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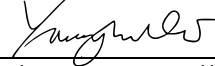
THE IMPORTANCE OF A MULTIDISCIPLINARY APPROACH TO PUBLIC HEALTH:  
ADDRESSING FOOD INSECURITY THROUGH A BIOLOGICAL AND SOCIOLOGICAL  
LENS

By  
Chloe A. Grant

A thesis submitted to the faculty of The University of Mississippi in partial fulfillment of the  
requirements of the Sally McDonnell Barksdale Honors College.

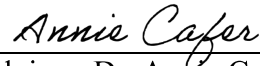
Oxford, MS  
May 2021

Approved By



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Advisor: Dr. Yongjian Qiu



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Advisor: Dr. Annie Cafer

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Reader: Dr. Colin Jackson

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## DEDICATION

This research is dedicated, first and foremost, to all those experiencing food insecurity. It is also dedicated to my friends and family, all of whom I love dearly.

## ACKNOWLEDGEMENTS

I owe many people my deepest gratitude for my success in this work. First, I would like to thank the Sally McDonnell Barksdale Honors College for their funding of my research and their continual encouragement of my many ambitions. I would also like to thank Dr. Annie Cafer, whose wisdom and mentorship helped me grow as an individual throughout this project. To Dr. Yongjian Qiu, your mentorship over the past two years has shaped my time as a student and a person. To Dr. Colin Jackson, thank you for taking the time to better my work as a reader.

For my research on food insecurity, I would first and foremost like to acknowledge Dan Parks. You were with me every step of the way, from brainstorming our survey questions to making our defense presentations. I'm truly grateful we got to know each other during that time; your kindness and passion for helping others inspire me, and your friendship and support mean so much to me. I also owe my endless thanks to every single person that's put in work at Grove Grocery this year. To Mary Beth Gillespie, none of the amazing work we've done this year would have been possible without your brilliant mind and kind spirit. To Susan Soh, your fierce leadership, wit, and determination do so much to keep this organization running each and every day. To Kate Forster, you have gone above and beyond as a student organization leader; we all owe you a tremendous amount of gratitude for everything you've done. To Kate Reinhardt, thank you for making this work possible; your work last year as Director created such a strong foundation for me to build upon. To the Grove Grocery executive team: Maddi Estes, Blake Hydeman, Anastasia Jones-Burdick, Azaziah Parker, Gianna Schuetz, Tina Truong, Isabella Uhls, and Karen Wong, thank you for all of your hard work, leadership, and most importantly, friendship. To every committee member and volunteer at Grove Grocery, thank you for all that you do.

In the Qiu Lab, I would first like to thank Caroline Clutton, whose friendship made this project so enjoyable. Many thanks to Abhishesh Bajracharya, who taught me so much in the lab and never failed to brighten up my day. To Karen Wong (again), I've loved getting to know you and I'm so happy to call you my friend. To Eden Bayer, I'll miss talking to you whenever I come into the lab. To Karlie Grace, who I've known since my freshman year, I'm glad this lab brought us closer as friends. To everyone else that I've worked with in the lab: Julia Lott, Alyssa Stoner, Suzanne Crull, Ella Newton, and Roshan Dhakal, I'm so glad we had a chance to get to know one another.

Finally, to my friends and family, I love you all so much. And to Maeve Grant, my sister and my favorite person, thank you for always being there to support me (or to bully me, depending on the day). Either way, you push me to be a better person and life is better with you in it.

## ABSTRACT

CHLOE A GRANT: The Importance of a Multidisciplinary Approach to Public Health:  
Addressing Food Insecurity Through a Biological and Sociological Lens under the direction of  
Dr. Yongjian Qiu and Dr. Annie Cafer

Plants can sense the change of 1 °C in their growth environment and thus global climate change has a great impact on plant growth and development. The phenomenon that warm non-stress temperatures promote stem and petiole elongation, as well as leaf hyponastic growth, is collectively known as thermomorphogenesis. While it is known that the basic helix-loop-helix (bHLH) transcription factor PIF4 is highly inducible by temperature elevations and controls thermomorphogenesis in dicots (e.g., *Arabidopsis thaliana*), the molecular mechanism underlying thermomorphogenetic growth in monocots is not clear. In this study, I identify PIF4 orthologs in several economically important monocotyledonous species and demonstrate that the expression of one rice and one sorghum PIF4 ortholog is also thermo-inducible. Moreover, conserved motifs in the promoters of these PIF4 orthologs are identified and they may serve as potential binding sites for key transcription factors that regulate PIF4 transcription under warming conditions. Therefore, this study lays the groundwork for future studies in developing climate-change-resistant crops.

Additionally, sociological research on the prevalence of, impact of, and solutions to food insecurity (FI) at the University of Mississippi was conducted. The national rate of FI is approximately 10%, while the rate among postsecondary students is estimated to be about 40%. FI has many negative impacts on physical and mental wellbeing. In order to assess FI at the University of Mississippi, a survey was distributed to students. Results indicate that approximately 41% of students are food insecure while 16.8% are highly food insecure. Food insecurity was correlated with factors such as the lack of a financial safety net, worsened academic performance, and the need for a paid job (which may have the downstream impact of decreasing post-graduation employability and social mobility). Additionally, students that were food insecure also reported struggling with issues such as mental illness. An assessment of Grove Grocery (the University's food pantry) was also performed, which found that it is capable of providing acute relief for food insecurity but that it is an inadequate long-term solution. Suggestions were made to administration and pantry leaders, including that a holistic approach to student wellbeing be taken, that existing campus resources be supported and advertised, and that issues of student wellbeing such as FI be addressed before they progress to emergency situations.

## PREFACE

I've always been one to approach a problem from all angles, and public health is no different. I am completing my undergraduate degree in biology, so I've learned a lot about how advances in the biological sciences can make a positive impact on the field of public health. However, I recognize that scientific research is just one piece of the puzzle. Public health issues are multifaceted and therefore require multifaceted solutions. Food insecurity, for example, is caused by a number of factors, including the rising cost of food, climate change, unsustainable food production, supply chain and waste, socioeconomic inequality, and global conflict. No singular scientific discovery or policy change will eliminate food insecurity altogether.

My research aims to highlight this fact while also providing valuable contributions to the fight against food insecurity. In order to do so, I completed two separate research projects. I conducted plant and molecular biology research as a student researcher in Dr. Yongjian Qiu's lab. This lab ultimately aims to help develop climate-smart crop plants, which would maintain high crop yields even during the face of climate change. At the same time, I conducted sociological research as the Director of Grove Grocery, the University of Mississippi Food Pantry, on the prevalence of, impact of, and solutions to food insecurity at the University. My work on this project has taught me many things, including that scholarly pursuits can become much more valuable when they are treated as a collaborative effort rather than a singular one.

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PART I

Study of PHYTOCHROME-INTERACTING FACTOR 4 (PIF4)-mediated  
thermomorphogenesis in monocotyledonous plants

## INTRODUCTION

In 2019, 2 billion people faced food insecurity worldwide, while an estimated 746 million suffered from severe food insecurity. This was an increase of 60 million from 2014 when global hunger rates began rising for the first time in decades (UN 2020). The major contributing factor to the rise in hunger globally is the growing number of worldwide conflicts. Climate change and global inequality are also major factors (Global Citizen 2020). One of the major impacts of climate change on food consumption and the risk of hunger is the change in crop yields (Tomoko 2015). Since the pre-industrial era, there has been a 2 °C increase in global average surface temperature, which drives regional and seasonal temperature extremes, intensifies heavy rainfall, and changes habitat ranges for plants and animals (Lindsey 2021). Although the range of about 10 to 30 °C is considered non-stressful for many crop species, temperature variations within this range have drastic influences on many aspects of growth and development (Parent 2012). Specifically, fluctuations in the ambient growth temperature of plants can influence developmental, physiological, and morphological responses (Qiu 2021). The process by which some plant organs show specific changes in morphology and/or development when exposed to warmer, nonstressful temperatures is called thermomorphogenesis (Casal 2019). During thermomorphogenesis, moderate increases in ambient temperature cause changes such as exaggerated stem elongation and early flowering (Wigge 2013), which could potentially affect biomass, seed yield, and therefore crop yield (Jung 2009, Berry 2004).

One way to address this issue would be to study the biological, physiological, genetic, and molecular processes that mediate thermomorphogenesis. Long term, such work could be used to develop genetically modified (GM) crops that do not produce a thermomorphogenic response that is detrimental to their yield. Current understanding of the molecular mechanism

underlying plant thermomorphogenesis has been acquired from the studies in *Arabidopsis thaliana* (Arabidopsis), a model dicotyledonous plant. It has been shown that increases in the ambient temperature significantly stimulate the embryonic stem (called hypocotyl) growth of Arabidopsis (Qiu 2020). Because hypocotyl elongation primarily relies on cell elongation, not cell division, the thermo-induced hypocotyl growth in Arabidopsis has been used as a model to study the molecular and cellular mechanisms of thermomorphogenesis.

Among the factors identified in Arabidopsis, phytochrome B (phyB) and phytochrome-interacting factor 4 (PIF4) are two key proteins in the complex network that governs temperature sensitivity and early thermal responses in plants (Casal 2019). Phytochromes are photoreceptors found in plants (and other organisms) that respond to red (R) and far-red (FR) light (Rockwell 2006). In plants, phyB also functions as a temperature sensor (Casal 2019). PhyB has two isoforms in plants: an inactive R-absorbing Pr form and an active FR-absorbing Pfr form; therefore the R/FR ratio mediates the percentage of the active phyB isoform (Rockwell 2006). Additionally, Pfr also reverts to the inactive Pr form in a light-independent, temperature-dependent reaction called thermal reversion (Schäfer 1974). Elevations in ambient temperature increase the rates of thermal reversion, therefore decreasing the amount of Pfr found in plant cells (Legris 2016). PhyB regulates both PIF4 transcription with the Evening Complex and PIF4 protein stability through physical interactions (Qiu 2020). PIF4 is a basic loop-helix-loop (bHLH) transcription factor that induces the expression of genes involved in the biosynthesis and signaling of auxin (a growth-promoting phytohormone) in response to moderately increased temperature (Qiu 2020). The null mutant *pif4* failed to elongate its hypocotyl at warm temperatures and showed a drastically reduced temperature response compared with the wild-type plants. Warm temperatures induce *PIF4* transcription in both

long-day (LD) and short-day (SD) conditions but at a distinct time of the day - during the daytime in the LD regime, whereas toward the end of the night in the SD condition.

