to, involuntary food restriction,[171] dietary restraint,[172] and binge eating.[173] Research among a national sample of U.S. adults (n = 2,914) yielded results indicating that the prevalence of DEBs was greater among individuals who were food insecure (PR = 3.81; 95% CI = 2.26, 6.42) in comparison to those who were food secure.[174] Additional findings from another study among a separate sample of U.S. adults (n = 873) corroborate the positive relationship between food insecurity and DEBs in determining that the odds of bulimia nervosa was greater among individuals experiencing low food security (OR = 2.48; 95% CI = 1.39, 4.42) and very low food security (OR = 3.06; 95% CI = 1.64, 5.70) in comparison to those who were food secure.[175] Expansive findings from cross-sectional research among emerging adults in the U.S. (n = 1,813) indicated that food insecurity was positively associated with unhealthy weight control behaviors (PR = 1.27; 95% CI = 1.15, 1.39), extreme weight control behaviors (PR = 1.49; 95% CI = 1.13, 1.95), chronic dieting (PR = 1.43; 95% CI = 1.07, 1.93), overeating (PR = 1.47; 95% CI = 1.11, 1.96), and binge eating (PR = 1.49; 95% CI = 1.04, 2.12).[176] Longitudinal outcomes from the same study suggested that food insecurity increased the prevalence of binge eating over time (PR = 1.49; 95% CI = 1.04, 2.12).[176] Left unaddressed, food insecurity raises the likelihood of individuals adopting and practicing unhealthy eating behaviors that can give rise to increased disease risks resulting from poor dietary habits.

The positive relationship that has been detected between food insecurity and DEBs has been shown to be consistent across various U.S. regions. Outcomes from research among adults in the northeastern U.S. (n = 248) indicated that a positive link existed between food insecurity and binge eating (β = 0.37; 95% CI = 0.10, 0.72),[177]

while a different study among adults in the northeastern U.S. (n = 369) found a positive correlation between food insecurity and binge eating ($r = 0.14$; $p < 0.01$).[178] Results from research among adults in the midwestern U.S. (n = 720) during the COVID-19 pandemic detected a positive association between food insecurity and DEBs ($\beta = 1.24$; 95% CI = 1.01, 1.53).[179] Research among adults in the southwestern U.S. (n = 82) found that the prevalence of binge eating was more common among individuals experiencing food insecurity in comparison to those who were food secure ($F_{(4,77)} = 7.2$; $p = 0.009$).[180]

A study among adult food pantry clients in the southern U.S. (n = 503) discovered that the prevalence of dietary restraint behaviors were greater among individuals who were food insecure (M = 2.02, SD = 1.27) than those who were food secure (M = 1.59, SD = 1.32) ($p < 0.05$).[181] Separate research also conducted in the southern U.S. (n = 526) yielded results which suggested that DEBs were more severe among individuals who were food insecure (M = 6.92, SD = 5.48) than those who were food secure (M = 4.53, SD = 4.59) ($p < 0.05$).[182] Studies that have examined the relationship between food insecurity and DEBs among adults throughout the U.S. have largely found that DEBs are both more common and of greater severity among individuals who are food insecure. Experiencing food insecurity disrupts healthy eating habits by limiting access to healthy foods like fruits and vegetables. When DEBs are present, food insecurity experiences may hasten the emergence of poor health outcomes by pairing a diet with low nutritional quality with harmful eating habits.

2.4.3. Overweight and Obesity

Despite food insecurity entailing a lack of access to food, a food insecurity and obesity paradox persists among U.S. adults.[183] It has been posited that the food insecurity and obesity phenomenon is resultant of individuals experiencing food

insecurity consuming food that is palatable and high in calories with low nutritional quality.[162,184] Another interpretation of the food insecurity and obesity paradox theorizes that this relationship is the product of resource scarcity, which involves the aforementioned food security barriers of inadequate finances, skills, and information.[183] Alternative explanations of the food insecurity and obesity paradox point to the "food stamp cycle" as a culprit of promoting unhealthy weight gain among low-income individuals experiencing food insecurity, as those receiving food assistance often attempt to stretch their allotted money by purchasing cheaper, less nutritious foods.[185]

The overconsumption of cheap, unhealthy foods that are high in calories and low in nutritional quality is one of many potential explanations for what gives rise to the substantial amount of research evidence supporting the existing food insecurity and obesity paradox. Findings from research among a national sample of U.S. adults (n = 57,462) suggested that individuals who were food insecure had greater odds of obesity (OR = 1.32; 95% CI = 1.17, 1.50) in comparison to those who were food secure.[21] Supporting evidence from a longitudinal study among a national sample of U.S. adults (n = 46,145) confirmed a positive relationship between food insecurity and obesity, as obesity rates were greater among individuals who were food insecure (PR = 41.5; 95% CI = 39.9, 43.0) than those who were food secure (PR = 33.5; 95% CI = 32.7, 34.4).[186] Research among a national sample of low-income U.S. adults (n = 8,333) determined that the prevalence of obesity was greater among individuals who were food insecure (38.4%) in comparison to those who were food secure (33.7%) ($p < 0.001$).[187] Further evidence from the same study details a positive link between obesity and both low food security ($b = 0.04$; $p < 0.05$) and very low food security ($b = 0.05$; $p < 0.05$).[187] It is uncertain whether food insecurity more often precedes obesity, as there tends to be an

blend of factors relating to income, access, and nutrition that contribute to obesity outcomes.

Gender disparities also exist for the food insecurity and obesity paradox.[188] Research among a sample of U.S. adult females (n = 8,169) detected a dose response relationship between food insecurity severity and obesity, as the odds of being obese were greater among females experiencing food insecurity with hunger (OR = 2.81; 95% CI = 1.84, 4.28) and females experiencing food insecurity without hunger (OR = 1.47; 95% CI = 1.07, 1.94) in comparison to those who were food secure.[189] A study conducted among a nationwide sample of young adults in the U.S. (n = 13,720) determined that a greater percentage of females were experiencing food insecurity (14%) than males (9%) ($p < 0.001$).[190] Another study among a national sample of U.S. adults (n = 19,990) yielded similar outcomes showing that the prevalence of obesity was higher among White (OR = 1.41; 95% CI = 1.17, 1.70) and Hispanic (OR = 1.29; 95% CI = 1.04, 1.61) females who were food insecure when compared with White and Hispanic females who were food secure, while no differences in obesity were present among White and Hispanic males regardless of food security status.[152] Further research among a national sample of U.S. adults (n = 8,751) yielded results which suggested that the odds of being obese was greater among females who were food insecure (OR = 1.76; 95% CI = 1.44, 2.15) in comparison to those who were food insecure, yet no differences in obesity were detected for males of varying food security status.[191] Contrasting outcomes from a separate study among a national sample of U.S. adults (n = 8,510) suggested that the prevalence of obesity was greater among females with low food security (B = 10.8, SE = 2.6; $p < 0.01$) when compared with those who were food secure, while, contrarily, the prevalence of being classified as overweight was lower among men

with low food security (B = -8.3, SE = 3.9; $p < 0.05$) compared to those who were food secure.[188] U.S. adult females are more likely to have obesity when experiencing food insecurity compared to their male counterparts, and this disparity places females who are already vulnerable with food insecurity at an increased risk of obesity-related chronic diseases.

Regional study findings across the U.S. tell an identical story concerning the positive link between food insecurity and obesity, while also portraying the same gender disparity where a greater prevalence of females who were food insecure had obesity than males who are food insecure. Evidence from a study among adults in the northeastern U.S. (n = 176) indicated that the odds of being obese were greater among individuals who were food insecure (OR = 2.45; 95% CI = 1.15, 5.25) in comparison to those who were food secure.[192] Separate research among adults in the northeastern U.S. (n = 496) determined that the prevalence of obesity was higher among females who were food insecure (30.6%) than those who were food secure (27.2%) ($p = 0.007$).[193] A study of adults in the midwestern U.S. (n = 808) found that the body mass index (BMI) of females who were food insecure (M = 30.8, SD = 8.1) was higher than those who were food secure (M = 29.1, SD = 7.5) ($p = 0.04$).[194] Outcomes from research among adults in the southern U.S. (n = 1,457) suggested that the prevalence of obesity was greater among individuals who were food insecure (42.3%) when compared with those who were food secure (33.2%) ($p = 0.009$).[195] A study among low-income adults in the western U.S. (n = 35,747) yielded results which suggested that the prevalence of obesity was higher among women (PR = 1.14; 95% CI = 1.04, 1.25) and men (PR = 1.19; 95% CI = 1.04, 1.37) who were food insecure when compared with those who were food secure.[150] Outcomes from the same study indicated that the positive association

between food insecurity and obesity was strongest among males who are either Hispanic (PR = 1.36; 95% CI = 1.17, 1.58) or multiracial (PR = 1.16; 95% CI = 1.07, 1.26) and females who are Hispanic (PR = 1.22; 95% CI = 1.08, 1.38).[150] In having demonstrated a consistently strong relationship with obesity, food insecurity experiences pose additional problems concerning the risk for various chronic diseases being heightened among individuals with insufficient access to healthy food.

2.4.4. Chronic Disease

Food insecurity has been described as one of the leading health and nutrition issues in the U.S.,[67] which is a reality that demands greater attention to preventing chronic diseases through food security promotion. Among a nationally representative sample of U.S. adults (n = 41,854), both low food security and very low food security have been linked to an increased risk of various chronic diseases including hypertension (low $\beta = 0.345$, $p < 0.01$; very low $\beta = 0.641$, $p < 0.01$), coronary heart disease (low $\beta = 0.433$, $p < 0.01$; very low $\beta = 0.761$, $p < 0.01$), hepatitis (low $\beta = 0.305$, $p < 0.01$; very low $\beta = 0.508$, $p < 0.01$), stroke (low $\beta = 0.520$, $p < 0.01$; very low $\beta = 0.784$, $p < 0.01$), cancer (low $\beta = 0.295$, $p < 0.01$; very low $\beta = 0.339$, $p < 0.01$), asthma (low $\beta = 0.431$, $p < 0.01$; very low $\beta = 0.734$, $p < 0.01$), diabetes (low $\beta = 0.363$, $p < 0.01$; very low $\beta = 0.575$, $p < 0.01$), arthritis (low $\beta = 0.500$, $p < 0.01$; very low $\beta = 0.850$, $p < 0.01$), chronic obstructive pulmonary disease (low $\beta = 0.491$, $p < 0.01$; very low $\beta = 0.945$, $p < 0.01$), and kidney disease (low $\beta = 0.496$, $p < 0.01$; very low $\beta = 1.050$, $p < 0.01$).[196] A systematic review exploring the relationship between food insecurity and chronic disease concluded that the prevalence or severity of chronic disease often increases as food insecurity worsens.[197]

A meta-analysis that examined the relationship between food insecurity and type-2 diabetes among adults (n = 55,353,915) determined that food insecurity increased the odds of type-2 diabetes (OR = 1.27; 95% CI = 1.11, 1.42).[198] A more recent meta-analysis evaluated this same relationship among adults (n = 258,250) and yielded contradictory findings that suggested no association between food insecurity and type-2 diabetes (OR = 1.22; 95% CI = 0.96, 1.55).[199] Results from a study among a national sample of U.S. adults (n = 15,199) indicated that individuals who were food insecure had greater odds of diabetes (OR = 1.42; 95% CI = 1.04, 1.92) in comparison to those who were food secure.[200] Another study among a national sample of U.S. adults (n = 27,218) discovered that individuals who were food insecure had greater odds of being prediabetic (OR = 1.39; 95% CI = 1.21, 1.59), living with undiagnosed diabetes (OR = 1.81; 95% CI = 1.37, 2.38), or having already been diagnosed with diabetes (OR = 1.58; 95% CI = 1.29, 1.93).[201] Outcomes from research among a national sample of U.S. adults (n = 30,010) suggested that individuals experiencing either low food security or very low food security were at an increased odds of diabetes (low OR = 1.26, 95% CI = 1.06, 1.51; very low OR = 1.23, 95% CI = 1.02, 1.48), inflammation (low OR = 1.42, 95% CI = 1.21, 1.68; very low OR = 1.74, 95% CI = 1.49, 2.04), and hypertension (low OR = 1.18, 95% CI = 1.04, 1.35; very low OR = 1.42, 95% CI = 1.22, 1.65) when compared with those who were food secure.[202] Heart disease, among several other maladies, is another chronic disease that individuals who are food insecure have a greater risk of suffering from.

Research among a national sample of U.S. adults (n = 13,518) found that individuals with very low food security were at an increased odds of cardiovascular disease risk (OR = 2.36; 95% CI = 1.25, 4.46) when compared with those who were food

secure.[203] A study among a national sample of U.S adults who were obese (n = 9,203) discovered that individuals experiencing food insecurity had increased odds of coronary artery disease (OR = 1.5; 95% CI = 1.1, 2.0) and asthma (OR = 1.3; 95% CI = 1.1, 1.6).[204] Related research among a national sample of low-income adults in the U.S. (n = 5,094) yielded outcomes which suggested that individuals experiencing food insecurity were at an increased risk of hypertension (RR = 1.21; 95% CI = 1.04, 1.41) and diabetes (RR = 1.48; 95% CI = 0.94, 2.32).[205] Findings from a study among a national sample of low-income immigrant adults in the U.S. (n = 15,499) suggested that individuals who were food insecure had greater odds of coronary heart disease (OR = 1.56; $p < 0.01$) and having a heart attack (OR = 2.19; $p = 0.01$).[206]

The positive relationship that has been detected between food insecurity and heart disease among U.S. adults is not restricted to certain regions of the country. Research among adults in the northeastern U.S. (n = 2,066) determined that individuals experiencing food insecurity had a higher risk of cardiovascular disease ($\beta = 2.62$, $p < 0.001$) when compared with those who were food secure.[207] Another study conducted in the northeastern U.S. among adult Latinas (n = 201) determined that individuals experiencing very low food security had greater odds of having type-2 diabetes (OR = 3.33; 95% CI = 1.34, 8.23) in comparison to those who were food secure.[208]Results from a study among adults in the midwestern U.S. (n = 2,935) indicated that individuals who were food insecure had lower odds of good cardiovascular health (OR = 0.53; 95% CI = 0.31, 0.92) in comparison to those who were food secure.[209] A study among adult food pantry clients in the midwestern U.S. (n = 270) found that individuals experiencing food insecurity had increased odds of heart disease (OR = 2.65; 95% CI = 1.05, 6.69) when compared with those who were food secure.[210] Research among adults in the southern

U.S. (n = 1,457) produced results which suggested that individuals who were food insecure had greater odds of high cholesterol (OR = 1.65; 95% CI = 1.02, 2.65), metabolic syndrome (OR = 2.79; 95% CI = 1.42, 5.48), and heart disease (OR = 2.69; 95% CI = 1.51, 4.81).[195]

Research findings among a national sample of young adults in the U.S. (n = 14,786) indicated that individuals who were food insecure had higher odds of hypertension (OR = 1.40; 95% CI = 1.14, 1.72), diabetes (OR = 1.67; 95% CI = 1.18, 2.37), and chronic obstructive pulmonary disease (OR = 1.48; 95% CI = 1.22, 1.80).[211] A separate study among a national sample of U.S. adults (n = 10,455) determined that middle-aged adults old who were experiencing very low food security had a higher risk of cardiovascular disease (PR = 2.38; 95% CI = 1.31, 4.31) compared to those who were food secure.[212] Similar age-related findings among a national sample of older adults in the U.S. (n = 3,552) determined that individuals with either two-to-four (OR = 2.12; 95% CI = 1.45, 3.09) or five-or-more chronic diseases (OR = 3.64; 95% CI = 2.47, 5.37) had greater odds of experiencing food insecurity compared to those with less than two chronic diseases.[213] The extant literature suggests that, regardless of age or socioeconomic status, food insecurity is a risk factor for heart disease. Given the reviewed evidence that has depicted food insecurity as a risk factor for various potentially life-threatening chronic diseases, special emphasis needs to be placed on how the health-related problems associated with food insecurity are not exclusive to just physical health, but also mental health.

2.4.5. Mental Health Problems

Food insecurity among U.S. adults has been implicated as a risk factor for various mental health problems,[214] which include psychological distress,[215] anxiety,[216]

depression,[217] and suicidal ideation.[216] A meta-analysis examining the link between food insecurity and mental health among adults (n = 372,143) yielded results indicating that a positive relationship was present between food insecurity and both stress (OR = 1.34; 95% CI = 1.24, 1.44) and depression (OR = 1.40; 95% CI = 1.30, 1.58) but not anxiety (OR = 1.22; 95% CI = 0.98, 1.52).[217] Research among a national sample of U.S. adults (n = 68,111) found that a higher prevalence of individuals who are food insecure experience psychological distress (23.5%) than those who are food secure (7.7%) ($p < 0.001$).[218]

Research conducted among a national sample of U.S. adults (n = 5,452) detected a dose-response relationship between food insecurity and depression that demonstrated how the odds of depression were greater among individuals experiencing marginal food security (OR = 1.60; 95% CI = 1.27, 2.02), low food security (OR = 1.88; 95% CI = 1.58, 2.24) and very low food security (OR = 3.50; 95% CI = 2.98, 4.12) when compared to those with high food security.[219] Another study among a national sample of U.S. adults (n = 1,965) during the COVID-19 pandemic determined that individuals who were food insecure had a greater prevalence of both anxiety (PR = 2.60; 95% CI = 1.91, 3.55) and depression (PR = 1.71; 95% CI = 1.21, 2.42) when compared with those who were food secure.[220] Research among a national sample of young adults in the U.S. (n = 14,786) determined that individuals who were food insecure had greater odds of depression (OR = 1.67; 95% CI = 1.39, 2.01), anxiety (OR = 1.47; 95% CI = 1.16, 1.87) and suicidal ideation (OR = 2.76; 95% CI = 2.14, 3.55) when compared with those who were food secure.[216] Additional findings from research among a national sample of low-income adults in the U.S. (n = 1,476) during the COVID-19 pandemic suggested that individuals who were food insecure had higher odds of high perceived stress (OR =

10.91; 95% CI = 7.78, 15.30), anxiety (OR = 6.19; 95% CI = 4.51, 8.51), and depression (OR = 7.72; 95% CI = 5.52, 10.80) than those who were food secure.[29] A strong association between food insecurity and poor mental health among U.S. adults is conspicuous. Ambiguity remains in whether it is more common for food insecurity to hinder mental health or if poor mental health decreases food security.

U.S. adults who are parents and enduring household food insecurity are also at risk of poor mental health. Findings from a study among parents in the U.S. (n = 18,456) suggested that the odds of psychological distress were higher among parents experiencing food insecurity for both mothers (OR = 2.6; 95% CI = 1.9, 3.5) and fathers (OR = 4.2; 95% CI = 2.4, 7.3) when compared with those who were food secure.[221] Research among a national sample of mothers in the U.S. (n = 5,306) yielded outcomes indicating that individuals who were food insecure had higher odds of depression (OR = 2.69; 95% CI = 2.33, 3.11) in comparison to those who were food secure.[222] Supporting evidence from a separate study among a national sample of mothers in the U.S. (n = 2,870) found that individuals who were food insecure had greater odds of depression (OR = 2.2; 95% CI = 1.6, 2.9) and anxiety (OR = 2.3; 95% CI = 1.5, 3.6) compared to those who were food secure.[223] Parents whose mental health is exacerbated by food insecurity experiences are faced with overcoming these adverse circumstances all while being responsible for supporting their children.