The aim of this study was to identify orthologs of *Arabidopsis thaliana* *PIF4* (*AtPIF4*) and study whether the thermo-induced *PIF4* accumulation is a conserved mechanism in monocots. To investigate whether monocotyledonous crop plants exhibit a thermomorphogenic response similar to that of *Arabidopsis*, rice (*Oryza sativa*) and sorghum (*Sorghum bicolor*) were grown at differential non-stress temperatures (20 °C and 27 °C). The shoot length and expression of *AtPIF4* orthologs were measured in order to assess their thermomorphogenic response. It was found that both rice and sorghum exhibit elongated shoot length (e.g., second leaf length) and induction of *PIF4* expression at an elevated warm temperature. This research suggests that a conserved thermomorphogenetic mechanism may exist in angiosperm and lays the foundation of future studies on *PIF4*-mediated thermomorphogenesis in flowering plants.

## MATERIALS AND METHODS

### **Plant materials**

The maize (*Zea mays*) cultivar B73 (accession PI 550473) and the brachypodium (*Brachypodium distachyon*) cultivar Bd21 (accession W6 36678) and Bd21-3 (accession W6 39233) were obtained from the U.S. National Plant Germplasm System. The rice (*Oryza sativa subsp. japonica*) cultivar Nipponbare and the sorghum (*Sorghum bicolor*) cultivar Btx623 were provided by Dr. Scott Baerson of the USDA Natural Products Research Center in Oxford, Mississippi.

### **Seed sterilization and plant growth**

Seeds were rinsed with 70% ethanol for <1 minute, surface sterilized with commercial bleach (3% sodium hypochlorite, 0.05% Triton X-100) for 10 minutes, and washed 6 times with double-distilled H<sub>2</sub>O. Surface-sterilized seeds were plated on one-half-strength Murashige and Skoog medium (1/2 MS 0) with 0.8% [w/v] agar. Seeds were sown one line per dish without aggregation either in GA-7 plant culture boxes (bioWORLD, USA) or on 100 mm × 100 mm square plastic Petri dishes (Fisher Scientific, USA). Boxes or Petri dishes were sealed with porous vent tape (3M, USA) and stratified in dark at 4 °C for 2-5 days before being transferred to a LED growth chamber (Percival Scientific, USA). (continuous red light, light intensity of 50  $\mu\text{mol m}^{-2} \text{s}^{-1}$ ).

## **Phenotypic measurements**

Seedlings were placed on clear transparency films and scanned at 800 pixels/inch using an Epson Perfection V600 Photo Scanner. Measurements were taken of the coleoptile, first leaf sheath, first leaf blade, second leaf, and total shoot length using ImageJ/FIJI software (NIH). Seedling images were processed in Adobe Photoshop.

## **RNA extraction**

Samples of plant tissue were collected by using ethanol-sterilized forceps and scissors. Seedlings were removed from the growth vessel, placed in individual 1.5 mL microcentrifuge tubes, flash-frozen in liquid nitrogen, and stored at -80 °C until use. Three biological replicates per strain per treatment were collected.

RNA was prepared using the Quick-RNA MiniPrep RNA kit (Zymo Research, USA) following the manufacturer's instructions. Samples were removed from storage (-80 °C freezer) and pulverized using a ceramic mortar and pestle chilled with liquid nitrogen. The fine powder of tissue samples was then transferred to a 1.5 mL nuclease-free microcentrifuge tube and lysed in 600  $\mu$ L RNA Lysis Buffer. The homogenized sample was cleared by centrifugation at 16,000  $\times$  g for 1 min, and the supernatant was filtered through a Spin-Away filter. An equal volume of 100% ethanol was added to the flow-through and the mixture was filtered through a Zymo-Spin IIICG column to bind total RNA to the column. After on-column DNA digestion, RNA was washed with RNA Prep Buffer and RNA Wash Buffer and finally eluted with 50-100  $\mu$ l nuclease-free water. The concentrations of eluted RNA were measured using Nanodrop 2000 (Thermo Fisher Scientific, USA).

### **First-strand cDNA synthesis**

Total RNA (approximately 2.5 µg) was reverse transcribed using Invitrogen SuperScript III Reverse Transcriptase (Thermo Fisher Scientific, USA) following the manufacturer's instructions. Specifically, 1 µL of oligo(dT)<sub>20</sub> (Thermo Fisher Scientific, USA), 2.5 µg of total RNA, 1 µL 10 mM dNTP mix (NEB, USA), and nuclease-free water were added to a nuclease-free microcentrifuge tube, heated to 65 °C for 5 minutes, and incubated on ice for 1 minute. 5× First-Strand buffer, DTT, RNaseOUT (Thermo Fisher Scientific, USA), and SuperScript III RT (200 units/µL) were added. Mixtures were incubated at 50 °C for 30 min, 55 °C for 30 minutes, and inactivated by heating at 70 °C for 15 minutes. Synthesized cDNA of each sample was diluted 45 times in nuclease-free water before used for quantitative PCR.

### **Primer design for qPCR**

The qPCR primers for *PIF4* orthologs and reference genes of each species were designed by using NCBI Primer BLAST. The detailed settings are as follows: PCR product size = 90-130 nucleotides;  $T_{m_{min}} = 52$  °C,  $T_{m_{max}} = 57$  °C,  $T_{m_{opt}} = 55$  °C, max  $T_m$  difference = 2 °C; min intron length = 200 nucleotides; primer size = 19-24 nucleotides; primer GC content = 30-60%; GC clamp = 1, max GC in primer 3' end = 2. Primers were synthesized and ordered from MilliporeSigma, and diluted to 10 µM in nuclease-free water for qPCR reactions. The gene loci and primers used for qPCR are listed in Table 1.



**Table 1: RT-qPCR primers of *PIF4* orthologous genes in *O. sativa*, and *S. bicolor***

Name	Gene Locus	Forward Primer	Reverse Primer	Size
<i>Oryza sativa</i> spp. <i>japonica</i>				
<i>OsPIF4.1</i>	LOC4352761	CGATGGCGGAGGATGAGTC	GTCATTTGCGCCGAACAGCTC	94 bp
<i>OsPIF4.2</i>	LOC9270162	CAGAATCACCACCGGAAGC	AGGTCCGAGAAGATGTCCTTC	134 bp
<i>OsUBQ1</i>	LOC4341860	GGAGCTGCTGCTGTTCTAGG	ACAATGAAACGGGACACGACC	101 bp
<i>Sorghum bicolor</i>				
<i>SbPIF4</i>	LOC8070136	CCATGAACCAGTACATCTCTG	CATGGACTCTGTTGGGAAATG	128 bp
<i>SbPP2A</i>	LOC8073551	CAGACACAACCCGCAAACC	CAGGTCGGGCTCATGGAAC	143 bp

## qPCR

qPCR was performed in a Qiagen Rotor-Gene Q 5Plex Thermocycler. Three technical replicates were set up for each qPCR reaction, in which the diluted cDNA was mixed with a pair of primers and 2× FastStart Universal SYBR Green Master Mix (MilliporeSigma). The expression level of each *PIF4* ortholog was normalized to that of a reference gene using the  $2^{-\Delta\Delta Ct}$  method. Means and standard deviations were used to generate bar plots and unpaired t-tests were performed to calculate *p*-values in Microsoft Excel.

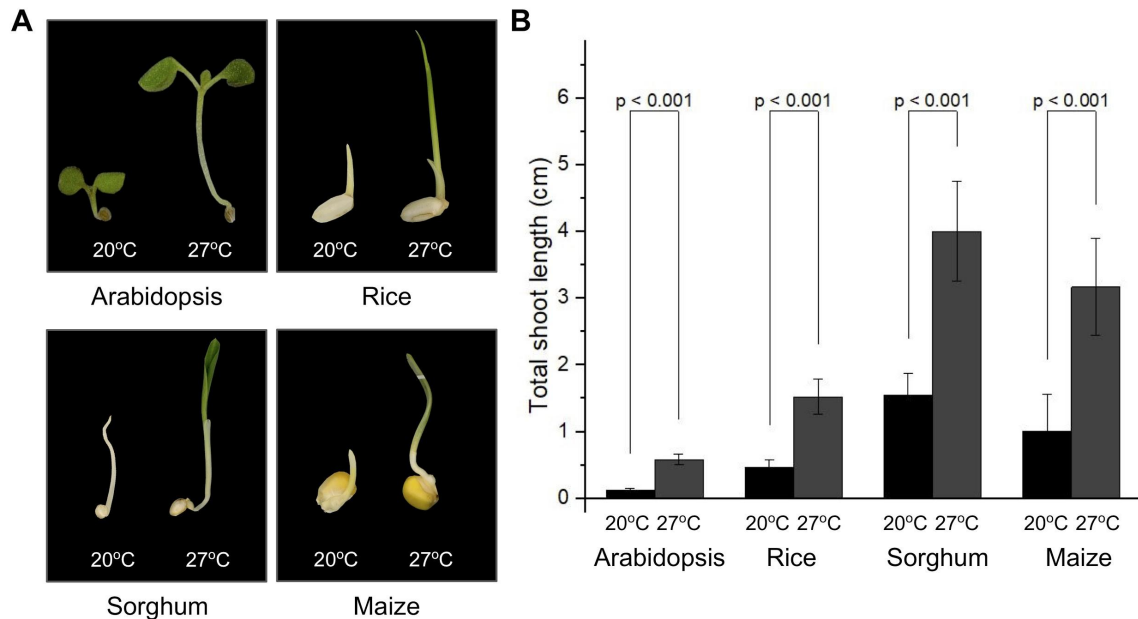
## Identification of *AtPIF4* orthologs in monocotyledons

To identify orthologous genes of *AtPIF4* in each monocotyledonous species, the amino acid sequence of *AtPIF4* was obtained from the Arabidopsis Information Resource (TAIR) database (Gene locus: AT2G43010) and used as a query in NCBI Protein BLAST. The detailed settings are as follows: Database, Non-redundant protein sequences (nr); Organism, *Oryza sativa*, *Zea mays*, *Sorghum bicolor*, or *Brachypodium distachyon*; Algorithm, blastp (protein-protein BLAST).

## RESULTS

### Three monocots show a temperature-induced growth response

**Figure 1. *Arabidopsis thaliana* and three monocots show a temperature-induced growth response of total shoot length.** (A) Images of seedlings grown at 20 °C and 27 °C. (B) Shoot lengths of the seedlings shown in (A). Error bars represent standard deviations.