The inverse relationship between food insecurity and mental health among adults in the U.S. is not excluded to certain regions of the country. Results from a study among adults in the midwestern U.S. (n = 291) indicated that the odds of poor mental health were greater among individuals who were food insecure (OR = 3.2; 95% CI = 1.6, 6.2) when compared with those who were food secure.[224] Longitudinal research conducted

among females in the midwestern U.S. (n = 753) determined that food insecurity worsened depression over time ($\beta = 0.75$; $p < 0.01$).[225] Research among adults in the southern U.S. (n = 1,488) yielded results which suggested that individuals experiencing food insecurity had worse overall mental health scores (M = 46.5, SE = 0.8) in comparison to those who were food secure (M = 53.4, SE = 0.2) ($p < 0.0001$).[226] Research among adults who were experiencing homelessness in the southern U.S (n = 566) detected a positive association between food insecurity and depression ($\beta = 1.52$; $p < 0.001$).[227] With food insecurity having been linked to an array of poor mental and physical health outcomes, there is an urgent need to remove barriers to accessing healthy food that are too often encountered by individuals who are food insecure.

2.5. Barriers to Food Security in the United States

Adults experiencing food insecurity in the U.S. are often confronted with a variety of barriers that prevent them from accessing food. Typical barriers to accessing food that individuals experiencing food insecurity are often confronted with involve having inadequate finances,[89] transportation,[90] skills,[48] stigma,[228] and information.[51] Research conducted among adult food pantry clients in the western U.S. (n = 196) identified, transportation difficulties, inadequate resources, and insufficient information as barriers to accessing food assistance.[229] A study among college students in the southeastern U.S. (n = 899) found that the prevalence of food insecurity was higher among individuals who experienced barriers to accessing a campus food pantry (52%) than those who did not report any barriers (17%) ($p < 0.001$).[52] Outcomes from a mixed-methods study among college students in the U.S. (n = 529) indicated that individuals who were food insecure had greater odds of encountering barriers to accessing local food pantries (OR = 1.94; 95% CI = 1.11, 3.89) in comparison to those who were food secure.[230]

Qualitative findings from the same study highlighted transportation difficulties, insufficient information (e.g., eligibility, location, hours of operation), and both personal and social stigma as barriers to accessing food pantries.[230]

Evidence from a qualitative study among college students in the U.S. (n = 1,328) identified both personal stigma and social stigma as barriers to food security.[228] Results from a study examining racial and ethnic differences in barriers to accessing food among adults in the northeastern U.S. (n = 2,928) indicated that individuals who are White had a greater odds of experiencing personal stigma compared to those who are Asian (OR = 0.23; 95% CI = 0.08, 0.63), Black (OR = 0.27; 95% CI = 0.10, 0.76), or Latino (OR = 0.28; 95% CI = 0.13, 0.64).[231] Qualitative findings from a mixed-methods study among college students in the southeastern U.S. (n = 899) revealed common barriers that prevent individuals experiencing food insecurity from accessing food pantries, two of which included social stigma and insufficient information (e.g., eligibility, location, hours of operation).[52] Further qualitative findings from separate research among volunteers (n = 8) at eight separate food pantry locations indicated that stigma and transportation were perceived as primary barriers preventing individuals experiencing food insecurity from accessing food pantries.[232]

Research among households in the midwestern U.S. (n = 199) determined that food insecure households were more likely to experience transportation difficulties (48% food insecure, 20% food secure; $p < 0.0001$) and competing costs like rent (food insecure 50%, food secure 16%; $p < 0.001$) and utilities (food insecure 32%, food secure 11%; $p = 0.0004$) as barriers to accessing food.[233] Findings from a separate study among adults in the midwestern U.S. (n = 562) suggested a positive association existed between food insecurity and transportation difficulties ($\beta = 0.76$; $p < 0.01$).[101] Further

evidence from research among adults in the midwestern U.S. (n = 575) indicated that individuals experiencing food insecurity had greater odds of encountering transportation difficulties (OR = 3.09; 95% CI = 1.20, 7.97) as a barrier to accessing food.[234] Research among a largely Latino sample of adults in the southern U.S. (n = 460) yielded outcomes which suggested that the risk of food insecurity was over five times greater among individuals with no regular transportation (RR = 5.29; 95% CI = 2.89, 9.70).[55] A study among college students in the southeastern U.S. (n = 320) found that a higher prevalence of individuals experiencing food insecurity reported inadequate financial resources (74% food insecure, 52% food secure; $p < 0.001$) and transportation difficulties (18% food insecure, 6% food secure; $p < 0.001$) as barriers to accessing food when compared to those who are food secure.[235] These findings are supported by qualitative evidence from a study among adults in the southern U.S. (n = 22) along with a study among adults in the southeastern U.S. (n = 18) that both reported transportation difficulties and inadequate financial resources as primary barriers preventing individuals who are food insecure from accessing food.[236,237] Overall, having a lack of transportation presents a substantial barrier to accessing food among individuals who otherwise might have access to adequate information and finances to obtain healthy food.

Possessing adequate knowledge, resources, and skills for food preparation and cooking have also been identified as potential barriers to consuming healthy foods once they are obtained. Research among households in the U.S. (n = 135) determined that food insecure households have fewer cooking utensils (9.9% food insecure, 11.5% food secure; $p = 0.001$), food preparation utensils (10.9% food insecure, 13% food secure; $p < 0.001$), small kitchen appliances (6.3% food insecure, 7.5% food secure; $p = 0.008$), and large kitchen appliances (5.2% food insecure, 5.6% food secure; $p = 0.01$) when

compared with food secure households.[238] Findings across regions of the U.S. yielded outcomes from a study among households in the midwestern U.S. (n = 904) indicated that individuals who were food secure had better resource management skills when compared with those who were food insecure ($p < 0.01$).[239] Research among college students in the midwestern U.S. (n = 226) found that cooking self-efficacy scores were lower among individuals who were food insecure (M = 43.4, SD = 7.1) in comparison to those who were food secure (M = 44.9, SD = 7.2) ($p < 0.05$).[240] Results from an intervention study among adults in the midwestern U.S. (n = 13) detected that a nutrition education program involving lessons on cooking skills decreased food security skills from baseline (M = 7.4; SD = 3.7) to post-training (M = 1.4, SD = 1.8) with a mean score difference of -6.0 (95% CI = -8.5, -3.5).[241] Findings from research among college students in the southeastern U.S. (n = 557) suggested a negative relationship existed between food insecurity and cooking skills ($\beta = -0.09$; 95% CI = -0.14, -0.04).[242] Supporting evidence from a study among college students in the southern U.S. (n = 368) indicated that an inverse relationship existed between food insecurity and cooking skills ($p < 0.02$), as cooking skills worsened across those with high food security (M = 4.1, SD = 0.7), marginal food security (M = 4.0, SD = 0.8), low food security (M = 3.9, SD = 0.6), and very low food security (M = 3.8, SD = 0.8).[243]

Having insufficient information for how to obtain healthy food has also been a barrier to accessing food among individuals experiencing food insecurity who have readily available food assistance resources in their community. Research among young adults in the midwestern U.S. (n = 720) during the COVID-19 pandemic yielded qualitative findings that emphasized insufficient information (e.g., SNAP benefits, food pantry location, and food pantry hours of operation) as a primary barrier preventing

individuals who were food insecure from accessing food.[244] A qualitative study conducted among adults in the northeastern U.S. (n = 121) discovered that insufficient information, transportation difficulties, and poor budgeting skills were frequently reported barriers to accessing food among individuals experiencing food insecurity.[100] Findings from additional qualitative research among low-income adults in the western U.S. (n = 53) highlight a lack of information as a primary barrier that prevented nearly half (47%) of the respondents from obtaining food from a community food pantry.[51] Outcomes from a study examining racial and ethnic differences in barriers to accessing food among adults in the northeastern U.S. (n = 2,928) indicated that Latino adults had greater odds of encountering information barriers involving the location (OR = 2.98; 95% CI = 1.25, 7.10) and hours of operation (OR = 2.82; 95% CI = 1.23, 6.45) of local food pantries in comparison to White adults.[231] There remains a critical need for testing and identifying ways to remove barriers preventing individuals who are food insecure from accessing much needed food assistance.

2.6. Food Insecurity Interventions and Longitudinal Research

2.6.1. Food Pantry-based Food Insecurity Interventions

Food insecurity interventions primarily aim to eliminate barriers preventing vulnerable individuals from obtaining food by increasing access to food assistance resources. A longitudinal study that tracked adults who were obtaining food from traditional (i.e., food banks) or alternative (i.e., community gardens) resources over nine months (n = 450) yielded results which suggested that utilizing food pantries lowered the odds of severe food insecurity (OR = 0.22; 95% CI = 0.10, 0.44).[245] Food pantry-based interventions have been found to improve food security along with outcomes related to dietary behaviors and health.[85,88] A food insecurity intervention conducted among food

pantries examined the extent to which food security could be improved by allowing food pantry clients (n = 233) to choose their own food rather than having it prepackaged for them.[93] Findings from this intervention study suggested greater improvements were observed in the intervention group for both food security score (Intervention = +1.64, Control = +0.65; $p = 0.01$) and fruit and vegetable servings (Intervention = +1.90, Control = -1.40; $p < 0.01$) when compared with the control group.[93]

Further findings from the same intervention in a different study indicated that participants in the intervention group had lower odds of experiencing very low food security (OR = 0.42; 95% CI = 0.24, 0.72) in comparison to the control group.[87] A separate intervention that tested whether cooking classes could improve the food security status of food pantry clients (n = 63) found that intervention group participants had lower food insecurity schools at the six-month post-intervention follow-up (M = 2.07, SD = 2.9) than at baseline (M = 3.2, SD = 36) ($p < 0.01$).[94] Another intervention study among food pantry clients (n = 462) used diabetes-appropriate food boxes and text message-based health education to promote food security, and determined that the intervention reduced the prevalence of food insecurity from 68.8 percent at baseline to 62.5 percent after six months ($\chi^2 = 72.6$; $p < 0.001$).[246] Food insecurity intervention research among military veterans (n = 125) used targeted communication of food pantry services at veteran service organizations in an effort to promote food security among veterans.[96] Outcomes derived from this study suggested that the intervention improved the odds of both adult (OR = 1.10, SE = 0.04; $p = 0.01$) and household (OR = 1.10, SE = 0.04, $p = 0.009$) food security from baseline to post-intervention follow-up.[96] Food insecurity interventions expand beyond food pantries by evaluating the impact of government assistance on food security.

2.6.2. SNAP-related Food Insecurity Interventions and Longitudinal Research

Individuals experiencing food insecurity in the U.S. often qualify for much needed food assistance benefits, like SNAP. Results from a longitudinal study among parents of children who were medical clinic patients in the midwestern U.S. (n = 116) qualitatively describe how one-time communication is likely not a sufficient approach to bolster SNAP enrollment among households experiencing food insecurity, as few parents who were food insecure reported registering for SNAP after being asked by a clinician if they would like to receive assistance enrolling for SNAP.[247] Conflicting qualitative evidence from a similar but separate study conducted in a medical setting found that referring patients who are food insecure to food assistance resources could boost SNAP enrollment.[248]

Longitudinal research among a national sample of U.S. households (n = 65,269) determined that SNAP participation reduced household food insecurity over time (β = -0.582; $p < 0.01$).[249] These findings support additional evidence from a seminal study among a national sample of U.S. adults (n = 2,179) that examined the effect of the food stamp program on food security, and concluded that food stamp program participation could help alleviate food insecurity (β = -3.604; $p < 0.01$).[250] Intervention research among female head-of-households in the midwestern U.S. (n = 219) sought to identify the effect of a food stamp nutrition education program on household food security, which yielded estimates indicating that a greater proportion of the experimental group was food secure (94%) than the control group (84.7%) and a lesser proportion of the experimental group was food insecure (6%) compared to the control group (15.3%) at the end of the intervention ($p = 0.03$).[251]

Longitudinal research among adults who were enrolled in SNAP (n = 1,030) at some point during 2001–2009 found that individuals who remained enrolled in SNAP had lower odds (OR = 0.34; $p < 0.001$) of experiencing very low food security in comparison to those who unenrolled from SNAP during the study.[97] A separate longitudinal study among SNAP recipients (n = 3,375) examined how enrolling in SNAP impacted food security status over time, and determined that the prevalence of household food insecurity had been reduced to 53.9 percent at six-months after SNAP enrollment from 65 percent when those same households had just enrolled in SNAP (D = -11.1, SE = 0.9; $p < 0.01$).[98] Another longitudinal study among a national sample of U.S. adults (n = 470) during the COVID-19 pandemic produced outcomes which suggested that SNAP enrollment among food insecure households was greater during the pandemic (67%) than before the pandemic (62.5%) ($p < 0.01$).[99]

A randomized controlled trial conducted among adults in the midwestern U.S. (n = 575) used an educational program intervention to inform participants about identifying healthy foods and cooking healthy meals.[252] Outcomes from this study indicated that greater improvements occurred in the intervention group for both adult (D = 0.9, SE = 0.3; $p < 0.01$) and household (D = 1.2, SE = 0.4; $p < 0.01$) food security when compared with the no-treatment control group.[252] A randomized controlled trial conducted among households in the southern U.S. (n = 2,202) investigated whether supplementing pre-existing SNAP benefits based on income and distance to grocery store would improve the food insecurity of adults and children in the household.[253] Findings from this intervention suggested that the SNAP supplement did not change the prevalence of food insecurity among adults (treatment = 53.9%, control = 53%; $p = 0.65$) or children (treatment = 37.1%, control = 35.2%; $p = 0.81$).[253]

A separate research intervention among adults in the southwestern U.S. (n = 54) matched participants dollar-for-dollar up to $10 in SNAP dollars spent to purchase fruits and vegetables at farmers' markets, which found that the intervention reduced the study group's average food insecurity scores (Baseline = 3, Follow-Up = 2.3; $p < 0.05$).[254] A separate study among adults in the southwestern U.S. (n = 138) sought to build upon these findings by implementing the same intervention that matched up to $10 in SNAP dollars spent at farmers' markets to purchase fruits and vegetables.[255] Results from this second study suggested that the intervention lowered the prevalence of low food security (Baseline = 36%, Follow-Up = 33%) and very low food security (Baseline = 34%, Follow-Up = 22%) while increasing high and marginal food security (Baseline = 30%, Follow-Up = 45%) ($p = 0.001$).[255] This compiled evidence signifies how beneficial U.S. government food assistance, like SNAP benefits, can be in promoting food security among vulnerable individuals. A variety of other food insecurity interventions have also been tested to address this ongoing problem more thoroughly.

2.6.3. Other Food Insecurity Interventions and Longitudinal Research

An assortment of longitudinal food insecurity studies have either used observational methods to examine the impact of existing food assistance resources on food insecurity or intervention methods to test novel approaches for promoting food security. A meta-analysis of 39 studies (n = 170,605) that examined the effect of interventions to address food insecurity yielded results detailing how interventions offering food assistance (OR = 0.53; 95% CI = 0.33, 0.67) and interventions offering monetary assistance (OR = 0.64; 95% CI = 0.49, 0.84) both reduced the odds of food insecurity.[256] Researchers in a separate study simulated an intervention by using longitudinal data from the CPS to identify whether a combined cash and food benefits

program could reduce food insecurity among a national sample of U.S. adults (n = 28,194), and determined that allocating an additional $1,000 to each participant in the sample would have attenuated the risk of food insecurity (β = -0.011; $p < 0.05$).[257]

Longitudinal research examining the impact of Medicaid expansion on household food security in a national sample of U.S. counties (n = 722) discovered that expanded Medicaid eligibility yielded county-wide reductions in household food insecurity (β = -0.06; p = 0.01).[258] Further results from another longitudinal study which evaluated the effect of Medicaid expansion on the food security status of low-income U.S. adults (n = 41,053) highlight how expanding Medicaid eligibility reduced the prevalence of very low food security (PR = -2.23; 95% CI = -2.25, -2.21).[259] Separate longitudinal research among low-income adults in the midwestern U.S. (n = 443) investigated the impact of periodic payment allocation derived from an earned income tax credit, and found that participants receiving the periodic cash payment intervention experienced decreased food insecurity over time (β = -2.21; p = 0.004).[260]

Another longitudinal study among older adults in the southern U.S. (n = 717) evaluated the extent to which changes in food security status occurred as a result of the Older Americans Act Nutrition Program (OAANP), which is a government program distributing home-delivered meals and meals to be served in group settings (i.e., senior centers, faith-based organizations).[261] Findings from this study emphasize how the odds of achieving food security were greater in nutrition program participants (OR = 1.65; 95% CI = 1.10, 2.48) when compared with those who were on the program waitlist.[261] A similar longitudinal study among older adults in the northeastern U.S. (n = 101) tracked how the home-delivered meals aspect of the OAANP impacted food security status over

time, which yielded results indicating that food insecurity was reduced from baseline to six-months ($D = -0.102$; $p < 0.01$) and baseline to 12-months ($D = -0.154$; $p < 0.01$).[262]

Case-control research involving a natural quasi-experiment among households in the northeastern U.S. (n = 831) focused on the impacts of a new supermarket in a low-income food desert, which detected reductions in food insecurity among households in the neighborhood with the new supermarket in comparison to those from a separate low-income neighborhood that was also located in a food desert ($D = -11.8$; $p < 0.01$).[263] Separate research used a mobile grocery truck to target nutritional outcomes Native American households in the southwestern U.S. (n= 101), and found that the intervention had no effect on household food insecurity prevalence from baseline (57%) to follow-up (43%) ($p = 0.29$).[264] A cluster randomized controlled trial among households with children in the southern U.S. (n = 2,859) sought to identify whether home delivery of a monthly food box containing healthy food could improve food security over the span of 12 months.[265] Results derived from this research suggested that the prevalence of adult ($D = -2.8$; $p = 0.002$) and household ($D = 2.4$; $p = 0.003$) food insecurity at 12-months was lower among participants in the intervention group than to those in the control group.[265]

Another cluster randomized controlled trial among parent-child dyads in the southern U.S. (n = 371) tested the extent to which an educational nutrition program impacted household food insecurity.[266] Results indicated larger decreases in the proportion of food insecure participants within the intervention group at the immediate post-intervention ($D = -0.32$, $SE = -0.07$; $p = 0.002$) and two-year post intervention ($D = -0.49$, $SE = -0.22$; $p < 0.001$) in comparison to those in an active control group that received a different educational program intervention.[266] An intervention study among

parents of young children in the northeastern U.S. (n = 372) examined whether trauma-informed programming could promote household food security through lessons provided to participants that focused on emotional management, financial skills, and social and family dynamics.[267] Findings from this study indicated that participants with full participation in the trauma-informed program had lower odds of household food insecurity (OR = 0.45; 95% CI = 0.22, 0.90) in comparison to those with little-to-no participation.[267] A community-based participatory research project among Hispanic farmworker families in the western U.S. (n = 131) implemented a community gardening intervention involving the provision of seeds for planting and educational sessions on cultivating fruits and vegetables, which resulted in a reduced prevalence of food insecurity among participating families (Baseline = 15.6%, Follow-Up = 3.1%; p = 0.006).[268]

A research intervention among families residing in motel-shelters (n = 33) tested whether rescuing surplus food from colleges could promote household food security, and found a non-significant difference in changes of food security scores existed between the intervention group that received meals and the control group that did not receive meals (D = 2.2; p = 0.63).[269] A study examining the impact of a federal food-box delivery program on the food security status of low-income older adults in the northeastern U.S. (n = 93) determined that the program reduced the prevalence of food insecurity among participants receiving the intervention at senior housing (Baseline = 84.4%, Follow-Up = 48.9%; p < 0.001), while the food security status of those who had to retrieve the food boxes from local food pantries was unchanged (Baseline = 85.1%, Follow-Up = 78.8%; p = 0.37).[270] Intervention research among older adults in the southeastern U.S. (n = 51) examined whether a program that provided three home-delivered meals per week

promoted food security, and discovered that the intervention improved the food security status of participants over the span of two months (Baseline = 59.7%, Follow-Up = 78.4%; $p < 0.001$).[102]

An intervention study among adults with diabetes in the northeastern U.S. (n = 44) tested whether providing home delivery of 10 meals per week could improve outcomes for both healthy eating and food security.[271] Outcomes from this study highlighted a lower prevalence of food insecurity among intervention group participants (42%) than those who were in the control group (62%) ($p = 0.047$).[271] Separate intervention research among medical clinic patients in the southern U.S. who had at least one chronic disease (n = 43) evaluated whether providing a monthly food box, one nutrition education booklet, and five meal recipes could improve food security.[272] Results from this research indicated that no significant changes in food security occurred during the intervention.[272]

An intervention study among medical clinic patients in the southern U.S. (n = 172) tested the extent to which food insecurity could be alleviated through a food prescription program involving the distribution of nutrition education materials along with 30 pounds of fresh produce and nonperishable food items every two weeks for up to 12 food pantry visits.[273] Findings from this study suggested that the program drastically reduced the prevalence of food insecurity among participants from 100 percent at baseline to 5.9 percent immediately following the nine-month intervention ($p < 0.01$).[273] While the aforementioned food insecurity intervention studies were largely successful in addressing barriers involving financial resources and transportation, there remains a critical need for identifying effective approaches to eliminate persisting information barriers that prevent individuals who are food insecure from accessing food.

2.7. Informational Nudges in Behavioral Sciences Research

Nudging has become an increasingly common intervention mechanism used in studies that aimed to promote behaviors that can contribute to improved health outcomes.[109] A variety of positive health behavior changes have been generated in research interventions through the integration of text messages as informational nudges.[274] Expert recommendation for using informational nudges via text messaging to promote health emphasize the importance of initiating the messaging dialogue, tailoring the message content, and being responsive to communication.[274]

A meta-analysis of intervention studies using informational nudges via text messages to improve health outcomes (n = 35) included studies that targeted smoking cessation, weight loss, physical activity, substance use, nutrition, and several other behavioral health outcomes.[275] Findings from this meta-analysis underscore how most of the included intervention studies were successful in using text messages to improve their targeted behaviors (d = 0.24; 95% CI = 0.16, 0.32).[275] The majority of health interventions that used text messages to promote behavior change have been effective in improving outcomes concerning physical activity, weight loss, and smoking cessation.[276] This assertion is supported by evidence from a meta-analysis of research interventions using text messaging for health promotion, which underscores how desirable changes in behaviors and health outcomes have been achieved in smoking cessation (d = 0.45; 95% CI = 0.37, 0.53), physical activity (d = 0.51; 95% CI = 0.24, 0.78), and weight loss (d = 0.26; 95% CI = 0.06, 0.46) as a result of informational nudges communicated to participants via text messages.[277]

A separate randomized controlled trial among college students in the U.S. (n = 150) was successful in increasing the intervention group participants' recognition of food

groups ($p < 0.05$) and consumption of fruits and vegetables ($p < 0.05$) by sending biweekly text messages for seven weeks in a row that included the USDA's dietary guidelines.[278] Intervention research conducted among customers in a Portuguese supermarket (n = 1,636) tested whether fruit and vegetable purchasing could be increased through an intervention using strategically placed informational nudges that conveyed fruit and vegetable purchasing norms.[279] Results from this study indicated that participants in the intervention group purchased higher quantities of fruits and vegetables in comparison to those in the control group ($t_{(2,995)} = 15.46$, $p < 0.001$).[279]

Outcomes from a systematic review of studies using text message-based interventions that promote smoking cessation (n = 12) emphasize that informational nudges via text messages have been shown to increase the likelihood of people refraining from smoking once they quit (RR = 1.67; 95% CI = 1.46, 1.90).[280] A meta-analysis of 22 studies using text messaging-based interventions for smoking cessation (n = 15,593) yielded results indicating that intervention group participants in the included studies had greater odds of continuously abstaining from smoking (OR = 1.63; 95% CI = 1.19, 2.24) than control group participants.[281] Research among young adults in the U.S. (n = 102) compared whether a smartphone application or text messaging produced better smoking cessation outcomes, and found that text messaging produced more abstinence from smoking (80% quit) than a smartphone application (52% quit) ($p < 0.05$).[282]

A randomized controlled trial among U.K. adults (n = 5,524) tested the extent to which smoking cessation could be achieved by using text messages including tailored advice and support to help participants stop smoking.[283] Findings from this study indicated that the intervention group had a higher likelihood of presenting biochemically

verified continuous abstinence from smoking at six months (RR = 2.20; 95% CI = 1.80, 2.68) in comparison to a non-treatment control group.[283] Another randomized controlled trial conducted among smokers who were age 15 years and older (n = 1,705) implemented a text message program involving personalized messages that provided smoking cessation advice and support.[284] Findings from this study suggested that participants in the intervention group had a higher likelihood of quitting smoking after six weeks (RR = 2.20; 95% CI = 1.79, 270) compared to those in the control group.[284]

Results from a meta-analysis of 13 studies (n = 1,346) that used a text message intervention to promote physical activity indicated that interventions using text messages were successful in increasing the number of steps that people walk per day (D = 0.38; 95% CI = 0.19, 0.58) but did not yield meaningful changes in physical activity levels (D = 0.31; 95% CI = -0.01, 0.63).[285] Conflicting evidence from a systematic review that focused on mobile technology-based health interventions indicated that informational nudges via text messages increased physical activity levels.[286] Outcomes from a research intervention among sedentary females in the western U.S. (n = 41) detailed greater increases in daily total steps among an intervention group that received text message-based informational nudges which prompted them to significantly increase their steps from baseline (M = 5,394; 95% CI = 4,563, 6,224) to week three (M = 6,210; 95% CI = 5,379, 7,041) ($p < 0.001$).[287] A randomized controlled trial among adult females in Australia (n = 88) tested whether sending five tailored text messages per week could promote physical activity, and determined that the intervention increased the frequency of physical activity by 1.82 (SE = 0.18) days per week over 13 weeks ($F_{(2,85)} = 4.46$; $p = 0.04$).[288]

Findings from a different randomized controlled trial among U.K. adults (n = 77) suggested that increases in leisure time physical activity (Intervention M = 4.1, SD = 2.6; Control M = -5.5, SD = 3.5; $p < 0.001$) and decreases in body fat (Intervention M = -2.18, SD = 0.59; Control M = -0.17, SD = 0.81; $p = 0.04$) were greatest among intervention group participants who received tailored informational nudges that were communicated via emails and text messages and included solutions to overcoming physical activity barriers along with reminders to exercise.[289] A multi-arm randomized controlled trial among U.K. adults (n = 149) assessed the extent to which a physical activity intervention using text message reminders could increase brisk walking, which yielded outcomes indicating greater increases in brisk walking among participants in the intervention group ($F_{(2, 130)} = 3.12$; $p < 0.05$) when compared with the control group.[290]

Outcomes from a meta-analysis of studies examining the effect of text message interventions on weight management suggested greater weight loss outcomes occurred among intervention group participants (M = -2.56; 95% CI = -3.46, -1.65) in comparison to those in the control group (M = -0.37; 95% CI = -1.22, 0.48) ($p = 0.001$).[291] A randomized controlled trial among U.S. adults who were overweight (n = 65) examined whether meaningful weight loss could be achieved through an intervention that involved sending two-to-five text messages per day which included information about weight control.[292] Results from this study indicated that participants in the intervention group lost more weight than the control group after four months (D = -1.97; 95% CI = -0.34, -3.6).[292] Another research intervention among U.S. adults who were overweight or obese (n = 34) involved a one-time educational session about the benefits of eating fruits and vegetables, which was followed by bi-weekly text messages for 12 weeks.[293] Findings from this study indicated that greater reductions in body weight (Intervention M = -1.6;

Control M = 0.7; p = 0.006), waist circumference (Intervention M = -2.2; Control M = 1.5; p = 0.0005), and BMI (Intervention M = -0.6; Control M = 0.7; p = 0.03) were achieved in the intervention group when compared with the control group.[293]

Intervention research among college students in the northeastern U.S. (n = 52) used motivational text messages that were tailored to participants in an effort to promote the monitoring of caloric intake, physical activity, and weight goals.[294] Outcomes from this research highlighted how greater weight loss occurred among intervention group participants (M = -2.4, SD = 2.5) in comparison to those in the control group (M = -0.24, SD = 2.6) ($p < 0.05$).[294] Contrary findings from an intervention study among U.S. adults (n = 97) that tested whether text messages could promote adherence to a larger weight loss program suggested that text messages had no effect on treatment adherence (Intervention M = 57, SD = 29.6; Control M = 52.4, SD = 31.2; p = 0.31) nor weight change (Intervention M = 1.9, SD = 4.3; Control M = 1.6, SD = 3.4; p = 0.68).[295]

Findings from a meta-analysis of studies (n = 42) examining the effect of various nudge interventions on dietary behavior changes among adults indicated that nudging has primarily been found to increase healthy eating behaviors (PR = 15.3; 95% CI = 7.58, 23.0).[110] A randomized controlled trial conducted among college students in the U.S. (n = 1,639) aimed to promote healthy eating, physical activity, and stress management through an intervention program that used virtual educational lessons and informational nudges sent via email.[296] Findings from this study suggested that the program produced greater increases in fruit and vegetable intake among intervention group participants (Baseline M = 2.6, SD = 2.1; Post-Intervention M = 2.8, SD = 2.1) when compared with those in the control group (Baseline M = 2.7, SD = 1.9; Post-Intervention M = 2.5, SD = 2.1) (p = 0.001).[296] Another randomized controlled trial

among adults experiencing food insecurity in the northeastern U.S. (n = 50) used nudges to increase purchases of healthy food like fruits (β = 1.51; 95% CI = 0.59, 2.51) and vegetables (β = 2.21; 95% CI 0.41, 4.01), but this study did not track changes in food security status.[297]

Research evidence has illuminated informational nudging via text messages as an intervention approach that can produce favorable behavioral and health outcomes. Despite the increasing popularity of nudges being used to promote healthy behaviors, too few intervention studies have purposively sampled individuals experiencing food insecurity when using informational nudges to improve targeted outcomes. No known studies in the U.S. or internationally have used informational nudges to promote food security via food pantry use and SNAP enrollment. Therefore, additional intervention research is needed to address this knowledge gap by testing the extent to which targeted informational nudges can promote food access behaviors and improve food security outcomes.

CHAPTER 3

METHODS

3.1. Study Design

A mixed-methods feasibility study was conducted to test a novel food insecurity intervention. This research was carried out over the span of five months from November 2022 to March 2023. Phase 1 of the research involved testing the text message to be used as an informational nudge for the food insecurity intervention in one-time interviews among individual community members. Phase 2 included a two-month food insecurity intervention followed by limited efficacy testing of the intervention and an acceptability assessment of the participants' perceptions of the informational nudges. Testing the informational nudges in phase 1 involved interviewing 10 community members in the Phoenix, Arizona metropolitan area to gauge their perceptions and opinions of the text message that was used as the informational nudge intervention. Limited efficacy testing in phase 2 involved quantitative estimation for whether the intervention increased food pantry utilization, SNAP registration, and food security. Intervention acceptability assessments during phase 2 included qualitative interviews that focused on participant perceptions of the food insecurity intervention.[298]

It was hypothesized that this intervention would promote food security by increasing access to food assistance through the removal of information barriers. The intervention was designed to promote food security through informational nudges that would be delivered to participants in the form of weekly text messages containing food assistance information. Informational nudges that were sent via text message aimed to eliminate information barriers that may have been preventing vulnerable adults from accessing food. The weekly text messages included the name, location, and hours of

operation of a local food pantry along with details about services the food pantry provides to help clients register for SNAP benefits.

The primary phase of this study was carried out in collaboration with the NourishPHX in downtown Phoenix, Arizona. Study participants were adults who are food insecure, not enrolled in SNAP, and had regular access to a mobile phone that can receive text messages. Participants were randomly assigned to either an intervention group or a control group. Intervention group participants received the informational nudge text messages, while control group participants received no intervention. Study outcomes were examined statistically through bivariate and multivariable linear regression and logistic regression models and qualitative content analyses.

Throughout the research process, the accomplishment of the following study aims was pursued: *Aim* 1) Identify whether food pantry utilization is greater among participants receiving informational nudges, *Aim* 2) Determine if informational nudges increase SNAP registration rates, and *Aim* 3) Test the extent to which informational nudges improve food security. The extent to which informational nudges can increase food pantry utilization, raise SNAP registration, and promote food security were determined among a sample of first-time food pantry users through random assignment to a food insecurity intervention group or a control group. It was hypothesized that informational nudges would increase food pantry utilization, produce higher SNAP registration rates, and improve food security among food pantry clients.

3.2. Theoretical Model

The Theory of Planned Behavior (TPB) is the theoretical model that informed the design of this intervention study. In focusing on behavioral intention, the TPB was

founded on the notion that health behaviors are influenced by personal beliefs, social norms, and perceived behavioral control.[299] For this study, attention was primarily placed on the modification of perceived behavioral control, which involves the extent to which a person perceives that they are able to change or control an outcome. Perceived behavioral control comprises the environmental factors that promote or prevent a behavior. Proponents of the TPB have posited that, if a behavior is important and supported by social norms, then there is a higher likelihood of people engaging in that behavior when they also perceive that it is within their control to act.[300] According to the TPB, perceived behavioral control is impacted by factors that inhibit or facilitate a behavior. Inhibiting factors deter the performance of specific behaviors. Facilitating factors increase the likelihood of certain behaviors.

In the context of this study, informational nudges were used to improve the perceived behavioral control of first-time food pantry clients. Improving the perceived behavioral control of study participants who were food insecure and not registered for SNAP occurred by equipping them with critical information concerning when, where, and how they can obtain food. Given that food pantry clients are likely to perceive that obtaining food is both important and supported by social norms, the intervention applied in this study intended to bolster perceived behavioral control over receiving food assistance from a food pantry and SNAP. Promoting perceived behavioral control was performed through treating food assistance information as a facilitating factor of obtaining food by using informational nudges to communicate such details via text messages, which, in theory, acted to remove informational barriers that could have been inhibiting factors to accessing food.

3.3. Setting

The setting for this study was a food pantry named NourishPHX that is located in Phoenix, Arizona. NourishPHX is located in downtown Phoenix and occupies a building that is situated near a large, semi-permanent encampment of unhoused individuals. As a non-profit organization, NourishPHX operates with the purpose of supporting individuals who are economically disadvantaged by providing basic needs aid that includes food, clothing, registration for financial assistance programs, financial literacy training, and various self-enrichment workshops. NourishPHX was the sole setting of participant recruitment for this study. The study intervention did not occur at NourishPHX's physical location, as informational nudges were to be delivered via text messages. Food assistance information included within the intervention text messages stated the name, location, hours of operation of NourishPHX along with details about registering for SNAP at NourishPHX.

3.4. Participant Sampling

Adults residing in the Phoenix Metro area (n = 10) were recruited for the informational nudge testing process in study phase 1. Participant recruitment in phase 1 occurred by word of mouth within the cities of Phoenix, Arizona and Tempe, Arizona. Individuals who were eligible to participate in the informational nudge testing included the following: adults aged 18 years or older who are fluent in English, resided in the Phoenix Metro area, and were not food pantry clients. Recruiting participants from the same community of the partnering food pantry was necessary for appropriately tailoring the intervention to community members.[88]

Participants sampled for the feasibility study in phase 2 were adult food pantry clients (n = 24). Individuals who were eligible to participate in phase 2 of the research study included: adults aged 18 years or older who are fluent in English, food insecure,

not registered for SNAP, and had regular access to a mobile phone that can receive text messages. To prevent intervention treatment contamination in phase 2, the exclusion criteria for this study precluded adults from participating if they were food secure or registered for SNAP. An additional exclusion criterion that was eventually removed in phase 2 involved the requirement that participants be first-time food pantry users. This exclusion criterion was removed midway through the participant recruitment phase, as a large majority of survey screener respondents were being deemed as ineligible since they had previously utilized a food pantry.

With the phase 2 research having been longitudinal by design, it was anticipated that participant attrition would occur across the three data collection timepoints. The initial sample size target was 100 participants. Given the difficulty of participant recruitment among a vulnerable, low-income population and the strict exclusion criteria applied during the participant recruitment process, less than 25 percent of the sample size target was achieved. As a feasibility study, maintaining a certain participant sample size for statistical power purposes was of reduced importance since effect size estimation will occur through limited efficacy testing of the intervention effects on food pantry utilization, SNAP registration, and food security.[298] According to a systematic review and meta-analysis of previous food insecurity interventions, it was expected that roughly 20 percent of participants would be lost to follow-up.[256] In aiming to recruit a sample of 100 adult food pantry clients, it was initially estimated that complete data would be collected for 80 participants.

Participant recruitment for phase 2 occurred at NourishPHX during their hours of operation, which are regularly Monday through Friday from 9:00 AM to 11:00 AM. To recruit participants, study recruitment flyers were placed into boxes of food that were

eventually obtained by food pantry clients who were visiting NourishPHX. Content on the study recruitment flyers included a written advertisement detailing an opportunity to participate in a “Food Assistance Information Study” along with a brief study description and the potential to earn $20 for full participation in the study. Both a QR code and a website URL address were included on the flyer for interested respondents to access and complete the online screener survey via Qualtrics, which determined the respondents’ eligibility to join the study. Participants were recruited from November 14–18, 2022; November 28–December 9, 2022; and January 4–25, 2023. Recruitment periods scheduled around major holidays, and due dates related to the dissertation completion requirement restricted the recruitment timeline to late January since two subsequent waves of data collection were needed after baseline with four weeks in between each data collection.

The screener survey contained qualifying questions concerning a respondent’s age, English language fluency, food pantry use history, food security, SNAP enrollment status, and mobile phone access. Upon completing the screener survey, respondents who were eligible for study enrollment were redirected to an online consent form. Eligible respondents who wanted to join the study after reading the consent form then assented to becoming a research participant by proceeding in Qualtrics to the baseline survey. Participants were assigned into either the intervention group or the control group immediately after each participant completed their baseline data collection. Random assignment of participants to study groups was employed by flipping a two-sided coin to assign participants into either the intervention group or the control group.[301] The coin landing on heads resulted in a participant being assigned to the intervention group, while the coin landing on tails resulted in a participant being assigned to the control group.

3.5. Intervention

The text messages used as informational nudges in the food insecurity intervention were first tested in study phase 1 by having local community members (n = 10) evaluate them before they were used among food pantry clients (n = 24) in phase 2 of the study. Testing the informational nudges prior to implementing the intervention involved recording and transcribing interviews to gather community member responses to the following questions: 1) “What do you think the message is trying to convey?” 2) “On a scale from 1–5, with 5 being the best, how persuasive or convincing do you think this message would be for food pantry clients? Why did you choose this rating?” 3) “On a scale from 1–5, with 5 being the best, how personally relevant do you think this message would be for food pantry clients? Why did you choose this rating?” 4) “Was this message clear? If no, why not? 5) Was there anything about this message that you particularly liked?” 6) “Was there anything about this message that you particularly disliked?” 7) “What are your overall thoughts on the message that I just discussed with you?” The purpose of the informational nudge testing process was to seek and find any necessary modifications that should have been made to the content of the messages prior to them being used to promote food security during the study.