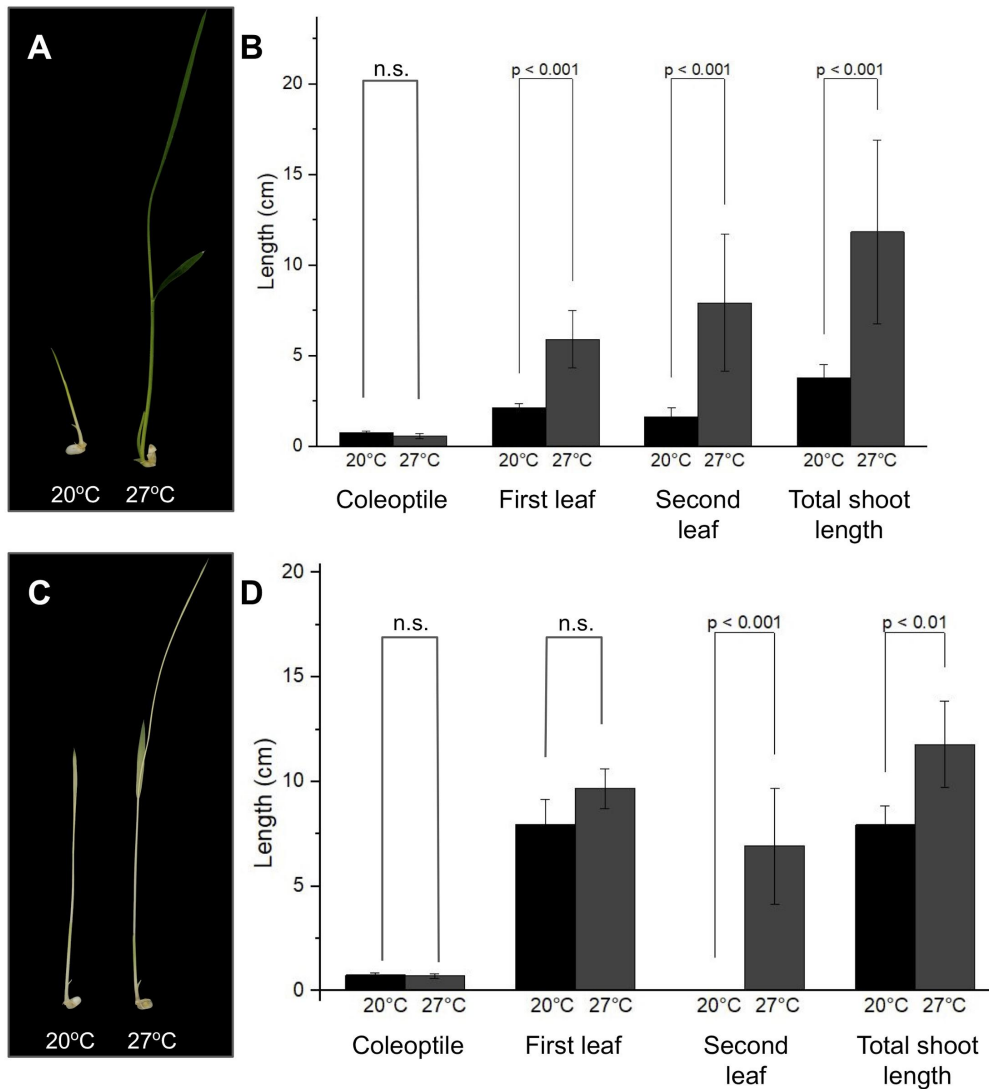
To investigate whether monocots exhibit a similar thermal response as *Arabidopsis*, we first compared the growth of rice, sorghum, and maize at a lower (20 °C) and a higher (27 °C) ambient temperature. These three species and *Arabidopsis* were grown in Petri dishes for two days at 20 °C and subsequently transferred to 27 °C or maintained at 20 °C for eight (monocots) or two (*Arabidopsis*) more days. As shown in Figure 1A, *Arabidopsis* grown at 27 °C had a longer hypocotyl length than when grown at 20 °C. Based on Tukey's test shown in Figure 1B, the total shoot length of *Arabidopsis* was significantly longer at 27 °C ( $p < 0.001$ ). Similarly, the total shoot lengths of rice, sorghum, and maize were longer at 27 °C than at 20 °C (Figure 1A and

1B). Additionally, monocotyledons grown at 27 °C had more green pigments (chlorophylls) than those grown at 20 °C, although no quantitative measurements or statistical analyses were performed. The results shown in Figure 1 indicate that these three monocotyledonous plants (rice, sorghum, and maize) exhibited a similar thermoresponsive growth phenotype as the one seen in *Arabidopsis*.

Although these initial experimentation helped us determine optimal growth conditions for rice, sorghum, and maize, and we indeed observed an *Arabidopsis*-like thermal response in all three monocotyledonous species, the Petri dishes we used for growing these monocots were not big enough to provide sufficient space for the seedling development. Therefore, we decided to repeat the experiments using GA-7 plant culture boxes, which provided a much bigger space for these monocots to grow. Besides, rice and sorghum were selected for further studies because of their higher growth rate and abundant seed stock in the lab.

***Oryza sativa* exhibits a thermomorphogenic response.**

**Figure 2. Leaves and shoots are elongated in *Oryza sativa* seedlings grown at 27 °C when compared to those grown at 20 °C. (A) Images of seedlings grown in magenta boxes for 9 days at 20 °C then transferred to 27 °C or maintained 20 °C and grown 9 more days. (B) Phenotypic measurements of the seedlings shown in (A). Error bars represent standard deviations. (C) Images of seedlings grown in magenta boxes for 7 days at 20 °C then transferred to 27 °C or maintained 20 °C and grown 4 more days. (D) Phenotypic measurements of the seedlings shown in (C). Error bars represent standard deviations.**

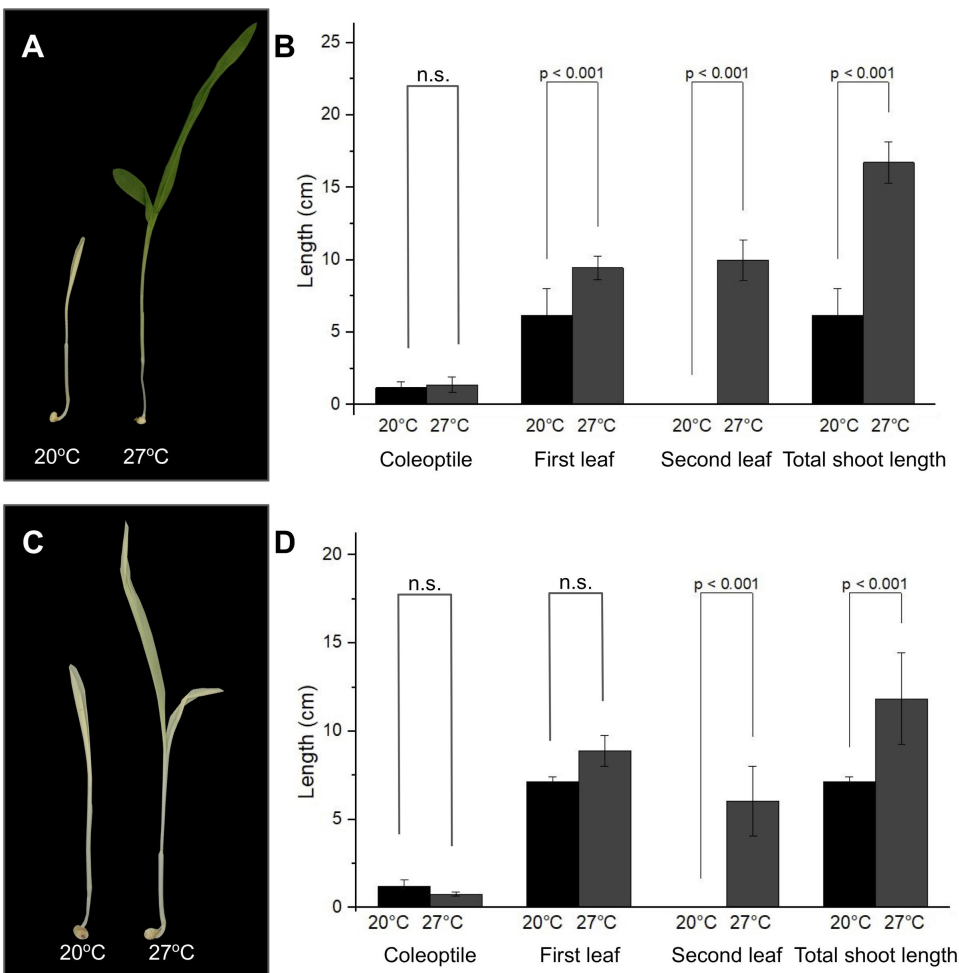


Rice seedlings were further studied in two separate experiments (trials 2 and 3) using plant culture boxes. The lengths of three structures were measured: the first leaf (including sheath and blade; measured from the seed coat to first leaf tip), second leaf, and coleoptile. The

coleoptile was measured at the suggestion of Dr. Yongjian Qiu. The leaves were chosen to be measured because a difference between them at 20 °C and 27 °C was visually observed and further analysis was needed. In trial 2, seedlings were grown for 2 days at 20 °C, followed by 9-day growth at either 27 °C or 20 °C (Figure 2A). In these growth conditions, the first leaf, second leaf, and total shoot length were all significantly longer at 27 °C than at 20 °C (Figure 2B). Additionally, the shoot color was greener in the seedlings grown at 27 °C than those grown at 20 °C, although no measurement or statistical analysis was performed. In trial 3, seedlings were grown for 7 days at 20 °C and then transferred to 27 °C or maintained at 20 °C for 4 more days (Figure 2C). Similarly, the second leaf and total shoot length were significantly longer in seedlings grown at 27 °C than those grown at 20 °C (Figure 2D). These results further confirmed the thermomorphogenetic phenotype of rice.

## *Sorghum bicolor* exhibits a thermomorphogenetic response

**Figure 3. Leaves and shoots are elongated in *Sorghum bicolor* seedlings grown at 27 °C when compared to those grown at 20 °C. (A) Images of seedlings grown in magenta boxes for 2 days at 20 °C then transferred to 27 °C or maintained 20 °C and grown 9 more days. (B) Phenotypic measurements of the seedlings shown in (A). Error bars represent standard deviations. (C) Images of seedlings grown in magenta boxes for 3 days at 20 °C then transferred to 27 °C or maintained 20 °C and grown 4 more days. (D) Phenotypic measurements of the seedlings shown in (C). Error bars represent standard deviations.**



Similar to rice, sorghum was further studied in two separate experiments (trials 2 and 3) using plant culture boxes. In both trials, the first leaf, second leaf, and coleoptile were measured. In trial 2, seedlings were grown for 2 days at 20 °C and then transferred to 27 °C or maintained at 20 °C for 9 more days (Figure 3A). As shown in Figure 3B, seedlings grown at 27 °C had significantly longer first leaf, second leaf, and total shoot lengths than those grown at 20 °C. In

trial 3, seedlings were grown for 3 days at 20 °C and subsequently transferred to 27 °C or maintained at 20 °C for 4 more days (Figure 3C). As shown in Figure 3D, seedlings grown at 27 °C had significantly longer second leaf and total shoot lengths than those grown at 20 °C. These results suggest that sorghum exhibits thermomorphogenesis in response to non-stress temperature increases.