Study participants who were randomly assigned to the intervention group received weekly informational nudges via text messages that contained details about local food assistance resources. This followed a similar approach used in past research that applied informational nudges as antecedent prompts to direct vulnerable individuals to needed goods and services.[105] Participants who were assigned to the no-treatment control group did not receive the intervention. No-treatment control groups are ideal for

testing novel interventions when there is uncertainty regarding whether the intervention will work,[302] which was the case in this research.

The informational nudges used in the study intervention included concise messages describing when, where, and how participants could access food assistance along with details about opportunities to register for SNAP benefits. These informational nudges were similar to those used in a separate informational nudging study where both information and a behavioral prompt to utilize a resource are included within the message as opposed to information alone.[105] Weekly text messages have been shown to aid program retention while producing meaningful changes in targeted outcomes,[276] so a total of eight intervention text messages were sent to participants once per week for eight weeks. Text messages were sent on a fixed frequency of once per week, as this approach has been shown to produce favorable intervention outcomes compared to varying frequencies.[303] The following script is an example of a text message to be used in the intervention, “The NourishPHX food pantry is open this week Monday through Friday from 9-11am. Come visit at 501 S 9th Ave, Phoenix, AZ. Ask a NourishPHX member about registering for SNAP food benefits! SNAP provides funds that can be used to buy food. Take care, The Food Assistance Information Team.”

3.6. Study Measures

3.6.1. Participant Characteristics

Personal biologic and sociodemographic information were collected during the baseline data collection to characterize the participant sample. The participant characteristics that were measured included age, sex, race/ethnicity, education, and annual income. Age was measured with one item stating, “Please indicate your age in

years." Response options for the age item ranged from 18 to 120. Sex was assessed with one item stating, "Please indicate your biological sex." Response options for the sex item were "Female" or "Male." Race/Ethnicity was determined with one item stating, "Please indicate your race/ethnicity." Response options for the race/ethnicity item were "American Indian/Alaska Native", "Asian", "Black", "Hispanic/Latino", "Native Hawaiian/Pacific Islander", "White", or "More Than One Race." Education was measured with one item stating, "Please indicate your highest level of education." Response options for the education item were "Less Than High School", "High School Graduate", "Some College", "Bachelor's Degree", or "Graduate Degree." Income was assessed with one item stating, "Please indicate your annual income level." Response options for the income item were "Less than $25,000", "$25,000 to $49,999", "$50,000 to $74,999", "$75,000 to $99,999", or "$100,000 or More."

3.6.2. Food Security

Food security was the primary outcome of this study. The 10-item USDA Adult FSSM was used to measure food security.[129] These 10 items include the following: "In the last 30 days, 1) I worried whether my food would run out before I got money to buy more; 2) the food that I bought just didn't last, and I didn't have money to get more; 3) I couldn't afford to eat balanced meals; 4) did 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?; 5) how often did this happen?; 6) did you ever eat less than you felt you should because there wasn't enough money for food?; 7) were you ever hungry but didn't eat because there wasn't enough money for food?; 8) did you lose weight because there wasn't enough money for food?; 9) did you ever not eat for a whole day because there wasn't enough money for food?; 10) how often did this happen?". In this study, response

options for items 1, 2, and 3 were “Often true”, “Sometimes true”, or “Never true”. Response options items 4, 6, 7, 8, and 9 were “Yes” or “No”. Response options for items 5 and 10 are “Almost every week”, “Some weeks but not every week”, and “Only one or two weeks”. The Hunger Vital Sign Two-Question Screener Tool, which includes the first two items of the Adult FSSM, was used to screen for food security prior to the full baseline data collection.[304] The 10-item Adult FSSM was used to measure food security at baseline, at one-month mid-intervention, and immediate post-intervention at two-months.

3.6.3. Food Pantry Use and SNAP Enrollment

Food pantry use was another primary outcome in this study. To measure food pantry utilization, this study included one single-item measure in the baseline data collection and a separate single-item measure for data collections at one-month mid-intervention and post-intervention at two months. The one-item measure to screen for food pantry use prior to the full baseline data collection went as follows: “Was your recent visit to NourishPHX the first time you had ever used a food pantry to obtain food?” Response options for this item were “Yes” or “No”. Separately, the one-item measure to evaluate food pantry use at one-month mid-intervention and post-intervention at two months went as follows: “In the last 30 days, how many times did you obtain food from a food pantry?” Response options for this item were “Zero”, “Once”, or “Twice”. SNAP enrollment was another primary study outcome that was estimated with a single-item measure. The one-item SNAP enrollment measure was derived from the CDC’s National Health and Nutrition Examination Survey,[305] and went as follows: “Do you or anyone in your household currently get SNAP or Food Stamps?” Response options for this item

were “Yes” or “No”. SNAP enrollment was measured at baseline, one-month mid-intervention, and post-intervention.

3.6.4. Feasibility of the Intervention – Acceptability

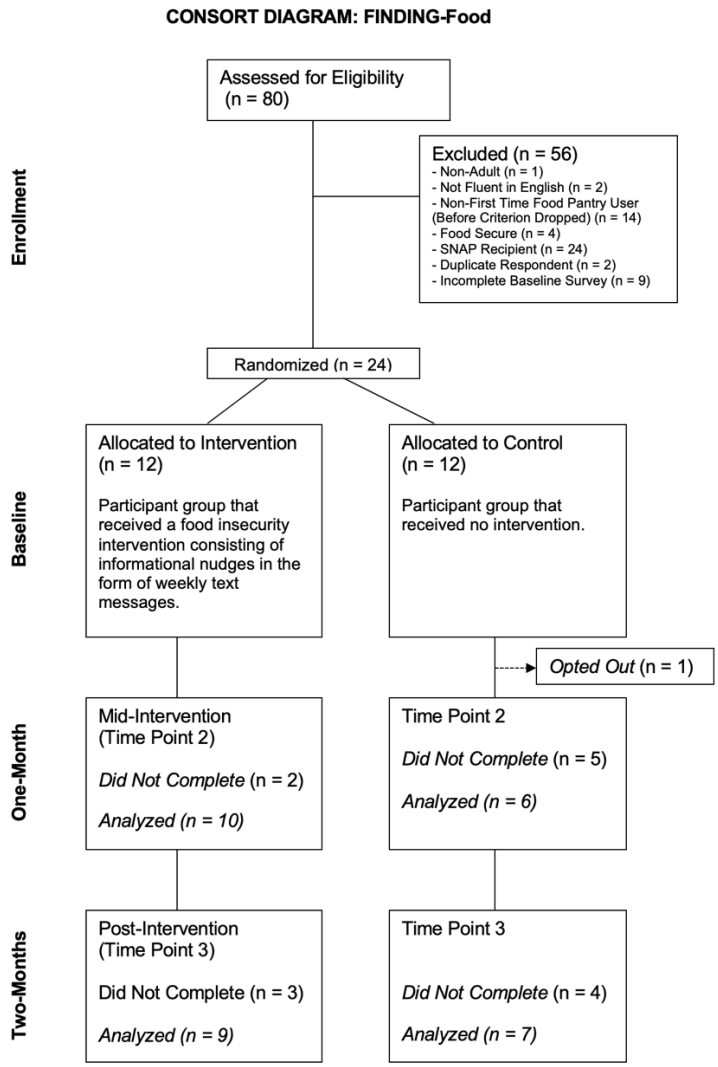
The extent to which participants perceived that the study intervention was acceptable was be evaluated with a mixed-methods approach involving three closed-ended questions and one open-ended question that were only asked among intervention group participants during the post-intervention data collection at two months. The first closed-ended question pertained to whether the information nudge text messages were read by participants, which asked “Did you read the text messages that you had received during the Food Assistance Information Study?”. A second closed-ended question gauged how comprehensible the text messages were by asking, “Were the text messages that you had received during the Food Assistance Information Study easy to understand?”. The third closed-ended question concerned whether the participants perceived the text messages to be helpful by asking, “Were the text messages that you had received during the Food Assistance Information Study helpful?”. Response options for the three closed-ended questions were “Yes” or “No”. The one open-ended question then inquired about general perceptions of the text messages through asking, “In a few words, what do you think of the text messages that you had received during the Food Assistance Information Study?”. A text box was available for participants to share their perceptions of the text messages in writing.

3.6.5. Data Collection

For study phase 1, participant data were collected through one-on-one interviews on 10 occasions across one month. Data for phase 2 were collected using online

surveys distributed to participants at baseline, one-month, and two-months. For phase 2, data collections were spaced out by four weeks during the intervention. The full phase 2 data collection period spanned five months, as all participants needed two-months to complete all the data collections regardless of if they joined earlier or later in the data collection process. For phase 2, approximately 6,750 study recruitment flyers were distributed into food boxes, and a total of 80 individuals responded to the screener survey, which yielded a 1 percent response rate (Figure 1).

Figure 1. Consort Diagram



A total of 24 eligible respondents became phase 2 research participants by signing the informed consent and completing the full baseline survey. After completing the baseline survey, participants were then assigned to either the intervention group (n = 12) or the control group (n = 12). By the data collection at one-month following the baseline survey, eight participants had dropped out of the study (Intervention n = 2; Control n = 6), and 16 participants remained (Intervention n = 10; Control n = 6). At the final data collection at two-months after the baseline survey, an additional intervention group participant had dropped out and one control group participant rejoined the study, as 16 participants remained (Intervention n = 9; Control n = 7).

Data collection for all three study time points were conducted online through Qualtrics. The primary outcome variables for which quantitative data were collected during all three timepoints included food security, SNAP enrollment, and food pantry use. Quantitative covariate data that were collected at baseline involved participant characteristics including age, biological sex, race/ethnicity, education, and income. Mixed-methods data that described whether the participants were accepting of the study intervention were collected at post-intervention and then organized and coded as quantitative or qualitative data. Quantitative study data for phase 2, which included the independent variable (e.g., informational nudge intervention), dependent variables (e.g., food security, food pantry use, SNAP enrollment), and covariates (e.g., participant characteristics), were coded and organized into a longitudinal panel dataset. Quantitative data pertaining to the acceptability of the intervention in phase 2 were similarly organized and coded. Qualitative data for testing the informational nudges in phase 1 and assessing the acceptability of the intervention in phase 2 were organized

separately and coded for themes along with the frequency and intensity of responses from participants in the intervention group.

3.6.6. Screener Survey and Baseline Data Collection

Participants who enrolled into the study following the eligibility screener survey and consent form process then completed the baseline data collection survey. The eligibility screener survey, consent form, and baseline survey occurred sequentially within the same online Qualtrics survey. Participant responses on the screener survey were combined with responses on the baseline survey to establish a full set of baseline data. The time required for participants to complete the screener survey, informed consent, and baseline survey was approximately 10 minutes. Combined data from the screener survey and baseline data collection that were collected for each participant included the following: food security, food pantry use, SNAP enrollment, mobile phone access, mobile phone number, alternate phone number of a friend or family member, email address, English language fluency, and participant characteristics (e.g., age, sex, race/ethnicity, income, education).

3.6.7. Time Point 2 Data Collection at One-Month Mid-Intervention

A second data collection occurred one month into the informational nudge intervention. Each participant enrolled at baseline was sent a text message inviting them to complete a brief follow-up survey to receive compensation for their continued participation. The text message included a URL link to access an online web page containing a Qualtrics research survey. Data collected at mid-intervention included the following: food security; food pantry use; SNAP enrollment; mobile phone number; and

email address. Participant characteristics were carried over from baseline. The time required to complete the first follow-up survey was approximately five minutes.

3.6.8. Final Time Point 3 Data Collection at Two-Months

The third and final data collection occurred post-intervention at two months. Data collection at post-intervention immediately followed the eighth informational nudge text message that was sent to intervention group participants. Each participant was sent a text message inviting them to complete a brief follow-up survey and receive compensation for their continued participation. The text message included a URL link to access a web page containing one of two online Qualtrics research surveys. One survey was designated for participants in the intervention group, as it included intervention acceptability questions. The other survey that was designated for participants in the control group was identical to the mid-intervention data collection survey. Data collected at post-intervention among intervention group participants included the following: food security; food pantry use; and SNAP enrollment; mobile phone number; email address; and participant perceptions of the text messages used in the intervention. Participant characteristics were carried over from baseline. The time required for intervention group participants to complete the post-intervention data collection survey was approximately 10 minutes. The time required for control group participants to complete the post-intervention data collection survey was approximately five minutes.

3.6.9. Data Management

Following the data collection period, study data was stored and managed in a longitudinal dataset. Data for the primary research outcomes and all covariates were scored, coded, and centered to create study variables. The study variables were then

used in longitudinal and cross-sectional statistical analyses to determine whether the primary aims for this research were achieved. A dichotomous Intervention variable was created to indicate which participants were randomly assigned to receive the intervention. Participants in the intervention group were coded as 1, while participants in the control group were coded as 0.

For the primary outcome of food security, responses provided on each of the 10 Adult FSSM items were scored as affirmative or negative. Affirmative responses to Adult FSSM items were scored one point per item, and negative responses were scored zero points. Response options that were affirmative and assigned one point included the following: “Often true” (items 1–3), “Sometimes true” (items 1–3), “Yes” (items 4 & 6–9), “Almost every week” (items 5 & 10), “Some weeks but not every week” (items 5 & 10), and “Only one or two weeks” (items 5 and 10). Negative response options that were assigned zero points included the following: “Never true” (items 1–3), and “No” (items 4 & 6–9). For the three timepoints during the study, scores from each of the 10 Adult FSSM items were summed to create a total food security score ranging from zero to 10.

An ordinal Food Security variable was created using the total Adult FSSM scores. High food security is indicated by a total score of 0, which remained coded as 0 to be the reference category. Marginal food security is signified by a total score of 1 or 2, but is coded as 1. Low food security is implied by a total score ranging from 3 to 5, and is coded as 2. Very low food security was suggested by a total score spanning from 6 to 10, and is coded as 3. The ordinal food security variable thus ranged from high food security (0), to marginal food security (1), to low food security (2), to very low food security (3). A dichotomous food security variable was also created using the ordinal food security variable. For the dichotomous variable, high food security and marginal

food security is considered food secure and coded as 0, while low food security and very low food security was treated as food insecure and coded as 1.

Survey responses provided on the items that assessed food pantry use in the past 30 days were used to create an ordinal variable for Food Pantry Utilization. Participants indicated whether they accessed a food pantry zero times (0), once (1), or twice (2) in the past 30 days, which informed the food pantry utilization score assigned to participants when coding data for each of the three data collection timepoints. Survey responses provided on the item evaluating SNAP enrollment were used to establish a dichotomous SNAP Enrollment variable. Responses indicating that a participant was not enrolled in SNAP were coded as 0, and responses suggesting that a participant was enrolled in SNAP were coded as 1.

The three survey items that quantitatively assessed the acceptability of the study intervention were scored and coded to create dichotomous variables. Item responses provided on the question asking whether participants read the text messages were coded as 0 for “No” and 1 for “Yes” in a dichotomous Texts Read variable. For the survey question asking if the text messages were easy to understand, responses were coded as 0 for “No” and 1 for “Yes” in a dichotomous Text Comprehensibility variable. Likewise, item responses reported on the question asking whether the text messages were helpful were coded as 0 for “No” and 1 for “Yes” in a Text Helpfulness variable. Outcomes on the one survey item that qualitatively assessed the acceptability of the intervention were compiled for a content analysis to establish common Text Perception themes that were derived from participant responses along with the frequency and intensity of participant responses.

Covariate data were coded in accordance with the nature of each participant characteristic. Age was coded as a continuous variable aligning with the number reported by participants when indicating their age in years (18–120). The age variable was zero-centered by subtracting 18 from each participant's age, as 18 was the lowest age that a participant could be to qualify for the study. Sex was coded as a dichotomous variable. Males were coded as 0 and females were coded as 1. Race/Ethnicity was coded as a categorical variable. Participants who reported that they are White were coded as 0 for reference category purposes. Responses indicating that the participant is non-White were coded as follows: Black was coded as 1; Hispanic/Latino was coded as 2; and More Than One Race was coded as 3.

Education was coded as an ordinal variable. Survey responses to the education item were coded as follows: Less Than High School was coded as 0; High School Graduate was coded as 1; Some College was coded as 2; and College Graduate was coded as 3. Income was coded as a dichotomous variable. Reponses on the income item were coded as follows: Less than $25,000 was coded as 0; and $25,000 or more was coded as 1. Initially, $50,000 to $74,999 was to be coded as 2; $75,000 to $99,999 was to be coded as 3; and $100,000 or More was to be coded as 4.Too few participants had incomes within these ranges, so a dichotomous variable was created.

3.7. Statistical Analysis

Study data was analyzed using SPSS 28.0.[306] Descriptive statistics were reported for characteristics of participants included within the study sample. Analyses to determine the association between participant attrition and study outcomes were conducted with bivariate logistic regression and linear regression analyses. For limited efficacy testing of the intervention effect on primary study outcomes, data was analyzed

using descriptive statistics, pairwise comparisons of means and proportions, bivariate logistic regression and linear regression, independent samples t-tests, multivariable logistic regression and linear regression, and Cohen's D and Cohen's h computations to determine the effect of the intervention on primary outcomes. Statistics are reported using sample means and standard deviations, t-scores, mean differences, standard errors, 95 percent confidence intervals, probability values, and effect size estimates.

Descriptive statistics were calculated to determine the mean averages, standard deviations, and percentages of the primary outcome variables between the intervention group and the control group across the three study time points. Bivariate regression analyses determined whether participants with missing data differed from participants with no missing data on group status and baseline values of food pantry utilization and food security scores. The impact of missing data on study outcomes was assessed using bivariate regression to test the significance of the relationship between missing data and primary outcomes at baseline.

Effect sizes were determined using Cohen's D for mean differences or Cohen's h for proportion differences to estimate the effect size of the intervention on food pantry utilization, SNAP registration, and food security at one-month and two months. Findings from similar intervention studies were used to estimate the effect size of informational nudges on food pantry utilization, SNAP enrollment, and food security. The expected effect size of the intervention is approximately 0.27, which is considered to be a small-to-medium sized effect.[308] This effect size was partially determined by a meta-analysis of 16 food insecurity intervention studies which estimated that, on average, using food assistance to promote food security was associated with a 0.53 (95% CI = 0.36, 0.77) reduced odds in food insecurity.[256] Calculating the log of odds ratio 0.53 produced an

estimated effect size coefficient of -0.28. Results from a separate meta-analysis of 35 intervention studies using text message-based informational nudges also influenced the expected effect size, as it was estimated that the average effect of the informational nudges on various behavioral health outcomes was 0.24 (95% CI = 0.16, 0.32).[275]

Cohen's D was calculated to determine the effect size of the intervention for primary study aim 3 by comparing mean differences in food security scores (aim 3) at time point two at one-month and time point 3 at two-months.[308] Cohen's h was calculated to estimate the effect size of the intervention for primary aim 1, primary aim 2, and primary aim 3 by comparing between-group differences in the proportion of participants who had recently utilized a food pantry prior to time point 2 and time point 3 (aim 1), those who recently enrolled in SNAP before time point 2 and time point 3 (aim 2), and those who were food insecure at one-month and two-months (aim 3).[308] Cohen's parameter values were followed to determine whether the size of the effect is small (0.14), medium (0.39), or large (0.59).