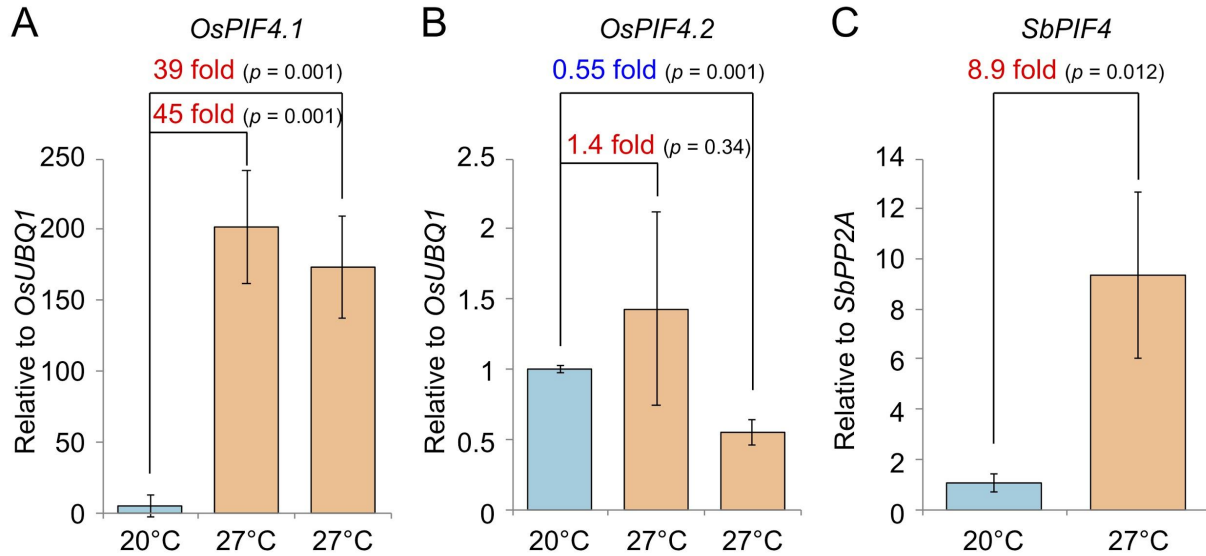
### **Identification of *AtPIF4* orthologs in monocotyledons**

Next, we asked whether the thermomorphogenetic mechanism in these monocots is the same as that in *Arabidopsis*, i.e., whether these three monocotyledonous species possess *AtPIF4* orthologs and whether these *AtPIF4* orthologs play similar functions in thermal response.

We first searched for *AtPIF4* orthologs in all three monocotyledonous species by using the amino acid sequence of *AtPIF4* as a query and the BLAST tool in the NCBI database. Two *AtPIF4* orthologs — XP\_015618074.1 (LOC4352761) and XP\_025880140.1 (LOC9270162) — were identified in *O. sativa*, and were named OsPIF4.1 and OsPIF4.2, respectively. One potential *AtPIF4* ortholog — XP\_021302233.1 (LOC8070136) — was identified in *S. bicolor*, and was renamed SbPIF4. The maize PIF4 — XP\_035822237.1 (LOC100280260) — was identified by other research groups and was named ZmPIF4 ([Shi et al. 2017](#)).

## Warm temperatures induce the expression of *AtPIF4* orthologs in monocots

**Figure 4. Warm temperatures activate the expression of *AtPIF4* orthologs in rice and sorghum.** RT-qPCR data show the expression levels of seedlings grown in monochromatic red light ( $50 \mu\text{mol m}^{-2} \text{s}^{-1}$ ) at 20 °C and 27 °C. Five-day-old 20 °C-grown seedlings were treated at 20 °C or 27 °C for 4 days. The expression of each *AtPIF4* ortholog was calculated relative to the transcript level of the reference gene in each species (*OsUBQ1* for rice and *SbPP2A* for sorghum) using the  $2^{-\Delta\Delta C_t}$  method. Error bars represent standard deviations (n = 3). Student t-test was performed to compare the expression levels of *PIF4* between plants grown at 20 °C and 27 °C. Values of fold change (red, increase; blue, decrease) and *p*-values are shown above the columns.



The expression of *AtPIF4* increases dramatically after 8 hours of temperature elevations (Qiu et al., 2019). We hypothesized that the thermo-induced growth response in monocots is also dependent on the thermal induction of *PIF4* expression. To test this hypothesis, we treated *O. sativa*, and *S. bicolor* with warm temperatures and compare the transcript levels of *AtPIF4* orthologs in plants grown at lower (20 °C) and warmer (27 °C) temperatures.

Whereas no significant difference of *OsPIF4.2* expression at 20 and 27 °C was detected, the transcript levels of both *OsPIF4.1* and *SbPIF4* were dramatically induced by the warm temperature (Figure 4). This data suggests that *AtPIF4* orthologs in monocots may play similar thermomorphogenetic functions as *AtPIF4*.



## DISCUSSION

Besides temperature extremes, fluctuations in ambient temperature also have a great impact on plant growth and development. Although a growing body of evidence has demonstrated the key function of PIF4 in thermomorphogenesis of dicots, the molecular mechanism underlying thermoresponsive growth in monocots was poorly understood. In the current study, we 1) determined that increased non-stress temperatures could also stimulate the shoot growth in three monocotyledonous species (rice, sorghum, and maize) (Figure 1-3) and 2) discovered that the expression of *OsPID4.1* and *SbPIF4*, orthologs of *AtPIF4* in rice and sorghum, respectively, was also inducible by ambient temperature elevations (Figure 4).

As hypothesized, the results of this experiment indicate that monocots exhibit a temperature-induced growth response similar to that of Arabidopsis. Further study is needed to explore the exact phenotypic responses that monocots exhibit in response to increased temperature. For example, this study focused on shoot length (especially leaf length). Future studies should investigate how increased temperatures affect other aspects of monocot crop development, such as root growth, flowering, crop product biomass, and seed yield.

Furthermore, results indicate that PIF4 is induced by warm temperatures in monocots. A detailed understanding of thermomorphogenic responses in crop plants is crucial if climate-change-resistant crops will be developed. For example, the pathway by which PIF4 and phyB interact with each other and the environment to create a thermomorphogenic response is already being studied in Arabidopsis. Therefore, the results of this study suggest that the existing pathway for PIF4 and phyB interaction may be similar in monocots as it is in Arabidopsis, although further research is needed in order to confirm this theory. For example, it may be

helpful to assess the expression level of phyB in plants at different temperatures, as well as other proteins that interact in the phyB-mediated thermomorphogenetic signaling pathway.

Additionally, future studies could knockout specific proteins in the PIF4/phyB pathway in order to determine the function they have on thermomorphogenesis.

In conjunction with existing research, further research could contribute to the development of climate-smart crop plants. Food insecurity is a problem that affects over a quarter of the world's population, and it will be crucial to consider all factors that impact food access worldwide in order to address this problem, including supply-chain level concerns such as food availability, nutritional content, and cost. Additionally, it will be imperative to assess consumer-level factors such as income, education, and access to food.

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## PART II

### Food Insecurity at the University of Mississippi: Prevalence, Impact, and Solutions

## INTRODUCTION

According to the USDA, food insecurity (FI) is “a household-level economic and social condition of limited or uncertain access to adequate food” (Coleman-Jensen, Rabbitt, & Gregory, 2020). Multiple studies have demonstrated FI is associated with numerous adverse health effects, including decreased nutrient intakes; increased rates of mental health problems and depression, diabetes, hypertension, and hyperlipidemia; worse outcomes on health exams; being in poor or fair physical health; and poor sleep outcomes (Gundersen & Kiliak 2015). In 2019, 10.5% of households in the U.S. were food insecure (Coleman-Jensen et al. 2020).

Although a limited number of studies exist on FI among college students, the limited evidence available suggests that it is experienced by an average of approximately one-third to one-half of students (Bruening 2017). In a systematic review of literature that examines cross-sectional correlates of FI among postsecondary education systems, average rates of FI were 35% and 42% across the gray and peer-reviewed literature, respectively. FI was consistently associated with financial independence, poor health, and adverse academic outcomes (Bruening 2017). FI has also been shown to be related to lower work productivity among adults (Borre 2010) and poorer academic outcomes among children and adolescents (Jyoti 2005). Particular sociodemographic characteristics tend to be associated with FI among postsecondary students: students of color, younger students, students with children, and students who are financially independent are more likely to report FI. This could be because modern postsecondary world reflects a shift in student demographics. For example, more students of low socioeconomic status, older men and women, and single parents are seeking postsecondary education than in the past (Bruening 2017).

Furthermore, the rate of FI in Mississippi is consistently and statistically higher than the national average. Mississippi has been ranked as first or second in food insecurity rate every year for the past 15 years. Furthermore, although FI rates are trending downwards nationally, they are on the rise in Mississippi (Haggard 2017).

The number of studies on postsecondary FI is limited, and the number of studies on the efficacy of solutions to this problem is even more limited. However, the most common ongoing solutions reported include campus food pantries, financial coaching, and interpersonal interventions (such as an app for sharing meal swipes). Very few studies have been conducted on the effectiveness of food pantries in postsecondary education and not many have been conducted on their effectiveness among other populations (Bruening 2017). However, existing studies suggest that although postsecondary food pantries ease some of the food insecurity that users experience, they typically do not address the root causes of food security, nor do they typically provide adequate nutrients for the period of time they are intended to nourish recipients (Farahbakhsh 2017).