Independent samples t-tests and pairwise comparisons of mean average and proportion differences were calculated to compare outcomes in food pantry utilization, SNAP registration, and food security between the intervention group and control group at one-month and two-months. The initial independent t-tests and pairwise comparisons were performed with bivariate regression to assess between-groups differences in outcomes at one-month and two-months without statistically adjusting for covariates. Adjusted independent t-tests were then conducted with multivariable regression models that statistically adjusted for covariates including baseline values of the primary outcome covariates and the participant characteristics of age, sex, race/ethnicity, education, and income.

3.7.1. Aim 1 – The Effect of Informational Nudges on Food Pantry Utilization

To achieve the first primary aim of this study, effect sizes of the intervention were estimated with Cohen's h test of proportion differences to assess the impact that the informational nudges had on food pantry utilization among intervention group participants at time point 2 at one-month mid-intervention and again for the final time point 3 at two-months. Independent t-tests were then conducted using bivariate linear regression to determine between-groups differences in food pantry utilization at one-month and two-months. Multivariable linear regression analyses were then used to perform independent t-tests that statistically adjusted for covariates including baseline values of food pantry utilization and the participant characteristics of age, sex, race/ethnicity, income, and education. Mean differences, standard errors, and 95% confidence intervals that resulted from the bivariate and multivariable linear regression analyses determined whether significant differences existed in food pantry utilization between the intervention group and control group at both one-month and two-months.

3.7.2. Aim 2 – The Effect of Informational Nudges on SNAP Enrollment

To accomplish the second primary aim of this study, effect sizes of the intervention were estimated with Cohen's h test of proportion differences to determine the impact that the informational nudges had on SNAP enrollment among intervention group participants at one-month and again at two-months. Independent t-tests were then conducted using bivariate logistic regression to determine between-groups differences in SNAP enrollment at one-month and two-months. Multivariable logistic regression analyses were then used to perform independent t-tests that statistically adjusted for covariates including baseline values of SNAP enrollment and the participant characteristics of age, sex, race/ethnicity, income, and education. Mean differences,

standard errors, and 95% confidence intervals that resulted from the bivariate and multivariable logistic regression analyses determined whether significant differences existed in SNAP enrollment between the intervention group and control group at both one-month and two-months.

3.7.3. Aim 3 – The Effect of Informational Nudges on Food Security

To accomplish the third primary aim of this study, effect sizes of the intervention were estimated with Cohen's D test of mean differences to examine the impact that the informational nudges had on food security scores among intervention group participants at one-month and again at two-months. Independent t-tests were then performed using bivariate linear regression to analyze between-groups differences in food security scores at one-month and two-months. Multivariable linear regression analyses were then used to conduct independent t-tests that statistically adjusted for covariates including baseline values of food security scores and the participant characteristics of age, sex, race/ethnicity, income, and education. Mean differences, standard errors, and 95% confidence intervals that resulted from the bivariate and multivariable linear regression analyses determined whether significant differences existed in food security scores between the intervention group and control group at both one-month and two-months.

Effect sizes of the intervention were estimated with Cohen's h test of proportion differences to examine the impact that the informational nudges had on the food security status of intervention group participants at one-month and again at two-months. Independent t-tests were executed using bivariate logistic regression to explore between-groups differences in food security status at one-month and two-months. Multivariable logistic regression analyses were then used to perform independent t-tests that statistically adjusted for covariates including the participant characteristics of age,

sex, race/ethnicity, income, and education. Mean differences, standard errors, and 95% confidence intervals that resulted from the bivariate and multivariable logistic regression analyses were used as indicators to determine whether significant differences existed in food security status between the intervention group and control group at both one-month and two-months.

CHAPTER 4

RESULTS

4.1. Informational Nudge Testing

A sample of community members (n = 10) participated in one-on-one interviews about their perceptions of an informational nudge text message. Feedback provided by the participants was then applied to modify the text message prior to applying it as an intervention in the main study phase. First, the participants read through the following text message: “The food pantry at NourishPHX is open this week on Monday through Friday from 9 to 11 AM. Visit Nourish PHX at this address: 501 S. 9th Ave., Phoenix, AZ 85007. When you visit, ask a member of NourishPHX about registering for SNAP food benefits! Take care, The Food Assistance Information Team.” Then, participants were asked to provide their answers to seven questions in an interview.

The first question that participants were asked during the interview was, “What do you think the message is trying to convey?” Participant 1 stated, “The message is pretty informative. It gives you everything about like when [NourishPHX] is open from what time to what time its open and where it is.” Shorter responses included, “That there is food available” (Participant 3), “It’s trying to let people know about this SNAP food benefits” (Participant 8), and “That help is available. Like, nutrition help, I guess” (Participant 9). Other answers included specific details that were included in the text message, like “The times available to visit the food pantry and the address and how to get there” (Participant 4), and “It’s trying to convey the hours of operation, the location, and the name of the business, and asking [people] to come in to register to receive benefits” (Participant 6), along with “It’s trying to convey not only operational information, like time, address, whatever, but also the fact that there are SNAP food benefits”

(Participant 7). Most responses to this question commented on how the message was conveying specific details to access available food assistance resources.

The second interview question that participants were asked was, “On a scale from 1–5, with 5 being the best, how persuasive or convincing do you think this message would be for food pantry clients?”, which was followed by, “Why did you choose this rating?” Starting with the lowest rating, Participant 5 provided a rating of 2 and stated, “I don’t see an immediate benefit on why I should do this.” Five participants provided a rating of 3 (Participants 2, 3, 6, 7, and 9) and commented that, “It’s a 2-hour window through just Monday through Friday, so I feel like it makes it hard for people” (Participant 2); “It’s not persuasive, just more informational” (Participant 3); “It would have been a 5 if it would have detailed some more of the benefits” (Participant 6); “When you’re saying ‘ask’, it’s a little bit more passive. I’d probably use a strong action word if you’re trying to get them to come” (Participant 7); and “They’re already a part of the food pantry network, so they just need a reminder” (Participant 9). Two participants gave a rating of 4 (Participants 8 and 10) and stated, “It’s pretty convincing. Everything is very clear, but maybe in the message [you] could let people know more about what SNAP food benefits entailed” (Participant 8), and “You can maybe grab the reader’s attention more in the beginning, like, ‘looking for food?’ or ‘In need of food?’ or ‘Need help?’ or something along the lines of that” (Participant 10). Two separate participants gave the highest rating of 5 (Participants 1 and 4) while saying, “It is pretty informative, and if a message is pretty informative, it’s really incentivizing for people to look into it” (Participant 1), and “It gives all the information needed” (Participant 4). The average rating provided by the participant sample was a mean score of 3.5 (SD = 0.97). This rating suggested that

modifications to the text message were needed to improve how persuasive or convincing it would be for food pantry clients.

The third interview question that participants were asked was, “On a scale from 1–5, with 5 being the best, how personally relevant do you think this message would be for food pantry clients?”, which was followed by, “Why did you choose this rating?” Beginning with the lowest rating, Participant 5 provided a score of 2 while stating, “It’s generic.” Participant 8 gave a rating of 3 and said, “(I don’t know) what SNAP food benefits entail.” Three participants provided a rating of 4 (Participants 2, 3, and 9) while mentioning, “People that need the food, they can go out there and get it” (Participant 2); “Very relevant…Something that keeps it short and simple would be nice and convenient” (Participant 3); and “It’s relevant, but it’s not really personalized” (Participant 9). The five remaining participants provided a rating of 5 (Participants 1, 4, 6, 7, and 10) and commented, “Anything about what the place is, where the place is, from when to when it’s open, and what sort of thing you have to do when you go there so you can register for the SNAP food benefits. So I think it’s pretty relevant for all the people” (Participant 1); “I think it would be very relevant if this is where to get food and if they’re looking for food then I don’t think it could be more relevant” (Participant 5); “It’s such an important benefit and asset to people in need” (Participant 6); “I’d assume those clients know what SNAP is and would want to take advantage of it” (Participant 7); and “Very beneficial and relevant, especially if you’re someone who is frequently visiting food pantries” (Participant 10). The average rating provided by the participant sample was a mean score of 4.2 (SD = 1.03). This rating indicated that, from the hypothetical perspective of a food pantry client, the information within the text message was perceived as relevant.

The fourth interview question asked participants, “Was this message clear?”, followed by “Why not?”, if an answer of no was provided. One participant (Participant 2) indicated, “No” and followed the initial response with, “It could be clearer. I think that maybe adding a picture showing exactly where the address is.” The other nine participants (Participants 1, 3, 4, 5, 6, 7, 8, 9, and 10) stated “Yes”. A couple participants provided a reason for their “Yes” response. One participant stated that “It’s got like everything in it. I don’t think there’s any lack of information in it that’s going to confuse a potential member for this particular program” (Participant 1), while another participant commented, “It’s telling me that I’m getting food during these days at this time. It gave the address. I think that’s enough information” (Participant 3).

The fifth interview question asked participants, “Was there anything about this message that you particularly liked?” One participant suggested that there was nothing that they liked in answering, “Nothing really stands out” (Participant 8). A separate participant liked that the message sought to serve a good purpose in stating, “Just the fact that it’s a food pantry, and it’s like, I know you’re trying to help people out in the community” (Participant 2). A primary theme that emerged from participant responses to this question related to the informational content of the text messages, as certain replies to this question included, “How many details the message actually covers” (Participant 1), and “This is who it’s from, and, you know, a greeting is always nice that their name is known (Participant 4), along with “It presented the key elements of the information such as the hours of operation and location” (Participant 6). Responses also emphasized how participants liked the structure of the messages, as answers to this question included, “That it was short and to the point” (Participant 5), “I liked the flow of the message. The fact that it was brief” (Participant 6), and “I like that it was short. I think that if it was a

long message, you would almost deter people from reading it all" (Participant 10). Another theme that emerged included participants liking the friendly tone of the text message. Participants particularly liked the "Take care" sendoff at the end of the message (Participants 3, 4, and 7), and another participant liked how the nudge was "encouraging me, inviting me to come in" (Participant 6). Participants also suggested that they liked both the name NourishPHX and that the name was included in the message, through stating "I like the name NourishPHX. I think that's an appealing name" (Participant 3), and "It's good to have the name" (Participant 9). Overall, participant responses primarily showed that what they liked most about the text message included the informational content, the wording structure, and that it was communicated in a friendly way.

The sixth interview question asked participants, "Was there anything about this message that you particularly disliked?" Five participants responded with "No" (Participants 1, 4, 6, 7, and 10). One participant stated, "I don't like the 'Food Assistance Team' part" (Participant 3). A separate participant commented, "I kind of wish the format was a little spaced out more" (Participant 9). Three participants disliked aspects of the message relating to SNAP (Participants 2, 5, and 8). One participant did not like "the fact that it says SNAP food benefits, because that kind of tells me that, are you like targeting me more? Because, like, it makes me feel like I'm less fortunate" (Participant 2). Two participants were uncertain what the acronym SNAP meant, as they commented, "The acronym SNAP. People might not know what SNAP means" (Participant 5), and "I kind of don't like how it doesn't tell me what SNAP food benefits is about. I'd like it to give me a little bit more of something" (Participant 8). The participant responses to this question

made clear that more details were needed in the message explaining what SNAP is and how it is relevant to the recipient.

The seventh and final interview question asked participants, “What are your overall thoughts on the message that I just discussed with you?” Two participants expressed concerns about the possibility message recipients identifying it as spam, as one participant stated, “People could think it’s spam and delete it immediately” (Participant 5), while another participant mentioned, “I think [the message] would be helpful for people who know about [the program] already, but if you didn’t then I’d completely ignore it” (Participant 9). Three participants shared thoughts that primarily centered on details in the message related to SNAP (Participants 4, 7, and 10). One participant recognized that SNAP was a central component of the message and stressed how mentioning SNAP later in the message may be problematic in elaborating, “It takes me a minute to get to the SNAP food part. I almost wonder if it’s even the spacing. Like, if it’s as simple as that, just spacing it out more, but it took me a second read to understand that, okay the overall goal is to understand that, yes there are SNAP food benefits offered” (Participant 7). Two participants highlighted the need to further clarify what SNAP is and why it is beneficial in saying, “Maybe it’s known to the people that are receiving this [message] but I’m not sure what SNAP is” (Participant 4), and “I think the message is clear and concise and simple, but I could just see again where there may need to be more clarity for the SNAP benefits” (Participant 10).

The 10 community members who were interviewed to test the text message to be used as an informational nudge in the intervention shared favorable opinions about the message and provided some useful suggestions for improving the message. A recurring recommendation made by the interviewees involved the need for the message to explain

more details about the benefits of SNAP (Question 2 – Participants 2 and 8; Question 3 – Participant 8; Question 6 – Participants 5 and 8; Question 7 – Participants 4 and 10). Additionally, an important consideration concerning the spacing and readability of the message was raised by participants (Question 6 – Participant 9; Question 7 – Participant 7). As a result of the feedback provided by interviewees, modifications were made to the original message to produce the following: “The NourishPHX food pantry is open this week Monday through Friday from 9–11am. Come visit at 501 S 9th Ave, Phoenix, AZ. Ask a NourishPHX member about registering for SNAP food benefits! SNAP provides funds that can be used to buy food. Take care, The Food Assistance Information Team”. Changes to the original message included a brief explanation detailing the benefits of SNAP, and additional spacing by inserting a blank row in between each sentence of the message. The message was then used as an informational nudge text message for the intervention phase of the study.

4.2. Limited Efficacy Testing

Descriptive statistics (Table 1) from baseline showed that food pantry clients (n = 24) enrolled in the study were an average age of 35.9 (SD = 15.1) years old, and a majority of participants were female (66.7%), Hispanic-Latino (41.7%), had an annual income of less than $25,000 per year (75%), and reported high school being their highest completed education (50%). For time point 2 at one-month, food pantry clients (n = 16) who were still active in the study were an average age of 39.9 (SD = 16.1) years old, and most participants were female (80%), Hispanic (31.25%) or White (31.25%), had an annual income of less than $25,000 per year (75%), and reported some college as their highest completed education (50%). At the final time point 3 at two-months, food pantry clients (n = 16) still active in the study were an average age of 37.8 (SD = 15.2)

years old, and a majority of participants were female (73.3%), Hispanic (31.25%), had an annual income of less than $25,000 per year (68.75%), and reported some college as their highest completed education (50%).

Table 1. Participant Characteristics of Food Pantry Clients across Three Time Points

Characteristics	T1 Total (%)	T2 Total (%)	T3 Total (%)
Sample size	24	16	16
Age (Years)	M = 35.9 SD = 15.1	M = 39.9 SD = 16.1	M = 37.8 SD = 15.2
Sex			
Female	16 (66.7)	12 (80)	11 (73.3)
Male	8 (33.3)	4 (20)	5 (26.7)
Race/Ethnicity			
Black	6 (25)	3 (18.75)	4 (25)
Hispanic/Latino	10 (41.7)	5 (31.25)	5 (31.25)
White	5 (20.8)	5 (31.25)	4 (25)
More Than One Race	3 (12.5)	3 (18.75)	1 (18.75)
Income			
< $25,000	18 (75)	12 (75)	11 (68.75)
≥ $25,000	6 (25)	4 (25)	5 (31.25)
Education			
Less Than High School	3 (12.5)	1 (6.25)	1 (6.25)
High School Graduate	12 (50)	6 (37.5)	6 (37.5)
Some College	8 (33.3)	8 (50)	8 (50)
College Graduate	1 (4.2)	1 (6.25)	1 (6.25)
Group Status			
Intervention	12 (50)	10 (62.5)	9 (56.25)
Control	12 (50	6 (37.5)	7 (43.75)
Food Security Score	M = 8.2, SD = 2.5		
Past Food Pantry Use			
No	15 (62.5)		
Yes	9 (37.5)		

[a]M = Mean; SD = Standard Deviation; T1 = Time Point 1 at baseline; T2 = Time Point 2 at one-month; T3 = Time Point 3 at two-months

Results from the bivariate logistic regression and linear regression analyses that assessed the impact of participant attrition on primary study outcomes revealed a non-significant relationship between attrition and study group status (B = -0.267, SE = 0.21; *p* = 0.22), food pantry utilization (B = 0.11, SE = 0.21; *p* = 0.61), and food security scores (B = 1.33, SE = 1.05; *p* = 0.22). No significant differences were detected between participants with full data (n = 15) and participants with missing data (n = 9) concerning study group status, food pantry utilization, and food security scores. Similar bivariate regression analyses were not conducted for the primary study outcomes of SNAP registration and food security status, as all participants at baseline were food insecure and not enrolled in SNAP.

Effect size estimation and mean difference tests (Table 2) using Cohen's D for mean differences or Cohen's h for proportion differences were executed for the primary study outcomes of food pantry utilization, SNAP enrollment, and food security at time point 2 at one-month mid-intervention and for the final time point 3 at two-months.

Table 2. Descriptive Statistics and Effect Size Estimates of the Intervention on Food Pantry Utilization, SNAP Registration, and Food Security.

Outcome	Time Point	Intervention	Control	Effect
Food Pantry				
	Baseline	33% Past Use	44% Past Use	
	One-Month			h = 0.21
		10% No Visits	16.7% No Visits	
		30% One Visit	16.7% One Visit	
		60% Two Visits	66.6% Two Visits	
	Two-Months			h = 0.18
		22.2% No Visits	14.7% No Visits	
		11.1% One Visit	14.7% One Visit	
		66.7% Two Visits	70.6% Two Visits	
SNAP				
	Baseline	0% Registered	0% Registered	-
	One-Month	0% Registered	17% Registered	h = 0.85
	Two-Months	0% Registered	29% Registered	h = 1.14

FS Score				
	Baseline	M = 7.9 SD = 2.4	M = 8.4 SD = 2.7	
	One-Month	M = 6.6 SD = 3.2	M = 7.7 SD = 2.9	D = 0.35
	Two-Months	M = 5.6 SD = 4.0	M = 8.0 SD = 2.8	D = 0.71
FS Status				
	Baseline	100% Food Insecure	100% Food Insecure	-
	One-Month	80% Food Insecure	100% Food Insecure	h = 0.93
	Two-Months	56% Food Insecure	100% Food Insecure	h = 1.45

[a]Baseline n = 24 (12 Intervention & 12 Control); One-Month n = 16 (10 Intervention & 6 Control); Two-Months n = 16 (9 Intervention & 7 Control)
[b]D = Cohen's D Effect Size; h = Cohen's h Effect Size; FS = Food Security; M = Mean; SD = Standard Deviation
[c]At baseline, eligible participants could not be registered for SNAP and had to be food insecure.