The University of Mississippi provides various support resources to its students. For example, the Student Health Services provides visits free of charge and charges only a small fee for lab work (*University Health Services* 2021). The University Counseling Services provides students with up to ten free counseling sessions (*Counseling Center* 2021). The U\_Matter and Title IX offices are dedicated to case management, conflict resolution, and addressing violence towards students (*U\_Matter at Ole Miss* 2021). Grove Grocery, the University of Mississippi Food Pantry (formerly known as the Ole Miss Food Bank) provides students, faculty, and staff with food essential items free of charge and without item limits (*Grove Grocery: The UM Food Pantry* 2021). For the purposes of this paper, “Food Bank” will refer to the organization before

the name change took place, and “the Food Pantry,” “the Pantry,” and “Grove Grocery” will refer to the organization after the name change took place. According to a 2020 student Honors Thesis, which analyzed the nutritional content of food offerings at the Ole Miss Food Bank (as it was known at the time), there were significant deficits in traditional food categories of vegetable, protein, fruit, and grain when compared to MyPlate (Jefferson 2020). Furthermore, at the time of the study, the Food Pantry provided no resources to address the underlying causes of hunger, which studies have suggested is necessary in order to adequately address the problem of FI.

This study aims to help fill in some gaps in existing research and to assist future Grove Grocery leaders. We will assess the prevalence and impact of FI among undergraduate students at the University of Mississippi and analyze potential solutions to the problem. Specifically, this study will measure the impact of FI using metrics that reflect the financial bottom line for the University of Mississippi in order to provide future leaders of Grove Grocery with a tool to advocate to the administration and elected officials to provide improved support for students facing food insecurity.



## MATERIALS AND METHODS

### **Survey Distribution**

A cross-sectional, non-probability survey was created in QualtricsXM. Responses were anonymized; no personal information was recorded and contact association was removed. The survey received IRB-exempt approval from the University of Mississippi IRB office. The survey was distributed through the University of Mississippi Office of Institutional Research, Effectiveness, and Planning (IREP) to a representative sample of 5000 students via email in November 2020. Students included graduate and undergraduate students and were limited to students studying via the Oxford campus (although not necessarily located in Oxford due to social distancing measures during the COVID-19 pandemic). 410 responses were recorded. In order to incentivize participation, the first 200 respondents to the survey were given a \$5 gift card, which was specified in the recruitment email. In order to collect contact information but keep the survey anonymous, after respondents filled out the first survey, they were prompted to fill out a secondary Qualtrics survey that asked for their name and email address. The first 200 respondents to fill out this survey were contacted about a gift card. Responses to the second survey were optional and not tied to the first survey's responses. The funding for the gift cards distributed during this research was generously provided by the University of Mississippi Sally McDonnell Barksdale Honors College.

A secondary survey was created in Qualtrics in order to get direct feedback from users of Grove Grocery's services. The survey was advertised in the Food Pantry facility, on Grove Grocery's online grocery order form, and on the meal swipe application form. Students were

informed that the survey received IRB exempt approval from the University of Mississippi IRB office and that whether or not they chose to participate had no impact on the services they received. 24 students responded and all responses were used in data analysis.

### **Assessment of Food Security Status**

The prevalence and severity of food insecurity were assessed using the USDA U.S. Household Food Security Survey Module: Six-Item Short Form. The survey module and the associated Six-Item Food Security Scale were developed by researchers at the National Center for Health Statistics (Economic Research Service 2012). Slight modifications were made to the six-item module. First, when the original version of the module asked whether something had occurred “within the past six months,” our survey asked if something had occurred “since the beginning of the Fall 2020 semester” (the survey was distributed on November 13, 2020, near the end of the Fall 2020 semester). This was done in order to assess the food insecurity of students during the school year when they are more likely to live near the University, away from family, and use the University’s resources. Additionally, question AD1a as noted in the original version of the survey was also asked under questions AD2 and AD3, although these two additional questions were not counted towards a student’s raw score.

### **Analysis of Data**

Prior to statistical analysis, survey responses were checked for validity. Responses that were denoted by Qualtrics as survey preview, survey test, and spam were removed from the dataset. Responses with a completion rate of less than 66% were also removed. Statistical analysis was conducted using SPSS. Charts were created using OriginLab.

### **Calculation of the Number of Meals Distributed**

The number of meals distributed by Grove Grocery is calculated by weighing each food item that patrons take from the Pantry when checking out then converting the number of pounds to the number of meals using a formula created by the USDA (“The Impact of Dollars Donated to Feeding America”).

CHAPTER 1 - THE PROBLEM OF FOOD INSECURITY AT THE  
UNIVERSITY OF MISSISSIPPI

## PREVALENCE AND IMPACT OF FOOD INSECURITY AT THE UNIVERSITY OF MISSISSIPPI

After cleaning the dataset, a sample of 321 responses was left on the emailed, cross-sectional survey. Of the valid responses, 75.2% were female, 72.4% white, and 68.3% undergraduate. A little more than half (56.8%) were Mississippi residents, 78.6% of respondents reported living off campus, 24.6% were involved in Greek life, and 29.5% were first-generation students. In comparison, in the 2020-2021 academic year, enrollment at the University of Mississippi (Oxford and regional campuses) was as follows: 57.0% female, 55.9% Mississippi residents, 75.6% white, and 83.3% undergraduate (IREP 2021).

### **Prevalence of Food Insecurity at the University of Mississippi**

Analysis of USDA U.S. Household Food Security Survey Module: Six-Item Short Form showed that 188 (58.4%) respondents experienced high or marginal food security, which are defined by the USDA as “having no reported indications of food-access problems or limitations” and “one or two reported indications - typically of anxiety over food sufficiency or shortage of food in the house; little or no indication of changes in diets or food intake,” respectively (USDA ERS et al.). Of the remaining participants, 41.4% of students surveyed are classified as food insecure, which is defined by the USDA as having “reduced quality, variety, or desirability of diet” and can include disrupted eating patterns and reduced food intake (USDA ERS et al.). This is in line with existing studies, which show an average rate of FI at 42% among postsecondary education (Bruening 2017). Additionally, research conducted in 2017 by Megan Eubanks estimated the food insecurity rate at the University of Mississippi to be 41.5% (Eubanks 2017). In breaking down the levels of food insecurity at the University of Mississippi, 79 students surveyed (24.5%) experienced low food security, which is defined by the USDA as “reduced

quality, variety, or desirability of diet” with “little or no indication of reduced food intake” (USDA ERS et al.). 54 students surveyed (16.8%) experienced very low food security, which is defined by the USDA as “reports of multiple indications of disrupted eating patterns and reduced food intake” (USDA ERS et al.). Comparatively, 11.5% of students had very low food insecurity at the University in 2017 (Eubanks 2017). It is important to note that based on the results of our study, the rate of both food insecurity and very low food security among Ole Miss students are four times higher than the rate for general U.S. households (10.5% and 4.1%, respectively).

This data suggests we can estimate that between 12.7% and 20.9% of University of Mississippi students are highly food insecure. Using the 2019 enrollment figure of 22,273, this comes out to be between 2,835 and 4,660 students that may show multiple indications of disrupted eating patterns or reduced food intake.

When the USDA food security score was compared to the sociodemographic data, significant relationships were found between food security and first-generation students ( $p = 0.004$ ), self-reported academic struggle ( $p = 0.001$ ), and having to extend time at school ( $p = 0.002$ ). 28.4% of first-generation students reported very low food security compared to only 11.9% of non-first-generation students. Additionally, food insecurity approached a significant relationship with involvement in Greek Organizations ( $p = 0.066$ ), where those involved in Greek life are less likely to be food insecure. Somewhat surprisingly, there was no significant relationship between food security and race, gender, Mississippi residency, or classification. This lack of correlation could indicate that food insecurity impacts a wide range of students.

### **Food Insecurity, Financial Insecurity, and Financial Independence**

Unsurprisingly, FI was highly correlated with self-reported financial stress (Chi-Square = 124.1,  $p = 0.000$ ). FI was also significantly associated with paying for one’s own educational

expenses (Chi-Square = 22.545,  $p = 0.004$ ), paying for one's own essential expenses (such as food and rent) (Chi-Square = 24.511,  $p = 0.002$ ), and not having someone to provide financial support in an unplanned financial emergency (such as an ER visit, unexpected car repairs, job loss, etc.) (Chi-Square = 18.945,  $p = 0.000$ ). Students that indicated that they have someone to support them in a financial emergency were prompted to name who would cover these expenses for them. Of the 217 respondents, a vast majority ( $n=192$ ) listed their parent(s). Other common respondents included other family members, such as grandparents ( $n=26$ ) and siblings ( $n=14$ ).

### **Food Insecurity and the Need to Work**

Food insecurity was significantly associated with needing a job to pay for essential items such as food and rent (Chi-Square = 63.741,  $p = 0.000$ ). Students that said they needed a paid job to cover essential expenses were asked how it impacted them (using a multiple selection question model). Among the 144 people that answered this question, over half checked "I don't have enough time to get involved on campus or in the community because I need a paid job" (51.39%). Other responses included "I am unable to get an unpaid internship because I need a paid job" (47.22%), "I can't afford to get involved in campus activities (such as Greek life) because I need a paid job" (43.75%), and "I don't have enough time to focus on my schoolwork because I need a paid job" (31.25%).

In the same survey question as above, students were also given a choice to fill in their own response. One student said, "I just can not afford tuition!". Two students mentioned working for the school as a graduate student: "My TAship pays so little I must also work other jobs" and "I am a graduate student and am required to work for the school" were their responses. Yet another student said "The day only has 86,400 seconds which I have to dedicate all to job due to

financial insecurity, high rent and food expenses in Oxford due to the University presence that provides little to none protections to rent slumlords. Places like Denver implement rent schemes based on Tax brackets, something that Olemiss should offer as a protection for its students.” It is clear that students (especially those, such as graduate students, that are particularly vulnerable because of their financial independence and need to work) need additional support in order to succeed both at the University and after graduation.

### **Food Insecurity and Academic Success**

FI was significantly negatively correlated with GPA (Spearman Correlation = -2.683,  $p = 0.008$ ) and significantly associated with self-reported academic struggle (Chi-Square = 22.140,  $p = 0.000$ ). Students that reported experiencing academic struggle were given a multiple selection question asking which factors contributed to this issue. Other than grades, the most common answer was mental illness (48.22%), followed by uncertainty about the future/career path (43.23%), family problems (32.78%), and financial insecurity (31.03%). FI was significantly correlated with most of these factors, including mental illness (Chi-Square = 16.313,  $p = 0.038$ ), family problems (Chi-Square = 16.467,  $p = 0.036$ ), and financial insecurity (Chi-Square = 58.220,  $p = 0.000$ ).

FI was also significantly associated with having to extend one’s time as a student at the University of Mississippi (Chi-Square = 9.613,  $p = 0.008$ ). As with the last question, students that reported experiencing this issue were given a multiple selection question asking which factors contributed to it. The most common response (after grades) was mental illness (45.63%), then uncertainty about the future (37.47%), then financial insecurity (37.04%). Mental illness (Chi-Square = 23.976,  $p = 0.002$ ), uncertainty about the future (Chi-Square = 19.111,  $p = 0.014$ ),



and financial insecurity (Chi-Square = 34.633,  $p = 0.000$ ) were also significantly associated with FI.

### **Food Insecurity and Individual Wellbeing**

Although the number of food insecure students at the University of Mississippi is substantial, it is important to recognize that each one of these individuals is much more than a data point. In our secondary survey, students that utilize Grove Grocery's resources were given an open-ended question that asked what benefits they received from the Pantry's services. One student said that they liked receiving meal swipes because, "It makes the food far more accessible. I don't have to dedicate as much thought to where my next meal is going to come from or if I'll have time to even make that next meal."

CHAPTER 2 - CURRENT SOLUTIONS TO FOOD INSECURITY AT THE  
UNIVERSITY OF MISSISSIPPI

## SERVICES PROVIDED BY GROVE GROCERY

Grove Grocery offers a variety of free resources to students, faculty, and staff, detailed below.

### **The Pantry**

Our pantry is located in Kinard Hall, Room 213. We offer groceries, toiletries, and cleaning products. It is confidential and free to all University of Mississippi students, faculty, and staff.

### **The Kitchen**

Grove Grocery opened a kitchen location in January 2021. It is across from the Lyceum, right next to the Library. The new space is a fully equipped kitchen with a stove, microwave, crockpot, and other accessories. There is a fridge and freezer stocked with snacks, ingredients, and pre-made meals. Patrons are welcome to bring your own food as you choose, or use whatever you need from our supply. The Grove Grocery Kitchen is currently open Monday through Friday from 8 a.m. to 5 p.m. during the semester.

### **Meal Swipes**

Grove Grocery Meal Swipes is a temporary assistance program sponsored by Grove Grocery, Aramark, and community donated meals. This is a short-term assistance program that can allocate up to 30 meal swipes per semester to students, faculty, and staff in need. Those interested in receiving meal swipes must fill out an online application form that will be reviewed by a caseworker in the UMatter office. Meals received through this program can only be used at

on-campus dining hall locations that include the Rebel Market and the RC South Dining facility (Swipes cannot be used in Student Union or Pavilion Dining).

### **Grab and Go Bags**

Grab and Go Bags contain a recipe and all the ingredients needed to make it. They can be found outside the Pantry (Kinard Hall, Room 213) at all times.

### **Grocery Orders**

UM students, faculty, and staff can place an order for groceries, toiletries, and cleaning products from Grove Grocery. Orders are filled by volunteers and are available for pickup outside the Pantry (Kinard Hall, Room 213), usually the day after they are placed. Grocery orders are placed through a Google Form that lists all of the items in the Pantry at that time. Patrons can order as many items as they would like and can place an order as often as every day.

### **Recipes**

We have worked with graduate students in the Nutrition and Hospitality Management Department's Coordinated Program in Dietetics to create nutritious recipes using ingredients commonly found in the Pantry and can be found on the Pantry's website.

### **Connection to Outside Resources**

Grove Grocery lists outside resources on its website, such as SNAP, the Oxford Food Pantry, local health clinics, mental health services, and the UMMatter office. In doing so, we hope

to guide students towards services that can help them find long-term solutions to problems they may be facing.

## AWARENESS, UTILIZATION, AND EFFICACY OF GROVE GROCERY'S RESOURCES

### **Awareness of Grove Grocery's Resources**

The survey began with three questions to gauge awareness of the new name. Regardless which name was asked about, student awareness was low, and the majority of students reported being unfamiliar. When asked about familiarity with Grove Grocery, only 24.9% of participants claimed to be familiar or very familiar, with 33.9% claiming to be completely unfamiliar. More participants (34.9%) reported familiarity with the UM Food Bank, with only 24.6% reporting to be completely unfamiliar.

This lack of awareness of the Pantry can have serious ill-effects on students. One survey participant described how they did not use Grove Grocery's services until their situation became severe, saying, "Until I was direly in need of the resource, no one mentioned it to me. There are not many announcements for the resource, which backfires for a time like mine when I didn't even realize the resource existed and wasted time, money, strength, and was exhausted trying to make things work with no money in a small town. I don't mean to sound self-pitying, but the truth is not always pretty."

The survey identified two main barriers to use of the pantry. One survey question asked "Would you use Grove Grocery in a time of need?". Students that did not answer yes were given a follow up question asking them to select all the reasons why. Of the 126 students who saw this question, 41 were food insecure. Their responses can be found in the following table:

**Table 1: Survey responses (multiple-selection) to a survey question asking students why they would not use Grove Grocery in a time of need.**

Why would you not use the Pantry?	All respondents <i>n</i> (%)	Food insecure respondents <i>n</i> (%)
Number of responses	126	41
Embarrassment or Shame	34 (27)	13 (31.7)
Unsure of how it works	78 (61.9)	29 (70.7)
Feel like I don't qualify for the resources	78 (61.9)	24 (58.5)
Lack of transportation	8 (6.3)	4 (9.8)
I use different support resources	21 (16.7)	5 (12.2)

Among all respondents and food insecure respondents, the two most commonly selected barriers to use were “Unsure of how it works” or “Feel like I don’t qualify for the resources,” with the former being more common among food insecure students. It is important to note that the question asked if students would use the Pantry “in a time of need,” meaning that they would, in fact, qualify for the services.

### **Utilization of Grove Grocery’s Resources**

Despite these marketing problems, Grove Grocery distributed over 15,000 meals to students (including 790 meal swipes) in the 2020 calendar year. Grove Grocery did not begin recording the number of meals distributed until fall 2019, so we do not have a number from the 2019 calendar year to make a comparison. However, the average number of meals distributed from fall 2019 to fall 2020 increased by over 90% (from 99 to 189). This could be due to a number of factors, such as increased availability of resources, increased awareness of the pantry, or increased student need due to the COVID-19 pandemic.

Data on the increase in Pantry usage during the COVID-19 pandemic has been collected. In the spring 2020 semester, the average number of meals distributed per week before vs. after the pandemic more than tripled. Specifically, from January 20 - March 15 (before the campus shutdown), we distributed an average of 140 meals per week. From March 16 - May 9 (after the campus shutdown), we distributed an average of 426 meals per week. In other words, we distributed over 3x as many meals per week after the pandemic started. However, we do not have data from the spring 2019 semester to compare whether such an increase throughout the spring semester is typical. Either way, the COVID-19 pandemic caused devastating damage to global employment rates, particularly among the non-standard workforce (including service industry jobs), which are common jobs for college students. One study found that in Japan, the number of working students decreased by 45.9% from April 2019 to April 2020. This workforce trend indicates that college students may be particularly vulnerable to issues such as financial insecurity and thus food insecurity (Tsurugano 2021).

### **Efficacy of Grove Grocery's Resources**

In a secondary survey distributed directly to Grove Grocery users (n=24), students were asked how various Grove Grocery resources (the pantry, meal swipes, grocery orders, and grab and go bags), benefitted them. For each resource, students were more likely to say that it made a short-term improvement in their quality of life than a long-term one.

Additionally, participants were asked to list some things they liked about their experience at Grove Grocery. Three responses to this question (out of a total of seven responses) mentioned the grocery order system, indicating that this resource is popular among users. For example, one respondent said that Grove Grocery has “been incredibly accommodating, especially during the



pandemic. The pick-up option has been a real life-saver.” Other responses mentioned that this service was “quick,” “easy,” and “comfortable.” When asked what benefits students found from receiving meal swipes from Grove Grocery, one student answered, “It makes food far more accessible. I don’t have to dedicate as much thought to where my next meal is going to come from or if I’ll have time to make that next meal.” Similarly, when given a free response question asking if and why they liked Grab and Go Bags, one respondent answered, “available at all times. helped me get a meal when grocery is not available.” These responses suggest that Grove Grocery users generally appreciate services that are quick, easy, accessible, and convenient.

When respondents were asked what they didn’t like about Grove Grocery, one respondent (n=3) said “The foods available are not as healthy as they should be. Mostly ramen and sugar.” In a separate question asking for additional comments or suggestions, another respondent suggested that Grove Grocery “include healthier food.” This is in line with existing research, which identified significant deficits in traditional food categories of vegetable, protein, fruit, and grain at Grove Grocery when compared to MyPlate (Jefferson 2020).

## DISCUSSION

### **Conclusion**

Existing literature suggests that shifting student demographics could mean that students today are more vulnerable to issues such as FI than they were in the past (Bruening 2017). Additionally, although many people perceive postsecondary students as financially well-off, they may be uniquely vulnerable to these issues when compared to the general populations; this is due to factors such as a lack of income, a lack of a financial safety net, a lack of awareness (or ability to access) of available resources, high tuition costs, and being listed on parents' taxes even though they are not financially supported. Therefore, FI and other related struggles may lead to negative outcomes for college students (and the institutions they attend) that are often overlooked.

Specifically, at the University of Mississippi, it is clear that student FI is a substantial problem for students and that current resources do not adequately address the issue. In line with existing studies, 41.4% of students surveyed are classified as food insecure, while 16.8% are highly food insecure; both of these rates are approximately four times the national average. Comparatively, the overall rate of FI at the University of Mississippi was estimated to be 41.5% in 2017, while 11.5% of all students reported very low food security (Eubanks 2017). This could suggest that the rate of FI has remained the same, but the severity of the issue has increased. This could be due to the COVID-19 pandemic or the fact that students typically report higher FI as the semester progresses, which is when our study was conducted (Bruening 2017).

Certain sociodemographic factors were significantly associated with FI, including first-generation students. There was no significant relationship between food security and race,

gender, Mississippi residency, or classification, which could indicate that food insecurity impacts a wide range of students.

Food insecurity was also significantly correlated with self-reported financial stress, paying for one's expenses, the lack of a financial safety net, and the need to work in order to pay for essential items. Importantly, the need for a paid job can cause students to lose out on other opportunities such as unpaid internships, involvement in campus or community activities (such as Greek life), and time spent on schoolwork. Graduate students that must work as TAs seemed to be particularly impacted by the need to work, although further research is needed to confirm this. Involvement in things such as internships, campus activities, and Greek life can help students network and build work experience, which are all valuable assets in the job market. Furthermore, existing research has demonstrated that working students are more likely to drop out than nonworking students (Gleason 1993). Therefore, it is possible that the need to find paid work for essentials in college may decrease one's employability in the long run. In fact, the University of Mississippi ranks among the lowest in overall mobility index when compared to other selective public colleges in the United States (303 of 369) and the lowest in overall mobility index among Mississippi colleges (28 of 28). (Note: the mobility measure reflects both access and outcomes, representing the likelihood that a student at the University of Mississippi moved up two or more income quintiles after graduation) (Chetty 2017).