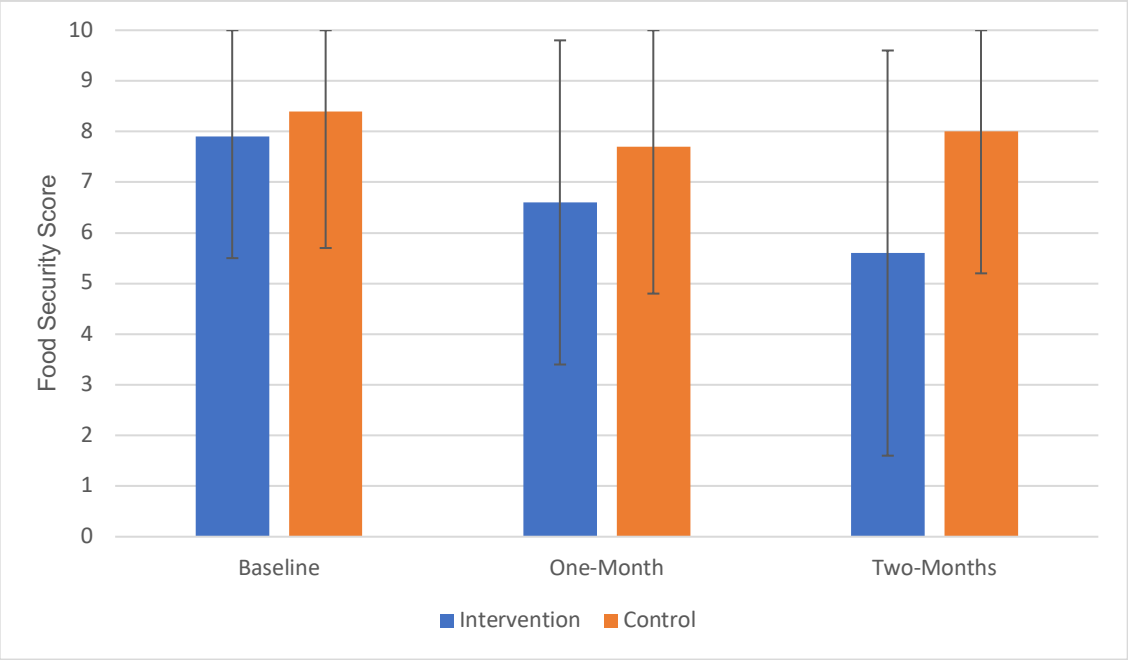
At baseline, 33 percent of the intervention group (n = 12) and 44 percent of the control group (n = 12) had previously utilized a food pantry. For time point 2 at one-month, participants who reported no visits to the food pantry comprised 10 percent of the intervention group and 16.7 percent of the control group, participants who reported one visit to a food pantry comprised 30 percent of the intervention group and 16.7 percent of the control group, and participants who reported two visits to a food pantry comprised of 60 percent of the intervention group and 66.6 percent of the control group. It was determined that the intervention had a small effect on food pantry utilization from baseline to one-month (h = 0.21). At time point three at two-months, participants who reported no visits to the food pantry comprised 22.2 percent of the intervention group and 14.7 percent of the control group, participants who reported one visit to a food pantry comprised 11.1 percent of the intervention group and 14.7 percent of the control group, and participants who reported two visits to a food pantry comprised of 66.7 percent of the intervention group and 70.6 percent of the control group. It was estimated that the intervention maintained a small effect on food pantry utilization from baseline to two-months (h = 0.18).

Since no participants were registered for SNAP at baseline, effect size calculations to estimate the effect of the intervention on SNAP registration were only conducted for outcomes at one-month and two-months. At one-month, no intervention group participants were registered for SNAP, while 17 percent of the control group was registered for SNAP. A large intervention effect on SNAP registration at one-month was estimated (Cohen's h = 0.85), but the effect was in the opposite direction of what was intended, as SNAP registration was greater in the control group than the intervention group. The two-month SNAP registration rate remained at zero for the intervention group and increased to 29 percent of the control group. A very large intervention effect on SNAP registration was estimated at two-months (Cohen's h = 1.14), which remained in the unintended direction of less intervention group participants registering for SNAP than control group participants.

Mean food security scores (Figure 2) at baseline were 7.92 (SD = 2.43) for the intervention group (n = 12) and 8.42 (SD = 2.71) for the control group (n = 12). At one-month, mean food security scores were 6.60 (SD = 3.17) for the intervention group (n = 10) and 7.67 (SD = 2.86) for the control group (n = 6). A medium intervention effect on food security scores was estimated at one-month (Cohen's D = 0.35). At two-months, the mean food security score was 5.56 (SD = 3.97) for the intervention group (n = 9) and 8.00 (SD = 2.77) for the control group (n = 7). A large intervention effect on food security scores was estimated at two-months (Cohen's D = 0.71). Since all participants were classified as food insecure at baseline, bivariate analyses to determine between-group differences in food security status were only conducted for time points two and three. At one-month, 80 percent of the intervention group was food insecure, and 100 percent of the control group was food insecure. A very large intervention effect on food security

status was estimated at one-month (Cohen's h = 0.93). At two-months, 56 percent of the intervention group was food insecure, while 100 percent of the control group was food insecure. Similarly, a very large intervention effect on food security status was estimated again at two-months (Cohen's h = 1.45).

Figure 2. Between-Groups Mean Differences for Food Security Score Over Time



[a]Baseline n = 24 (12 Intervention & 12 Control); One-Month n = 16 (10 Intervention & 6 Control); Two-Months n = 16 (9 Intervention & 7 Control)

Independent samples t-scores and group differences in study outcome means or proportions were estimated with bivariate and multivariable regression models (Table 3), which calculated and compared results for food pantry utilization, SNAP registration, and food security between the intervention group and control group at one-month mid-intervention and at two-months when the intervention ended. Food pantry utilization results suggested that no significant between-groups differences existed for food pantry utilization at one-month (t = 0, p = 1; D = 0, SE = 0.39, 95% CI = -0.84, 0.84), and these findings stayed consistent after adjusting for covariates (t = -0.32, p = 0.76; D = 0.24, SE

= 0.32, 95% CI = -0.49, 0.97). Further food pantry utilization findings indicated that no significant differences existed between study groups at two-months (t = -0.29, p = 0.77; D = 0.13, SE = 0.43, 95% CI = -1.04, 0.78), which continued after adjusting for covariates (t = -0.40, p = 0.70; D = 0.11, SE = 0.54, 95% CI = -1.12, 1.35).

SNAP registration outcomes implied that no significant differences were present between study groups at one-month (t = -1.00, p = 0.36; D = -0.17, SE = 0.17, 95% CI = -0.56, 0.26). After adjusting for covariates, a significant difference in SNAP registration was detected between the intervention group and the control group (t = -2.63, p = 0.02; D = -0.34, SE = 0.15, 95% CI = -0.66, -0.10), which underscored how a greater proportion of control group participants registered for SNAP than intervention participants. Additional SNAP registration results suggested no significant between-groups differences in SNAP registration at two-months (t = -1.56, p = 0.17; D = -0.29, SE = 0.18, 95% CI = -0.74, 0.17), and these non-significant findings persisted after adjusting for covariates (t = -2.12, p = 0.05; D = -0.41, SE = 0.22, 95% CI = -0.91, 0.09).

Food security score findings indicated that no significant differences existed between study groups at one-month (t = -0.67, p = 0.51; D = -1.07, SE = 1.58, 95% CI = -4.46, 2.33), and non-significant outcomes remained after adjusting for covariates (t = -0.40, p = 0.69; D = -1.50, SE = 0.96, 95% CI = -3.71, 0.70). Further food security score outcomes revealed no significant between-groups differences at two-months (t = -1.45, p = 0.17; D = -2.44, SE = 1.69, 95% CI = -6.07, 1.18), which continued to be non-significant after adjusting for covariates (t = -0.81, p = 0.43; D = -1.21, SE = 1.32, 95% CI = -4.25, 1.84).

Results for food security status specified no significant differences between study groups at one-month (t = -1.15, p = 0.27; D = -0.20, SE = 0.18, 95% CI = 0.57, -0.17),

which stayed consistent after adjusting for covariates (t = -0.71, p = 0.48; D = -0.18, SE = 0.29, 95% CI = -0.48, 0.84). Further findings highlighted a significant difference in food security status between the intervention group and the control group at two-months (t = -2.21, p = 0.04; D = -0.44, SE = 0.20, 95% CI = -0.85, -0.01). Non-significant between-groups differences in food security status at two-months were then detected after adjusting for covariates (t = -1.28, p = 0.21; D = -0.19, SE = 0.26, 95% CI = -0.77, 0.40).

Table 3. Independent Samples t-Tests and Mean Difference Comparisons for the Intervention Effect on Food Pantry Utilization, SNAP Registration, and Food Security.

Outcome	Mean Difference (SE)	95% CI	*t*-Score	*p*-Value
Food Pantry				
Unadjusted				
One-Month	D = 0.00, SE = 0.39	-0.84, 0.84	t = 0.0	p = 1
Two-Months	D = -0.13, SE = 0.43	-1.04, 0.78	t = -0.29	p = 0.77
Adjusted				
One-Month	D = -0.24, SE = 0.32	-0.97, 0.49	t = -0.32	p = 0.76
Two-Months	D = -0.11, SE = 0.54	-1.35, 1.12	t = -0.40	p = 0.70
SNAP				
Unadjusted				
One-Month	D = -0.17, SE = 0.17	-0.56, 0.26	t = -1.00	p = 0.36
Two-Months	D = -0.29, SE = 0.18	-0.74, 0.17	t = -1.56	p = 0.17
Adjusted				
One-Month	**D = -0.34, SE = 0.15**	**-0.66, -0.10**	***t* = -2.63**	***p* = 0.02**
Two-Months	D = -0.41, SE = 0.22	-0.91, 0.09	t = -2.12	p = 0.05
FS Score				
Unadjusted				
One-Month	D = -1.07, SE = 1.58	-4.46, 2.33	t = -0.67	p = 0.51
Two-Months	D = -2.44, SE = 1.69	-6.07, 1.18	t = -1.45	p = 0.17
Adjusted				
One-Month	D = -1.50, SE = 0.96	-3.71, 0.70	t = -0.40	p = 0.69
Two-Months	D = -1.21, SE = 1.32	-4.25, 1.84	t = -0.81	p = 0.43
FS Status				
Unadjusted				
One-Month	D = -0.20, SE = 0.18	0.57, -0.17	t = -1.15	p = 0.27
Two-Months	**D = -0.44, SE = 0.20**	**-0.85, -0.01**	***t* = -2.21**	***p* = 0.04**
Adjusted				
One-Month	D = -0.18, SE = 0.29	-0.48, 0.84	t = -0.71	p = 0.48
Two-Months	D = -0.19, SE = 0.26	-0.77, 0.40	t = -1.28	p = 0.21

[a]Baseline n = 24 (12 Intervention & 12 Control); One-Month n = 16 (10 Intervention & 6 Control); Two-Months n = 16 (9 Intervention & 7 Control)

[b]CI = Confidence Interval; D = Mean Difference; SE = Standard Error
[c]Unadjusted models analyzed between-group mean differences in primary outcomes.
[d]Adjusted models analyzed between-group mean differences in the primary outcomes adjusted for covariates including baseline primary outcome values and the participant characteristics of sex, race/ethnicity, income, and education.

4.3. Intervention Acceptability

Of the initial 12 participants who were randomly assigned to the intervention group, nine participants (n = 9) completed the study and provided their perspectives on their perceived acceptability of the text messages used as informational nudges for the food insecurity intervention. Participants were asked to answer four questions toward the end of their final survey.

The first question asked participants, “Did you read the text messages that you had received during the Food Assistance Information Study?” Eight participants (n = 8) indicated “Yes” to this question, while one participant (n = 1) responded with “No”. The second question asked, “Were the text messages that you had received during the Food Assistance Information Study easy to understand?” Similarly, eight participants (n = 8) reported “Yes” to this question, and the same one participant (n = 1) responded with “No”. The third question then asked, “Were the text messages that you had received during the Food Assistance Information Study helpful?” Again, eight participants (n = 8) indicated “Yes” to this question, and the same one participant (n = 1) responded with “No”.

The fourth and final question that intervention group participants responded to involving their perceived acceptability of the intervention was an open-ended query that asked, “In a few words, what do you think of the text messages that you had received during the Food Assistance Information Study?” Four themes emerged as a result of participant responses. The qualitative themes derived from responses to the open-ended question were the following: 1) Unread, 2) Friendly, 3) Helpful, and 4) Informative.

The Unread theme was established from a single response by Participant 4, who was a 75-year-old White female with a high school education and a reported annual income of more than $25,000 per year. The response by Participant 4 stated, “I did not read any texts regarding the food study. I didn’t have time. Sorry.” Likewise, the Friendly theme was informed by a single response by Participant 3, who was a 26-year-old multiracial female who had completed some college for their education and reported an annual income of more than $25,000 per year. The response by Participant 3 stated, “UX (user experience) friendly.”

The Helpful theme was produced by responses from the three following participants: Participant 6, who was a 41-year-old multiracial female with a high school education and a reported annual income of less than $25,000; Participant 8, who was a 28-year-old Latina female with a high school education and a reported annual income of less than $25,000; and Participant 23, a 29-year-old Latina female who had completed some college for their education and also reported an annual income of less than $25,000 per year. In reference to her perception of the intervention text messages, Participant 6 concisely stated, “Very helpful.” Participant 8 added by commenting, “It was very helpful to help me understand everything I need to know for for (sic) this program.” Participant 23 simply remarked, “Helpful.”

The Informative theme was constructed from responses provided by the four following participants: Participant 12, who was a 50-year-old White female who had completed some college for their education and reported an annual income of less than $25,000 per year; Participant 13, who was a 26-year-old Black female with a high school education and a reported annual income of less than $25,000; Participant 15, who was a 52-year-old Black female who had completed some college for their education and

reported an annual income of less than $25,000 per year; and Participant 17, a 56-year-old Latino male who had completed some college for their education and reported an annual income of less than $25,000 per year. Regarding her perception of the intervention text messages, Participant 12 stated, “I think they were very informative.” Participant 13 mentioned, "Similar responses were provided by participants 15 and 17, as Participant 15 remarked, “It is very informative,” while Participant 17 commented, “Very informative.”

The most frequent theme that occurred throughout the qualitative data collection process was the Informative theme (n = 4), which was closely followed by the Helpful them (n = 3). The Unread (n = 1) and Friendly (n =1) themes were established as outlier themes with no other comparable qualitative data to group them with. Altogether, the qualitative results indicate that participants in the intervention group who completed the study largely perceived the text messages used as information nudges to be helpful and informative.

CHAPTER 5

DISCUSSION

5.1. Overview

This research involved a feasibility study that included constructing, testing, and assessing informational nudges (*e.g.,* text messages) used in a novel food insecurity intervention that was geared toward raising food pantry utilization, increasing SNAP registration, and promoting food security among food pantry clients who were food insecure by attempting to remove informational barriers that were potentially preventing these individuals from accessing healthy food. Informational nudge testing occurred in phase 1, which informed to the construction of the text messages that were used in the food insecurity intervention. The intervention showed to have no effect on food pantry utilization. Separately, it was found that the intervention group had lower rates of SNAP registration compared to the control group. There were encouraging study outcomes for food security, as mean food security scores decreased over time in the intervention group, which suggested improved food security throughout the study. This finding was supported by the reduced prevalence of food insecurity in the intervention group over the two-month research process. Overall, the informational nudges used as a food insecurity intervention showed potential in alleviating food insecurity.

This research added to the growing collection of food pantry-based intervention studies that were designed with the intention of promoting food security among vulnerable individuals.[88] Outcomes from this research reinforce previous findings from intervention studies that were successful in promoting food security among food pantry clients who were food insecure.[245] This study also made a meaningful contribution to the collection of scientific literature on informational nudges, as outcomes from previous

intervention studies using informational nudges were supported by the informational nudges in this study having been successful in improving the targeted outcome (*e.g.,* food security).[275] It should be noted that findings from this study were derived from a small sample size, and are therefore in need of replication among a larger participant sample in a study with sufficient statistical power to detect a significant intervention effect. Moreover, a novel contribution was made to the field of food insecurity research through an innovative application of informational nudges that were developed with the intention of promoting food insecurity by targeting and removing information barriers that could have been preventing individuals who were food insecure from knowing how to access healthy food.

5.2. Participant Recruitment

Participant recruitment proved to be a difficult endeavor throughout the duration of this study. Initially, the goal of this study was to recruit a total of 100 adult participants who were food insecure, not registered for SNAP, first-time food pantry clients, could speak and read English, and had regular access to a mobile phone that could receive text messages. The reasons for the recruitment difficulties are multifaceted.

One reason is how the participant recruitment approach was limited to study advertisement flyers being placed into boxes of food that were to be donated to food pantry clients. Throughout the recruitment process, it was realized that many individuals coming to obtain food from NourishPHX must wait in line for anywhere between 15-to-45 minutes before being checked-in by a NourishPHX member and proceeding to collect their food. This wait time would have been a good opportunity to engage in participant recruitment by greeting each client, explaining the study to them, and then offering them a flyer if they expressed interest in participating. Alternatively, using an electronic tablet

with the eligibility screener survey readily displayed on the screen for potential respondents is an additional recruitment approach that could have resulted in a larger participant sample.[86] This approach would have allowed for potential participants to complete the eligibility survey while standing in line instead of relying solely on the food pantry clients to see the flyer in their box, read the flyer, and access the eligibility survey using the QR code or URL on the flyer.

Another reason that participant recruitment fell short of the initial goal was that the flyers placed into boxes of donated food were only in the English language. NourishPHX, the food pantry location where participant recruitment took place, serves a highly diverse population of individuals. While volunteering by assisting with food pantry operations during participant recruitment, it was estimated that nearly one-third of the food pantry clients were not proficient in speaking or reading English, as many clients only spoke Spanish while a few others only spoke Mandarin Chinese. Since proficiency in speaking and reading English was one of the inclusion criteria to join the study, many individuals who otherwise would have been qualified to join were excluded based on their English language proficiency. This occurred despite a Spanish version of the food security measure being successfully used in past research.[268] The exclusion of food pantry clients who did not speak English could have resulted in these vulnerable individuals missing out on food security-related benefits resulting from the informational nudges.

A third reason for the smaller than desired participant sample is that the inclusion criteria originally required study participants to have never received food from a food pantry before. When participant recruitment initially began, a very small percentage of screener survey respondents were first-time food pantry clients. This resulted in

respondents being excluded from the study when they otherwise may have met the rest of the inclusion criteria. The intention of excluding individuals who had a history of accessing food from food pantries was to prevent recurring food pantry use by participants from influencing the intervention effect, as one of the aims of the informational nudges was to increase food pantry utilization. Once it was realized that too many potential participants were being excluded from the study due to their history of food pantry use, it was decided that the exclusion criteria of previous food pantry use would be removed. After removing the past food pantry use exclusion criterion, a much larger proportion of respondents were eligible for participation, which bolstered the participation rate.

A relatively diverse sample of participants was recruited for this study. It was important for a range of races and ethnicities to be represented in this feasibility study for multiple reasons. One reason was that testing the intervention would reveal differences in how the informational nudges impacted food pantry utilization, SNAP enrollment, and food security status across a variety of racial and ethnic groups. Uncovering whether race and ethnicity was a factor that influenced the efficacy of the informational nudges in changing the targeted outcomes is essential for applying necessary changes to improve the efficacy of this intervention for future use. These specific discoveries are essential because adaptations can be made to the intervention text messages to better address the unique food security-related informational needs of individuals and families across different people groups. An aspect of this study that was especially important for understanding the impact of the intervention across races and ethnicities were the intervention acceptability questions that participants in the intervention group responded to during their final data collection. The occurrence of

convergent and divergent opinions regarding the intervention was made discoverable by asking participants whether the text messages were easy to understand, if the text messages were helpful, and what their overall opinion of the text messages was. This qualitative data will be critical for applying modifications to the intervention for future use so that it is appropriately tailored for the target population.

An initial concern about addressing the information barrier to accessing food among individuals experiencing food insecurity involved the extent to which using text messages as an intervention would prevent the most vulnerable individuals from joining the study given the low-income status of the target population and their need for a mobile phone to receive the intervention text messages. Throughout the duration of the participant recruitment process, a large majority of screener survey respondents indicated that they had access to a mobile phone that could receive text messages. The bulk of respondents who reported that they had access to a mobile phone despite visiting a food pantry to access food highlighted the ubiquity of mobile phones even among those who are low-income earners. This was consistent among the sample of participants recruited for this study, as most participants reported earning less than $25,000 per year. An unverifiable supposition in the context of this study is that the lowest earners, who are individuals at the greatest risk of food insecurity, may not have bothered completing the screener survey given that the QR code and URL listed on the flyer needed to be accessed using an electronic device (i.e., mobile phone, tablet, computer). Accepting the premise that those at the greatest risk of food insecurity were likely excluded from the study on the basis of their lack of a mobile phone due to economic disadvantages would affirm that exclusively using text messages to address

the information barrier to accessing food is a potentially useful yet insufficient means to promoting food insecurity among individuals experiencing food insecurity.