Food insecurity also negatively impacts academic success; FI was significantly negatively correlated with GPA and significantly associated with self-reported academic struggle. Food insecurity was significantly correlated with many factors contributing to academic struggle, including mental illness, family problems, and financial insecurity. It is important to note that mental health was listed as the number one factor (other than grades) in academic

struggle and extension of time to graduate. This indicates that additional mental health resources may be necessary on campus, although such research is beyond the scope of this paper.

Additionally, our data indicates not only that students experiencing FI are more likely to struggle academically, but that these students are more likely to experience other struggles simultaneously. Therefore, in order to better support students academically, it may be beneficial to address both the underlying cause of issues such as FI and the problems associated with it.

Although resources such as Grove Grocery (the campus food pantry) exist to support students, they fall short in several ways. First, research found that general awareness of Grove Grocery was low (around 25%). This lack of awareness may prevent students from accessing our services until their situation becomes severe, as was the case with one student: “Until I was direly in need of the resource, no one mentioned it to me.” Additionally, two primary barriers to use of the pantry were that people felt like they didn’t qualify for its services (even if they did) or because they were unsure how it works. Improvements could be made to Grove Grocery’s marketing strategies in order to address these issues. Suggestions for such improvements are beyond the scope of this research. For further information on the topic, researchers should read Dan Parks’ thesis on marketing at Grove Grocery, which can also be viewed on eGrove.

Results indicate that Grove Grocery provides short-term improvements in users’ quality of life. When asked what they liked about Grove Grocery, patrons mentioned that it is easy, convenient, comfortable, accessible, and accommodating. When asked what they did not like about Grove Grocery, patrons mentioned that they would like a wider and healthier variety of food items.

However, more work and services may be necessary in order to address the underlying cause of FI, rather than the symptoms of the problem. For example, 960 grocery orders have

been completed by Grove Grocery since April 29, 2020, yet only 296 individual people have placed an order (an average of just over three orders per person). This could indicate that students remain food insecure after a single visit to the Pantry. Additionally, patrons were more likely to report that Grove Grocery's services made a short-term improvement than a long-term improvement in their life.

### **Future research**

In the future, research could assess which of Grove Grocery's services are the most beneficial and why. Additionally, research could focus on the impact of and solutions to food insecurity among staff. It would also be useful to assess the efficacy of other campus services so that they can be improved and supported as needed. Additionally, more research should be conducted in order to assess if and how Grove Grocery makes sustainable improvements in people's lives, as our research primarily assessed Grove Grocery's success at providing acute relief to the hardships caused by FI, when these hardships are in fact the symptom of a larger issue.

### **Limitations**

There were many potentially limiting factors to this research. First, the COVID-19 pandemic could have increased severity of food insecurity on campus. It has also been found that students experience greater food insecurity later in the semester (Bruening et al. 2017), so the timing of the survey could have inflated food insecurity responses. That being said, the overall rate in our study was virtually identical to research conducted at the University in 2017 (41.4% vs. 41.5%, respectively). The rate of very low food insecurity increased from 11.5% in 2017 to

16.8% in our research. This indicates that although the severity of the problem may have increased due to the pandemic, the pandemic alone is not enough to explain the issue of FI at the University.

Additionally, it is possible that by asking our sample pool to assist in research about food insecurity, we attracted certain people. Perhaps some students had experienced food insecurity and wanted to help. Furthermore, the length of the survey may have impacted the results. We failed to insert a question late in the survey that tracked engagement, and some individuals may have quit reading the questions to finish faster. Also, because we removed all responses with less than 66% completion, it is possible that busier students gave up part of the way through the survey. There were also a number of questions that were very similar, and could have contributed to survey fatigue.

## CHAPTER 3 - RECOMMENDATIONS

## RECOMMENDATIONS

It is clear that more support is needed for students facing food insecurity. While Grove Grocery is able to provide short-term support to students, more resources are needed to address the underlying issues students face in order to make long-term improvements in their lives. As shown in our research and existing literature, two major factors in the experience of FI are financial insecurity and a lack of a safety net (Bruening 2017). Therefore, in order to best serve students facing food insecurity, it will be necessary to address acute food insecurity, address related acute issues (ex, physical or mental health problems), and address the underlying cause of these issues.

The problems that students face are multifaceted. Therefore, the solutions to these issues should also be multifaceted. The suggested solutions below are based on our findings of current need at the University.

### **Suggestions for University Administration**

- Make a collaborative effort among existing services on campus (especially those under the Department of Student Affairs), including but not limited to Grove Grocery, the Counseling Center, Student Health Services, U Matter, the Career Center, and the Center for Student Success, in order to support students in a more holistic manner. All of these services provide valuable resources to students on their own. However, a student in need of one of these services may be in need of another.
  - Hire additional case managers, especially one dedicated to basic needs, on campus whose sole purpose is to refer students to various services on campus (and to promote these services).



- Support existing resources on campus (such as Grove Grocery) so that they can serve students to the best of their ability.
- Improve awareness of existing services on campus. First, if students have an increased awareness of the services available to them, they will know where to reach out when they need help. Second, if students better understand what issues such as FI and mental illness are, they may be more likely to recognize when they or someone they know is struggling and therefore seek help.
  - Develop a centralized online platform that students can visit to learn more about student services. For example, students could fill out a survey and check off the issues that they are facing, and the results page could lead them to a list of services tailored to their needs.
- Address issues of basic needs insecurity (and other issues of student wellbeing) before they progress to emergency situations. In addition to the fact that an emergency is a difficult situation that should be avoided for the benefit of the student, a student's emergency may be costly for the University in the long run if it decreases academic performance or increases the likelihood of dropping out.
  - Introduce new services on campus such as financial counseling or financial literacy courses.
  - Screen students for potential issues such as food insecurity and financial insecurity early on.
- Share findings of this research with key stakeholders on campus, such as the Magee Institute, Office of Student Affairs, the retention advisory committee, and other senior leadership.

- Benchmark with other peer institutions to share findings and explore best practices for supporting students holistically.

### **Suggestions for Grove Grocery Leadership**

- Improve marketing efforts by better communicating who our services are for and how they can be accessed.
  - Since many students do not think they qualify for our resources when they do, it may be beneficial to incorporate some of the questions from the USDA Six-Item Short Form Food Security Module in our marketing materials. For example: “ ‘In the past twelve months, the food that I bought didn’t last, and I didn’t have money to get more.’ Sound familiar? Check out Grove Grocery”
  - Since many students do not feel confident about how to access our resources, it may be beneficial to redo our website in order to convey information about our services more clearly to the community.
- Connect Grove Grocery patrons with other resources, including but not limited to the U-Matter office, the Oxford Pantry, the Oxford Community Market, or local health clinics.
- Make ongoing improvements to our services and provide client-centered care
  - Survey respondents indicated that they prefer services that are easy, quick, accessible, available at all times, and comfortable.
  - Leaders should perform ongoing analysis of its quality of service and patron satisfaction to ensure that the Pantry is consistently performing to the best of its ability.
- Improve the nutritional content of food offered at Grove Grocery, since research

conducted at the Pantry in 2020 and patrons have indicated that this should happen.

- Continue to advocate for student support to administrators.
- Target services towards staff, who are often overlooked in our work (including in this research)

### **Suggestions for Elected Officials**

- Increase access to SNAP (food stamps) for college students. Generally, students attending postsecondary education more than half-time are not eligible for SNAP unless they meet an exemption and all other SNAP eligibility requirements (USDA Food and Nutrition Service). Congress created SNAP with a particular image of a student: someone entering college directly from high school, who is a financial dependent of their parents and has no dependents of their own, and has no income (Treisman). However, our research and existing literature show that this is not the case. Furthermore, college students face food insecurity at a rate higher than the national average.
- Develop and sustain programs to address the underlying causes of basic needs insecurity in order to better support citizens.

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## APPENDIX

Appendix A: Primary Qualtrics Survey (

Appendix B: Secondary Qualtrics Survey (“Grove Grocery Usage”)

Appendix C: USDA Six-item Short Form Food Security Survey Module



## Info sheet for irep

Q1.

Consent to Participate in Research

**Study Title:** Food Insecurity

### Key Information for You to Consider

- Voluntary Consent. You are being asked to volunteer for a research study. It is up to you whether you choose to participate or not. There will be no penalty or loss of benefits to which you are otherwise entitled if you choose not to participate or discontinue participation.
- Purpose. The purpose of this research is to analyze the degree of food insecurity on the University of Mississippi's campus and to measure how effective campus resources are at combating food insecurity.
- Duration. It is expected that your participation will last 12-20 minutes.
- Incentives. **The first 200 people who complete the survey will receive a \$5 gift card.**
- Risks and Benefits. There are no anticipated risks from participating in this study. You should not expect benefits from participating in this study. However, you might experience satisfaction from contributing to fighting food insecurity.
- Confidentiality. All information in the study will be collected from you anonymously: it will not be possible for anyone, even the researchers, to associate you with your responses.



## **What you will do for this study**

If you participate, you will fill out a survey asking about your experience with food insecurity, which takes about 15 minutes. The survey will not ask for your name or other identifying language.

## **IRB Approval**

This study has been reviewed by The University of Mississippi's Institutional Review Board (IRB). If you have any questions, concerns, or reports regarding your rights as a participant of research, please contact the IRB at (662) 915-7482 or [irb@olemiss.edu](mailto:irb@olemiss.edu).

**By continuing with this survey, I acknowledge my consent for participating.**

## **legality Q's**

Q2. Are you over 18?

- Yes  
 No

Q3. Are you a student at the University of Mississippi?

- Yes  
 No

## **Awareness**

Q4.

How familiar are you with Grove Grocery: The UM Food Pantry?

- Very familiar
- Familiar
- Might have seen before
- Somewhat unfamiliar
- Completely unfamiliar

Q5.

How familiar are you with the UM Food Bank?

- Very familiar
- Familiar
- Might have seen before
- Somewhat unfamiliar
- Completely unfamiliar

Q6.

How aware were you that the UM Food Bank changed its name to Grove Grocery: The UM Food Pantry?

- Very aware
- Aware
- Somewhat aware
- Might have seen before
- Completely unaware

Q7. Do you personally know someone who has been to Grove Grocery: UM Food Pantry, formerly known as the UM Food Bank?

- Yes
- Maybe
- No

Q8. How aware are you of the following services/items provided by Grove Grocery: The UM Food Pantry?