5.3. Study Phase 1 and Study Phase 2

Testing the informational nudge intervention through one-on-one interviews with community members was a useful method for modifying the text message to optimize its efficacy and acceptability among the target population of food pantry clients. By testing the original conceptualization of the informational nudge intervention in the first phase of this research study, unique interpretations and perspectives of the text message were communicated by community member interviewees that shed light on aspects of the message that could be improved through alteration and specific ways to alter the message toward improvement. Seeking the viewpoints of local community members regarding the informational nudge text message used in this food insecurity intervention was a vital step in appropriately tailoring the message to the eventual recipients of the message who were also members of the community.

Responses to interview question 1 were aligned with the intended purpose of the text message, as informational nudge testing participants perceived that the message was trying to convey to recipients the availability of food assistance resources in their community. The average score of 3.5 that was provided by the participant sample of community members on interview question 2, which asked how persuasive or convincing the message would be for food pantry clients, was an indication of the need to improve the message so that it would be more persuasive and convincing. Participant feedback about detailing more of the benefits of SNAP was applied to the message to enhance its level of persuasion when eventually delivered to food pantry clients. The average score of 4.2 that was given by the sample of community members on interview question 3,

which asked how personally relevant the text message would be for food pantry clients, suggested that the message would be reasonably relevant for its target population. Again, participant feedback emphasized the need to provide more details about what SNAP food benefits entail. This feedback contributed to the modifications that were made to the message, which aimed to strike a balance between providing sufficient details about SNAP food benefits while also keeping the message concise.

Nine of the 10 community member responses to interview question 4, which asked whether the message was clear, responded “yes” to it being clear. When asked if there was anything about the message that they liked in interview question 5, various aspects of the message were mentioned. The community members liked that the intention of the message was to help people in the community, that the message covered key information while remaining short and to the point, and how it was worded in a friendly manner. When questioned about anything they disliked about the message in interview question 6, concerns resurfaced about not knowing what SNAP is and how the message was not adequately spaced in its previous format. These issues were raised in several different interviews, which strengthened the case for improving the text message by elaborating upon the SNAP benefits and integrating more spacing in the message. The concern about the need for a more thorough description of SNAP benefits was again raised by community members in their responses to interview question 7 about their overall thoughts on the message.

Important modifications were made to improve the message by providing a brief explanation for what the SNAP program is, and through editing the format of the message to make it concise and more spaced out. Integrating community-based participation in the creative process of constructing the informational nudge used in this

study was a critical step in the process of delivering a text message-based food insecurity intervention to food pantry clients in the community. As in other community-based participatory research, it was important to account for the cultural values, social norms, and lived experiences of residing in the same community as the study location so that the intervention was best suited for its intended recipients.[309]

Despite missing data being present for eight of the 24 original participants, weak relationships were detected between participant attrition and intervention group status, as well as participant attrition and the primary study outcomes. These findings were important given the attrition rate for this study was 25 percent, and the typical attrition rate for food insecurity intervention studies is 20 percent.[256] With data missingness having been weakly related to group status and the primary study outcomes, this indicated that attrition did not impact study outcomes. The random assignment of participants to study groups seemed to have been successful in evenly distributing individuals who would eventually have missing data between the two groups.

The effect size estimations and independent samples t-tests that were conducted to determine how the intervention impacted each primary study outcome yielded findings that varied considerably across food pantry utilization, SNAP registration, and food security. The weak effect of the intervention on food pantry utilization suggested that the informational nudges had little-to-no impact on prompting participants in the intervention group to use their maximum allowed visits to food service entities within the Arizona Food Bank Network. One potential explanation for this outcome was the ceiling effect that the maximum of two food pantry visits imposed on the food pantry utilization outcomes at one-month and two-months.[301] Intervention group participants received the text message once per week on Monday mornings, so participants who had already

visited a food pantry twice in the first half of the month could no longer access the resources what the informational nudging was prompting them to use when they were receiving the text messages in the second half of the month. Only one known study has previously used informational nudges to prompt individuals to access a food pantry, and the study was successful in increasing food pantry utilization, but it is important to note that the food pantry in that study did not impose as strict of limitations on clients in terms of how often they could obtain food from the pantry.[105]

Another potential explanation for the small intervention effect on food pantry utilization is that a history effect, which is a threat to the internal validity of the estimated intervention effect that results from unmeasured changes in the circumstances of participants, may have obscured the estimated efficacy of the intervention.[301] While participants were randomly assigned to study groups which evenly distributed potential confounding variables between groups, there was not a feature integrated within the study to track emerging barriers or sources of support among participants in both study groups throughout the duration of the study. For example, after being randomly assigned to the intervention group, an individual may no longer have needed to access the food pantry in the following months due to external sources of economic support, or that same individual could have experienced a loss of transportation that prevented them from traveling to the food pantry despite them being nudged to use the food assistance resources available to them on a weekly basis.

However, the weak effect of the intervention could be an accurate depiction of how text messaged-based food insecurity interventions that aim to increase food pantry utilization by removing information barriers are received among individuals who had already accessed a food pantry at least once in the past. Accessing food pantries lowers

the odds of severe food insecurity,[245] so it is still necessary to determine how to best nudge individuals experiencing food insecurity to make the most of the food assistance that local food pantries offer. Given the limited number of monthly visits that individuals are allotted to food assistance entities within the Arizona Food Bank Network, a food insecurity intervention like the one used in this study may be best suited for individuals who are food insecure and have never obtained food from a food pantry and/or do not know of any food pantries in their community where they can access food. Nonetheless, the research hypothesis for primary aim 1 in this study was rejected since individuals in the intervention group did not demonstrate higher food pantry utilization when compared to those in the control group at one-month and two-months.

The non-existent impact that the intervention had on SNAP registration among participants in the intervention group produced a seemingly negative relationship between the intervention and registering for SNAP. Throughout the study, no individuals assigned to the intervention group registered for SNAP, while two individuals in the control group registered for SNAP. Given that the text messages sent to individuals in the intervention group included a nudge to ask a member of NourishPHX about registering for SNAP, the informational nudges were ineffective in helping people who were not registered for SNAP gain access to this food assistance program. Effect size estimates suggested that the intervention yielded opposite outcomes than were intended, as a lower prevalence of intervention group participants registered for SNAP than control group participants. These outcomes were especially unanticipated since an inclusion criterion to join this study required that participants were not registered for SNAP at baseline.

There are several potential explanations as to why none of the intervention group participants registered for SNAP throughout the study. One reason could be due to participants being able-bodied adults without dependents (ABAWD). According to the Arizona Department of Economic Security, ABAWD's between the ages of 18-49 years old are limited to three months of SNAP benefits in a three-year period if they are not working at least 80 hours a month or an average of 20 hours per week.[310] Four intervention group participants were exempt from the ABAWD work requirement due to being 50 years of age or older, so there could have been other explanations for them not registering for SNAP, including earning too high of a gross or net annual income, possessing assets that combine to be worth a high value, being a non-citizen of the United States, or some other unknown reasons.[311] In retrospect, this study could have involved asking participants whether they are eligible for SNAP. If the participant is not eligible, then a follow-up question could ask why specifically they are ineligible. If the participant is unsure about their eligibility, then the informational nudges would continue prompting them to ask a member of NourishPHX about their eligibility for SNAP benefits. If the participant is eligible and still does not register for SNAP throughout the study, then participants could be asked why they did not register for available SNAP benefits at the end of the study. Using this approach in the present study could have produced useful information as to why no intervention group participants registered for SNAP. Food insecurity is related to chronic disease[196] and can be alleviated through SNAP benefits,[97] so it is important to discover ways to identify individuals who are food insecure and eligible for SNAP but are not yet enrolled SNAP, while also determining how to best nudge these individuals to access the food assistance that is readily available to them. What was clear at the end of this study is how the research hypothesis for primary aim 2

was rejected since the rate of SNAP registration in the intervention group was not greater than the rate of SNAP registration in the control group.

Promoting food security among individuals who were food insecure was the ultimate goal of this research. Despite the unfavorable intervention outcomes that occurred for food pantry utilization and SNAP registration, it was determined that, after all participants were food insecure upon joining the study, just over half of the participants in the intervention group were still food insecure at two-months into the study while the entire control group remained food insecure throughout the duration of the research. A potential reason for the precipitous decline in food insecurity prevalence among the intervention group could that the informational nudges helped address an information barrier that had previously prevented participants from consistently knowing how to access food.[49,51,52] Food security-related outcomes from this study support the notion that information related to food assistance is critical for preventing or alleviating food insecurity, as results derived from the limited efficacy testing process in this study highlighted how the food security status of intervention group participants improved over time despite food pantry utilization and SNAP registration remaining unchanged. These findings also add to the growing field of literature that elucidates how informational nudges can be leveraged to improve health behaviors[110,275,277] and health outcomes.[289,291,293]

The beneficial impact of the informational nudges on food security was especially pronounced by how the effect size of the intervention increased over time for food security scores and food security status. Estimated effect sizes of the intervention on both food security scores and food security status were much larger than anticipated. Findings from previous meta-analyses of food assistance-based food insecurity

interventions[256] and behavioral health interventions using informational nudges[275] suggested that a medium-sized effect could be expected for the effect of the intervention on food security. Instead, large intervention effects were detected for food security scores and food security status, while one medium effect of the intervention on food security scores was detected at one-month. The effect of the intervention on food security was larger than expected in a favorable direction. The medium sized effect of the intervention on food security scores at one-month grew to a large effect by two-months, thus suggesting that the efficacy of the intervention was continuing to improve once the study had ended. Additionally, the large effect of the intervention on food security status grew in size from one-month to two-months, as more intervention group participants continued transitioning from being food insecure to becoming food secure.

Despite the significant between-groups differences in food security status being switched from significant to non-significant when statistically adjusted for covariates, the marked decrease in food insecurity prevalence in the intervention group warrants further testing of this intervention so that it may be applied among a larger sample of individuals who are food insecure. Food security scores and food insecurity prevalence were both reduced over time, but the small sample size that was recruited for this feasibility study produced large standard deviations in the food security outcomes, which may have been responsible for the non-significant food security score findings despite food insecurity scores having been lower in the intervention group for both within-groups and between-groups comparisons at each consecutive time point.[312] At face value, recruitment of a larger sample size would have likely been most beneficial for yielding a more accurate understanding of the intervention effect on food security, as the non-significant findings for food security scores and adjusted food security statuses could have been significant

had a larger sample size minimized the standard deviations of the outcomes and the between-group differences remained the same. Alternatively, the significant findings that were detected for unadjusted food security status can easily be discredited due to the lack of statistical power that resulted from a small sample size. Taking into full account the large effect sizes of the intervention on food security scores and food security status along with the significant differences in food security status in the unadjusted statistical model, there is still a strong rationale for scaling this intervention in a future randomized control trial that is adequately powered to detect significant intervention effects through similar within-groups and between-groups analyses. Therefore, the research hypotheses of primary aim 3 was not rejected, as the prevalence of food insecurity was lower in the intervention group than the control group at the end of the study.

The food insecurity intervention used in this study was deemed to be acceptable for the research sample, as a large majority of intervention group participants read the text messages, reported that the text messages were easy to understand, and found the text messages to be helpful. In addition, the themes that were established by participants' short answer responses to the open-ended question asking for their opinions about the text message were primarily positive in nature. The high frequency in which responses aligned with being helpful and informative provided reassurance that the informational nudge testing that occurred at phase one of the study produced an acceptable informational nudge that was ultimately well-received by the text message recipients in the intervention group. Having "informative" be the most common theme to arise in participant responses was a good sign that the text message carried out part of its intended purpose of informing individuals experiencing food insecurity about how they can access food. The text message used as an informational nudge was clearly more

informational than a nudge, as the prompt to visit the food pantry and register for SNAP did not prove to be efficacious in increasing food pantry utilization or SNAP registration. Overall, the high level of intervention acceptability communicated by participants suggested that it would be appropriate to reapply this informational nudge intervention among a similar target population after integrating some necessary improvements to improve the nudging component of the text message.

5.4. Strengths and Limitations

This study contained many strengths in its design and implementation. First, this research addressed a critical knowledge gap through feasibility research methods that allowed for an initial understanding to be gained concerning the extent to which weekly informational nudges in the form of text messages improved food security over time. Second, this study performed a novel application of informational nudges in a study focusing on food insecurity, as no other known study had used informational nudges to specifically promote food security. Third, this research employed a robust mixed-methods approach, which resulted in the accumulation of valuable qualitative data to supplement quantitative data that was produced from limited efficacy testing of the novel food insecurity intervention. Fourth, a majority non-White sample was recruited for this study that allowed for a diverse array of perspectives to be communicated concerning whether participants perceived the intervention to be acceptable, as having a variety of races and ethnicities represented in the participant sample was critical for determining whether perceptions of the intervention differed across participants. Fifth, the random assignment of the participants to study groups strengthened the validity of the study findings by randomly distributing confounding variables that impair the accuracy of the intervention effect between the intervention group and the control group. Sixth, the

longitudinal design of this study was equipped to track changes in the primary study outcomes of food pantry utilization, SNAP enrollment, and food security status over time so that alterations in these outcomes could be examined from before the intervention was implemented throughout the duration of the two-month intervention period. Seventh, the large effect size of the intervention on food security provided a noteworthy findings worthy of replication in future research studies that have adequate statistical power to detect a significant intervention effect without sample size being an issue.

There were also several limitations in this study. First, the participant recruitment approach of placing flyers into boxes of donated food was a useful yet insufficient means of recruiting participants, as the response rate for this approach was just above one percent. In hindsight, a multifaceted approach to participant recruitment should have been executed that was not limited to placing flyers into food boxes. Second, the inclusion criteria that required participants to be able to speak and read English prevented a large contingent of food pantry clients from joining the study, as many individuals who visited the food pantry to obtain food only spoke Spanish while a few others only spoke Chinese. For equity purposes, a Spanish version of the flyer advertisement and study surveys were needed to promote food security among non-English speaking individuals who otherwise would have been eligible to join the study. Third, the discarded inclusion criterion that initially required participants to be first-time food pantry clients restricted the number of screener survey respondents who were eligible to participate in the study. Due to its highly exclusionary nature and how the sample population were food pantry clients, this inclusion criterion that required participants to be first-time food pantry clients was removed, but not before the sample size was constrained due to a multitude of screener survey respondents being excluded

from the study based on their food pantry use history. Fourth, outcomes that resulted from the limited efficacy testing of the intervention effects on the primary study outcomes must be interpreted with caution, as this study did not have adequate statistical power for the quantitative study findings for the intervention to be translated as accurate effect size estimates due to the small sample size of research participants. Although the recruitment of a small sample was intentional in this feasibility study so as to not potentially waste resources while conducting a research intervention for which there was no certainty of a beneficial outcome, the statistical power drawbacks of recruiting a small sample still foster warranted skepticism about the legitimacy of any statistically significant study findings. Fifth, the inclusion criterion that required study participants to have regular access to a mobile phone that can receive text messages undoubtedly prevented some of the most vulnerable individuals experiencing the most severe cases of food insecurity from joining the study. Despite a large proportion of the U.S. adult population having access to a cell phone, those who are suffering from the most extreme forms of economic hardship and food insecurity are unlikely to be able to afford a mobile phone let alone a monthly cellphone plan that includes text messaging. Sixth, the survey-based nature of this research study consisted entirely of self-report approaches to data collection. Relying wholly on self-report data collection approaches potentially introduced biases that involve answering questions according to perceived researcher expectancies or social desirability. Seventh, participant attrition throughout the duration of the study resulted in missing data that could have helped provide research findings of greater accuracy. Despite that all available data were analyzed regardless of missingness, the disadvantageous incidences of missing data that arose from participants dropping out of the study caused an unanticipated absence of important information.

5.5. Conclusions

This feasibility study was a valuable research endeavor that successfully examined the limited efficacy and acceptability of a novel food insecurity intervention that used text messages as informational nudges to communicate critical food assistance information to individuals experiencing food insecurity. Evidence derived from the study indicated that a food insecurity intervention using informational nudges in the form of text messages was successful in promoting food security among food pantry clients who were food insecure. Effect size estimates revealed that the intervention had a large effect on improving food security. Despite the small sample size recruited for this research, findings provided evidence to justify scaling this food insecurity intervention to test whether the large effect of the intervention on food security can be replicated among food pantry clients experiencing food insecurity in a study with a larger sample size that has sufficient statistical power to detect a significant intervention effect. Eliminating barriers to food access is essential for mitigating the problem of food insecurity. It is critical that a greater priority be placed on eliminating food insecurity. Promoting food security enhances public health through the prevention of chronic diseases that result from poor diet, nutritional deficiencies, and hunger.

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APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL TO CONDUCT RESEARCH

APPROVAL: MODIFICATION

Christopher Wharton
CHS: Health Solutions, College of
602/496-1727
Christopher.Wharton@asu.edu

Dear Christopher Wharton:

On 10/31/2022 the ASU IRB reviewed the following protocol:

Type of Review:	Modification / Update
Title:	FINDING-Food: Frequent Informational Nudges Directing Individuals to Needed Goods. A Food Insecurity Intervention.
Investigator:	Christopher Wharton
IRB ID:	STUDY00016379
Funding:	Name: Arizona State University (ASU), Funding Source ID: CC0054, PG00295
Grant Title:	None
Grant ID:	None
Documents Reviewed:	• Baseline Survey, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Consent Form (Intervention Testing), Category: Consent Form; • Consent Form (Main Study), Category: Consent Form; • Eligibility Screener Survey, Category: Screening forms; • Intervention Testing Interview Script, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • IRB Form, Category: IRB Protocol; • Wave 2 Survey, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Wave 3 Survey, Category: Measures (Survey

	questions/Interview questions /interview guides/focus group questions);

The IRB approved the modification.

When consent is appropriate, you must use final, watermarked versions available under the "Documents" tab in ERA-IRB.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

IRB Administrator

cc: Michael Royer
Michael Royer
Christopher Wharton

Approved

Entered IRB: 10/25/2022 11:31 AM
Approval: 10/31/2022
Initial effective: 10/31/2022
Effective: 10/31/2022
Last updated: 10/31/2022 3:03 PM

Next Steps

View Modification/CR

Add Comment

Bundle Attachments to PDF

MOD00018982: Modification / Update #1 for Study FINDING-Food

Principal investigator: Christopher Wharton
Submission type: Modification / Update
Primary contact: Michael Royer

IRB office: ASU IRB
IRB coordinator: Richard Gilmour
Letter: Correspondence_for_MOD00018982.pdf(0.01)

Regulatory authority: Pre-2018 Requirements

APPENDIX B

PHASE 1 INFORMED CONSENT FORM FOR INFORMATIONAL NUDGE TESTING

[POTENTIAL PARTICIPANT GREETING]

Hello. Are you interested in completing a 5-minute interview for a $5 gift card?

> *If yes:* That's great! Before the interview, I would like to share some details about the work and get your consent.
>
> *If no:* Have a nice day.

[SHARE CONSENT FORM]

My name is Michael Royer and I'm from the College of Health Solutions at Arizona State University. I am working to develop and evaluate a novel food insecurity intervention using informational nudges via text messages to promote food security by informing vulnerable individuals about when, where, and how they can access food assistance. Your feedback in a 5-minute interview would provide valuable information to improve these text messages.

To participate in the interview, you must be at least 18 years old. You have the right not to answer any questions, and to stop participating at any time and your participation in this project is voluntary. Your responses will be confidential. After the interview, you will receive a $5 gift card for your participation. Your responses in this interview will be used to guide the design of a research intervention that we are testing. For this reason, the interview will be audio recorded with your permission. Please let me know if you do not want the interview to be recorded. You can end the interview at any time.

Please feel free to ask questions about the eventual research study. Contact the research team at Christopher.Wharton@asu.edu. If you have any further questions about your rights in this interview or if you feel that you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788.

Do I have your permission to start the interview?

[VERBAL CONSENT]

> *If yes*: Thank you. Let's get started.
> *If no:* Thank you for your time.

APPENDIX C

PHASE 1 INTERVIEW SCRIPT FOR INFORMATIONAL NUDGE TESTING IN STUDY

[START RECORDING, IF ALLOWED]

I am going to ask for your honest opinions about the text message that I will show. Let's get started. I will pull up the text message on the screen.

[PULL UP TEXT]

I have a few questions about this text message.

[PROVIDE TIME TO READ THE MESSAGE]

[READ THE FOLLOWING QUESTIONS ALOUD]

1. What do you think the message is trying to convey?

2. On a scale of 1-5, with 5 being the best, how persuasive or convincing do you think this message would be for food pantry clients?
    a. Why did you choose this rating?

3. One a scale of 1-5, how personally relevant do you think this message would be for food pantry clients?
    b. Why did you choose this rating?

4. Was this message clear?
    a. Why not? (if no)

5. Was there anything about this message that you particularly liked?

6. Was there anything about this message that you particularly disliked?

7. What are your overall thoughts on the message that we have just discussed with you?

That was the last question I have for our interview today. Thank you for your feedback on these messages. I appreciate your time and for sharing your ideas.

APPENDIX D

FLYER FOR PHASE 2 PARTICIPANT RECRUITMENT

ASU College of Health Solutions
Arizona State University

Food Assistance Information Study

Earn $20 while sharing your experiences involving food access and intake!

What is this study about?

We are interested in identifying beneficial and effective approaches to help individuals access food in their community.

How will this study happen?

During the study, some participants will receive weekly text messages about food resources from the research team. All participants will complete three 10-minute surveys over the span of three months. Compensation will be provided after each survey.

Who can join?

All adults ages 18 years and older are invited to access our eligibility survey with the QR code and website URL posted on this flyer!

chs.asu.edu

Interested in joining?
Scan the QR code below:

Or access the eligibility survey with this URL:
bit.ly/FINDINGfood

Contact us at:
RadicalSimplicityLab@ASU.edu

Participation is voluntary.

APPENDIX E

PHASE 2 PARTICIPANT ELIGIBILITY SURVEY FOR RESPONDENTS

Start of Block: Eligibility Screener

(Welcome) Welcome to the eligibility survey for the Food Assistance Information Study!

Please answer the following 7 questions to determine if you qualify to participate in our study.

EQ1 Are you an adult? (i.e., at least 18 years old or older)

- ○ No (1)
- ○ Yes (2)

Skip To: Ineligible If Are you an adult? (i.e., at least 18 years old or older) = No

EQ2 Can you speak and read English?

- ○ No (1)
- ○ Yes (2)

Skip To: Ineligible If Can you speak and read English? = No

EQ3-Pantry Was your recent visit to NourishPHX the first time you had ever used a food pantry to obtain food?

- ○ No (1)
- ○ Yes (2)

Skip To: Ineligible If Was your recent visit to NourishPHX the first time you had ever used a food pantry to obtain food? = No

EQ4-FSSM1 In the last 30 days, I worried whether my food would run out before I had money to buy more.

- ○ Often true (1)
- ○ Sometimes true (2)
- ○ Never true (3)

Skip To: Ineligible If In the last 30 days, I worried whether my food would run out before I had money to buy more. = Never true

EQ5-FSSM2 In the last 30 days, the food I bought just didn't last and I didn't have money to get more.

- ○ Often true (1)
- ○ Sometimes true (2)
- ○ Never true (3)

Skip To: Ineligible If In the last 30 days, the food I bought just didn't last and I didn't have money to get more. = Never true

EQ6-SNAP Do you or anyone in your household currently get SNAP or Food Stamps?

- ○ No (1)
- ○ Yes (2)

Skip To: Ineligible If Do you or anyone in your household currently get SNAP or Food Stamps? = Yes

EQ7 Do you have regular access to a mobile phone that can receive text messages?

- ○ No (1)
- ○ Yes (2)

Skip To: Ineligible If Do you have regular access to a mobile phone that can receive text messages? = No

Display This Question:

If Was your recent visit to NourishPHX the first time you had ever used a food pantry to obtain food? = No

Or Are you an adult? (i.e., at least 18 years old or older) = No

Or Can you speak and read English? = No

Or Do you have regular access to a mobile phone that can receive text messages? = No

Or Do you or anyone in your household currently get SNAP or Food Stamps? = Yes

Or In the last 30 days, I worried whether my food would run out before I had money to buy more. = Never true

Or In the last 30 days, the food I bought just didn't last and I didn't have money to get more. = Never true

(Ineligible) We're sorry, but you do not qualify for the Food Assistance Information study.

We thank you for your interest and time.

Skip To: End of Survey If We're sorry, but you do not qualify for the Food Assistance Information study. We thank you for y... Is Displayed

End of Block: Eligibility Screener

APPENDIX F

PHASE 2 INFORMED CONSENT FORM FOR ELIGIBLE RESPONDENTS

Welcome to the Food Assistance Information Study!

My name is Michael Royer, and I am a graduate student under the direction of Dr. Christopher Wharton in the College of Health Solutions at Arizona State University. We are conducting this research study to explore the connection between the awareness of food services and food access.

We invite you to participate in our study, which will involve completing an online survey consisting of questions concerning (1) your recent experiences obtaining food, (2) your past and current access to food assistance, (3) your sociodemographics (*e.g.,* age, sex, race/ethnicity), and (4) your mobile phone number.

Your participation in this study is voluntary. There is no penalty if you choose not to participate or to withdraw from the study at any time. Participants in this study must be adults aged 18 years or older who can speak and read English, are first-time food bank users, and have regular access to a mobile phone that can receive text messages. The study will consist of three brief online surveys over the span of three months. It is estimated that each survey will take approximately 5-10 minutes to complete. We will not ask for any identifying information in this survey other than your phone number and email. For research purposes, an anonymous numeric code will be assigned to your survey responses. Certain study participants will eventually receive weekly text messages from a member of the research team. A total of 10 text messages will be sent to participants throughout the duration of the study. Eight text messages that are to include information about food will be sent to participants every week for eight weeks straight. The remaining two text messages will be sent approximately one month and two months after the study begins, which will contain a link to complete a data collection survey. If you prefer not to answer a question, then please do not hesitate to close the survey in your web browser. Please be advised that no compensation will be provided for a partially completed survey. Participants will receive $5 for completing the first survey, $6 for completing the second survey, and $9 for completing the third and final survey. In total, participants will receive $20 for full participation. Compensation will be provided via online gift cards.

Benefits to participating in this study involve potentially receiving up-to-date information on a weekly basis concerning food assistance resources. Please know that your mobile phone number and email will remain confidential in being securely stored and never being shared with anyone. Also, please know that some survey questions may cause discomfort since they ask about your recent experiences obtaining food along with your current food assistance status.

Your responses on this survey are anonymous and will remain confidential. The results of this study may be used in publications or presentations, but there will be no way of knowing who the individuals were that participated in this research. All data collected as a part of this current study will not be shared with other individuals, groups, or entities for future research purposes.

If you have any questions concerning the research study, please contact the research team at: Christopher.Wharton@asu.edu. If you have any questions about your rights as

a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788. Please let me know if you wish to be part of the study.

By proceeding in this full survey, you are agreeing to be part of the study. Otherwise, please close your browser if you would not like to proceed.

Thank you for your time.

APPENDIX G

PHASE 2 BASELINE SURVEY FOR STUDY PARTICIPANTS

Start of Block: Food Access

FA9-11Qs This first section will include 6 to 8 items about your access to food.

FSSM3 In the last 30 days, I couldn't afford to eat balanced meals.

- ○ Often true (1)
- ○ Sometimes true (2)
- ○ Never true (3)

FSSM4 In the last 30 days, did you or anyone else in your household ever cut the size of your meals or skip meals because there wasn't enough money for food?

- ○ No (1)
- ○ Yes (2)

Display This Question:

If In the last 30 days, did you or anyone else in your household ever cut the size of your meals or... = Yes

FSSM5 How often did this happen?

- ○ Almost every week (1)
- ○ Some weeks but not every week (2)
- ○ Only 1 or 2 weeks (3)

FSSM6 In the last 30 days, did you ever eat less than you felt you should because there wasn't enough money for food?

- No (1)
- Yes (2)

FSSM7 In the last 30 days, were you ever hungry but didn't eat because there wasn't enough money for food?

- No (1)
- Yes (2)

FSSM8 In the last 30 days, did you lose weight because there wasn't enough money for food?

- No (1)
- Yes (2)

FSSM9 In the last 30 days, did you or anyone else in your household ever not eat for a whole day because there wasn't enough money for food?

- No (1)
- Yes (2)

Display This Question:

If In the last 30 days, did you or anyone else in your household ever not eat for a whole day becaus... = Yes

FSSM10 How often did this happen?

- ○ Almost every week (1)
- ○ Some weeks but not every week (2)
- ○ Only 1 or 2 weeks (3)

End of Block: Food Access

Start of Block: Participant Characteristics

PC7Qs This final section includes 7 items involving general details about yourself.

Age Please indicate your age in years.

▼ 18 (1) ... 120 (103)

Sex Please indicate your biological sex.

- ○ Female (1)
- ○ Male (2)

Race/Ethnicity Please indicate your race/ethnicity.

- ○ American Indian / Alaska Native (1)
- ○ Asian (2)
- ○ Black (3)
- ○ Hispanic / Latino (4)
- ○ Native Hawaiian / Pacific Islander (5)
- ○ White (6)
- ○ More than one race (7)

Education Please indicate your highest level of education.

- ○ Less than high school (1)
- ○ High school graduate (2)
- ○ Some college (3)
- ○ Bachelor's degree (4)
- ○ Graduate degree (5)

Income Please indicate your annual income level.

- ○ Less than $25,000 (1)
- ○ $25,000 to $49,999 (2)
- ○ $50,000 to $74,999 (3)
- ○ $75,000 to $99,999 (4)
- ○ $100,000 or more (5)

Phone Number Please provide your 10-digit mobile phone number (ex: 777-777-7777).

_____

Fr/Fam Phone Number In case we lose contact with you, please provide a 10-digit phone number (ex: 777-777-7777) for one of your friends or family members.

_____

Email Address Please provide your email address to receive a $5 virtual gift card as compensation for your participation.

_____

End of Block: Participant Characteristics

APPENDIX H

PHASE 2 TIME POINT 2 SURVEY FOR PARTICIPANTS

Start of Block: Welcome Back

(Welcome) Welcome back to the Food Assistance Information study!

Please proceed to complete your second study survey.

End of Block: Welcome Back

Start of Block: Food Access

FA10-12Qs This first section will include 10 to 12 items about your access to food.

SNAP Do you or anyone in your household currently get SNAP or Food Stamps?

- ○ No (1)
- ○ Yes (2)

Food Bank How many times did you obtain food from an Arizona-based food bank in MonthName?

▼ 0 (1) ... 2 (3)

FSSM1 In the last 30 days, I worried whether my food would run out before I got money to buy more.

- ○ Often true (1)
- ○ Sometimes true (2)
- ○ Never true (3)

FSSM2 In the last 30 days, the food that I bought just didn't last, and I didn't have enough money to buy more.

- ○ Often true (1)
- ○ Sometimes true (2)
- ○ Never true (3)

FSSM3 In the last 30 days, I couldn't afford to eat balanced meals.

- ○ Often true (1)
- ○ Sometimes true (2)
- ○ Never true (3)

Page Break

FSSM4 In the last 30 days, did you or anyone else in your household ever cut the size of your meals or skip meals because there wasn't enough money for food?

- ○ No (1)
- ○ Yes (2)

Display This Question:

If In the last 30 days, did you or anyone else in your household ever cut the size of your meals or... = Yes

FSSM5 How often did this happen?

- Almost every week (1)
- Some weeks but not every week (2)
- Only 1 or 2 weeks (3)

FSSM6 In the last 30 days, did you ever eat less than you felt you should because there wasn't enough money for food?

- No (1)
- Yes (2)

FSSM7 In the last 30 days, were you ever hungry but didn't eat because there wasn't enough money for food?

- No (1)
- Yes (2)

FSSM8 In the last 30 days, did you lose weight because there wasn't enough money for food?

- No (1)
- Yes (2)

FSSM9 In the last 30 days, did you or anyone else in your household ever not eat for a whole day because there wasn't enough money for food?

- No (1)
- Yes (2)

Display This Question:

If In the last 30 days, did you or anyone else in your household ever not eat for a whole day becaus... = Yes

FSSM10 How often did this happen?

- ○ Almost every week (1)
- ○ Some weeks but not every week (2)
- ○ Only 1 or 2 weeks (3)

End of Block: Food Access

Start of Block: Contact Information

CI2Qs This final section includes 2 items asking for your contact information.

Phone Number Please provide your 10-digit mobile phone number (ex: 777-777-7777).

_____

Email Address Please provide your email address to receive a $6 virtual gift card as compensation for your participation.

_____

End of Block: Contact Information

APPENDIX I

PHASE 2 TIME POINT 3 SURVEY FOR THE INTERVENTION GROUP

Start of Block: Welcome Back

(Welcome) Welcome back to the Food Assistance Information study!

Please proceed to complete your final study survey.

End of Block: Welcome Back

Start of Block: Food Access

FA10-12Qs This first section will include 10 to 12 items about your access to food.

SNAP Do you or anyone in your household currently get SNAP or Food Stamps?

- ○ No (1)
- ○ Yes (2)

Food Bank How many times did you obtain food from an Arizona-based food bank in MonthName?

▼ 0 (1) ... 2 (3)

FSSM1 In the last 30 days, I worried whether my food would run out before I got money to buy more.

- ○ Often true (1)
- ○ Sometimes true (2)
- ○ Never true (3)

FSSM2 In the last 30 days, the food that I bought just didn't last, and I didn't have enough money to buy more.

- Often true (1)
- Sometimes true (2)
- Never true (3)

FSSM3 In the last 30 days, I couldn't afford to eat balanced meals.

- Often true (1)
- Sometimes true (2)
- Never true (3)

FSSM4 In the last 30 days, did you or anyone else in your household ever cut the size of your meals or skip meals because there wasn't enough money for food?

- No (1)
- Yes (2)

Display This Question:

If In the last 30 days, did you or anyone else in your household ever cut the size of your meals or... = Yes

FSSM5 How often did this happen?

- Almost every week (1)
- Some weeks but not every week (2)
- Only 1 or 2 weeks (3)

FSSM6 In the last 30 days, did you ever eat less than you felt you should because there wasn't enough money for food?

- ○ No (1)
- ○ Yes (2)

FSSM7 In the last 30 days, were you ever hungry but didn't eat because there wasn't enough money for food?

- ○ No (1)
- ○ Yes (2)

FSSM8 In the last 30 days, did you lose weight because there wasn't enough money for food?

- ○ No (1)
- ○ Yes (2)

FSSM9 In the last 30 days, did you or anyone else in your household ever not eat for a whole day because there wasn't enough money for food?

- ○ No (1)
- ○ Yes (2)

Display This Question:

If In the last 30 days, did you or anyone else in your household ever not eat for a whole day becaus... = Yes

FSSM10 How often did this happen?

- ○ Almost every week (1)
- ○ Some weeks but not every week (2)
- ○ Only 1 or 2 weeks (3)

End of Block: Food Access

Start of Block: Texts

Texts4Qs This next section includes 4 questions about the text messages you had received during the Food Assistance Information Study.

Texts Read Did you read the text messages that you had received during the Food Assistance Information Study?

- ○ No (1)
- ○ Yes (2)

Text Comprehensib. Were the text messages that you had received during the Food Assistance Information Study easy to understand?

- ○ No (1)
- ○ Yes (2)

Text Helpfulness Were the text messages that you had received during the Food Assistance Information Study helpful?

- ○ No (1)
- ○ Yes (2)

Text Perception In a few words, what do you think of the text messages that you had received during the Food Assistance Information Study?

_____

End of Block: Texts

Start of Block: Contact Information

CI2Qs This final section includes 2 items asking for your contact information.

Phone Number Please provide your 10-digit mobile phone number (ex: 777-777-7777).

_____

Email Address Please provide your email address to receive a $9 virtual gift card as compensation for your participation.

_____

End of Block: Contact Information

APPENDIX J

PHASE 2 TIME POINT 3 SURVEY FOR THE CONTROL GROUP

Start of Block: Welcome Back

(Welcome) Welcome back to the Food Assistance Information study!

Please proceed to complete your final study survey.

End of Block: Welcome Back

Start of Block: Food Access

FA10-12Qs This first section will include 10 to 12 items about your access to food.

SNAP Do you or anyone in your household currently get SNAP or Food Stamps?

- ○ No (1)
- ○ Yes (2)

Food Bank How many times did you obtain food from an Arizona-based food bank in MonthName?

▼ 0 (1) ... 2 (3)

FSSM1 In the last 30 days, I worried whether my food would run out before I got money to buy more.

- ○ Often true (1)
- ○ Sometimes true (2)
- ○ Never true (3)

FSSM2 In the last 30 days, the food that I bought just didn't last, and I didn't have enough money to buy more.

- Often true (1)
- Sometimes true (2)
- Never true (3)

FSSM3 In the last 30 days, I couldn't afford to eat balanced meals.

- Often true (1)
- Sometimes true (2)
- Never true (3)

FSSM4 In the last 30 days, did you or anyone else in your household ever cut the size of your meals or skip meals because there wasn't enough money for food?

- No (1)
- Yes (2)

Display This Question:

If In the last 30 days, did you or anyone else in your household ever cut the size of your meals or... = Yes

FSSM5 How often did this happen?

- Almost every week (1)
- Some weeks but not every week (2)
- Only 1 or 2 weeks (3)

FSSM6 In the last 30 days, did you ever eat less than you felt you should because there wasn't enough money for food?

- ○ No (1)
- ○ Yes (2)

FSSM7 In the last 30 days, were you ever hungry but didn't eat because there wasn't enough money for food?

- ○ No (1)
- ○ Yes (2)

FSSM8 In the last 30 days, did you lose weight because there wasn't enough money for food?

- ○ No (1)
- ○ Yes (2)

FSSM9 In the last 30 days, did you or anyone else in your household ever not eat for a whole day because there wasn't enough money for food?

- ○ No (1)
- ○ Yes (2)

Display This Question:

If In the last 30 days, did you or anyone else in your household ever not eat for a whole day becaus... = Yes

FSSM10 How often did this happen?

- ○ Almost every week (1)
- ○ Some weeks but not every week (2)
- ○ Only 1 or 2 weeks (3)

End of Block: Food Access

Start of Block: Contact Information

CI2Qs This final section includes 2 items asking for your contact information.

Phone Number Please provide your 10-digit mobile phone number (ex: 777-777-7777).

_____

Email Address Please provide your email address to receive a $9 virtual gift card as compensation for your participation.

_____

End of Block: Contact Information