	Never Heard of it	I have heard of it, but don't know what it is	I know what it is, but don't know how to access it	Know what it is and how to access it
Food Pantry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Grab and Go Bags	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Meal swipes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hygiene Products	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cleaning Products	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Grocery Order Form	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q9. If asked to describe the following services, how confident are you that you could describe them accurately?

	Never Heard of it	I have heard of it, but don't know what it is	I know what it is, but don't know how to access it	Know what it is and how to access it
Food Pantry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Grab and Go Bags	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Meal swipes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Never Heard of it	I have heard of it, but don't know what it is	I know what it is, but don't know how to access it	Know what it is and how to access it
Hygiene Products	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cleaning Products	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Grocery Order Form	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q10.

Have you ever encountered @Grovegrocery or @olemissfoodbank on social media?

- Yes
- Maybe
- No

Q11. How did you initially encounter @Grovegrocery or @olemissfoodbank on social media?

Select all that apply.

- Saw in feed
- Friend posted about us
- From a raffle
- Searched for it
- Not sure
- Other. Please fill in below

Q12. How did you first hear about Grove Grocery: The UM Food Pantry?

- Social Media

- From a friend
- Flyer/Poster/Digital sign
- Radio
- From a teacher
- From this survey
- Other: Please Fill in below

Q13. Since the beginning of the semester, how have you heard about Grove Grocery: The UM Food Pantry?

- Social Media
- From a friend
- Flyer/Poster/Digital sign
- Radio
- From a teacher
- From this survey
- I have not heard about it
- Other: Please Fill in below

Q14. Have you ever needed or wanted to use our services, but not used them because of confusion/uncertainty.

- Yes
- No
- Doesn't apply to me



Q15.

Do you recognize this logo?

- Yes
- Somewhat
- No

Q16. How recently have you seen our ads?

- In the last week
- In the last month
- In the last 2 months
- At some point
- Never

Q17. Would you recommend a friend to use Grove Grocery if they were experiencing food insecurity?

- Definitely yes
- Probably yes

- Might or might not
- Probably not
- Definitely not

Q18. Do you know where the Food Pantry is located?

- Definitely yes
- Probably yes
- Might or might not
- Probably not
- Definitely not

## Usage

Q19. Have you ever been to Grove Grocery: The UM Food Pantry, formerly known as the UM Food Bank?

- Yes
- Maybe
- No

Q20. How many times have you used the following services/items from Grove Grocery: The UM Food Pantry?

	0	1-3	4-9	10 or more
Food Pantry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hygiene products	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	0	1-3	4-9	10 or more
Cleaning products	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Grocery Order Form	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Grab and Go Bags	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q21. Would you use Grove Grocery: The UM Food Pantry in a time of need?

- Yes
- Maybe
- No

Q22. Why would you not use the Grove Grocery: The UM Food Pantry? Please select all that apply.

- Embarrassment or shame
- Unsure of how it works
- Feel like I don't qualify for the resources
- Lack of transportation
- I use different support resources
- Other

Q23. Would you ever judge or look down on someone who uses Grove Grocery: The UM Food Pantry?

- I would judge them a lot
- I would judge them a little
- I would not judge them at all
- Unsure



Q24. Would you personally feel judged or embarrassed to use Grove Grocery: The UM Food Pantry?

- Very judged
- A little judged
- Not at all judged
- Unsure

Q25. To what extent would each of the following reasons influence your decision to use or not use Grove Grocery: The UM Food Pantry?

	No Influence	Almost no influence	Somewhat influence	Influence	Strong influence
Embarrassment or Shame	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unsure of How it Works	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I Feel Like I Don't Qualify for the Resources	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of Transportation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other Support Resources are Available	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q26. Do you have a meal plan on campus?

- Yes. Please enter your plan
- No

Q27. Thinking about my meal plan this semester, I would say:

- I need many more meal swipes
- I need a few more meal swipes
- I have the right amount of meal swipes
- I have a few extra meal swipes
- I have many extra meal swipes

## Food Insecurity Survey

Q28.

These next questions are about the food eaten in your household **since the beginning of the Fall 2020 semester** and whether you were able to afford the food you need.

Q29.

"The food that I bought just didn't last, and I didn't have money to get more." Has that been often, sometimes, or never true for you since the beginning of the Fall 2020 semester?"

- Often true
- Sometimes true
- Never true
- Don't know

Q30.

"I couldn't afford to eat balanced meals." Has that been often, sometimes, or never true for you since the beginning of the Fall 2020 semester?

- Often true
- Sometimes true
- Never true
- Don't know

Q32.

Since the beginning of the Fall 2020 semester, have you ever cut the size of your meals or skipped meals because there wasn't enough money for food?

- Yes
- No
- Don't know

Q73. How often did you cut the size of your meals or skip meals because there wasn't enough money for food—almost every week, some weeks but not every week, or in only 1 or 2 weeks?

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

Q34.

Since the beginning of the Fall 2020 semester, have you ever eaten less than you felt you should because there wasn't enough money for food?

- Yes
- No

Don't know

Q74. How often did you eat less than you felt you should because there wasn't enough money for food—almost every week, some weeks but not every week, or in only 1 or 2 weeks?

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

Q35.

Since the beginning of the Fall 2020 semester, have you ever been hungry but didn't eat because there wasn't enough money for food?

- Yes
- No
- Don't know

Q75. How often were you hungry but didn't eat because there wasn't enough money for food—almost every week, some weeks but not every week, or in only 1 or 2 weeks?

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

## Impact of Hunger

Q36. Have you had to extend your time as a student at Ole Miss longer than you initially expected? If so, by how many semesters?

- Yes (please specify the number of semesters; ex: 1 for one semester)
- No

Q37. To what extent did the following factors contribute to you extending your time as a student?

	Not applicable (I don't experience this)	No impact (I experience this, but it doesn't impact my time as a student)	Minor impact	Moderate impact	Major impact
Financial insecurity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Food insecurity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mental illness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Grades	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Illness/injury	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Family problems	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Legal issues	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Uncertainty about future/career path	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Had to get a job/work too many hours	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (please specify) <input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q38. What is your current GPA?

Q39. Do you feel like you are struggling academically?

- Yes, I am struggling a lot
- Yes, I am struggling a little
- No, I am not struggling

Q40. To what extent did the following factors contribute to your academic struggle?

	Not applicable (I don't experience this)	No impact (I experience this, but it doesn't impact my time as a student)	Minor impact	Moderate impact	Major impact
Financial insecurity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Food insecurity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mental illness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Grades	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Illness/injury	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Family problems	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Legal issues	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Uncertainty about future/career path	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Not applicable (I don't experience this)	No impact (I experience this, but it doesn't impact my time as a student)	Minor impact	Moderate impact	Major impact
Had to get a job/work too many hours	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (please specify) <input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q41. During your time at Ole Miss, have you had to get a job (or more than one job) in order to pay for essential items, such as tuition, food, and rent (i.e., not for spending money)?

- Yes, I currently have a job in order to pay for essential items
- Yes, I've had a job in the past in order to pay for essential items
- No
- Don't know or prefer not to answer

Q42. Do any of the following statements apply to you? Select all that apply.

- I am unable to get an unpaid internship because I need a paid job
- I don't have enough time to focus on my schoolwork because I need a paid job
- I don't have enough time to get involved on campus or in the community because I need a paid job
- I can't afford to get involved in campus activities (such as Greek life) because they are too expensive
- Other (please specify)
- None of these apply to me

## Finances

Q43. How would you describe your financial situation right now?

- Always stressful
- Often stressfful
- Sometimes stressful
- Rarely stressful
- Never stressful

Q44. How much of your educational expenses (tuition, books, etc.) do **you** pay for?

- All
- More than half
- About half
- Less than half
- Nothing

Q45. How else do you pay for your educational expenses? Select all that apply

- Family resources (parent/guardian, relative, spouse, etc.)
- Aid that must be repaid (loans)
- Aid that does not need to be repaid (grants, scholarships, military, etc.)
- Other (please specify)



Q46. How much of your essential expenses (food, utilities, rent, etc.) do **you** pay for?

- All
- More than half
- About half
- Less than half
- Nothing

Q47. How else do you pay for your essential expenses? Select all that apply.

- Family resources (parent/guardian, relative, spouse, etc.)
- Aid that must be repaid (loans)
- Aid that does not need to be repaid (grants, scholarships, military, etc.)
- Other (please specify)

## Financial emergency

Q48. In an unplanned financial emergency, (such as an ER visit, unexpected car repairs, job loss, etc.) do you have someone who could help you cover expenses (such as a parent or friend)?

- Yes
- No

Q49. What would this person be able to help you pay for?

- Cost of the emergency itself
- Cost of everyday expenses (such as food and utilities) until I get back on my feet
- Cost of the both the emergency and everyday expenses

Q50. If you feel comfortable, please say who would help you cover expenses. Examples include a partner, best friend, religious group, parents, grandparents, siblings, etc.

### Demographic Questions

Q76. What type of student are you?

- Freshman
- Sophomore
- Junior
- Senior
- Graduate student
- Other (please specify)

Q54. What type of graduate program are you in?

- Masters
- Doctorate
- Ed.S.

Q55. Do you have an assistantship?

- Yes
- No

Q56. Does your assistantship come with healthcare?

- Yes
- No

Q57. Does your assistantship come with tuition remission?

- Yes
- No

Q58. Do you have a 9 month or 12 month assistantship?

- 9 month
- 12 month

Q59. How much are you paid for your assistantship?

Q60. Do you have hourly work?

- Yes
- No

Q61. What is your hourly rate?

Q62. How many hours do you work per week?

Q63. Are you an international student?

- Yes (fully enrolled student)
- Yes (study abroad student)
- No

Q64. What is your country of origin?

Q65. Are you a first-generation student?

\*Note: A first-generation college student is defined as a student whose parent(s)/legal guardian(s) have not completed a bachelor's degree. This means that you are the first person in your family to attend a four-year college/university to attain a bachelor's degree.

- Yes
- No
- Don't know or prefer not to answer

Q66. Do you live on campus?

- Yes
- No

Q67. Are you involved in any of the following Greek organizations?

- IFC (Phi Delt, Sigma Nu, etc.)
- CPH (Tri Delt, KKG, etc.)
- NPHC (AKA, Delta Sigma Theta, etc.)
- None of the above

Q68. Are you a parent?

- Yes
- No

Q69. Does your child live in your household?

Yes

No

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## Information

Consent to Participate in Research

**Study Title:** Grove Grocery Usage

## Key Information for You to Consider

- **Voluntary Consent.** You are being asked to volunteer for a research study. It is up to you whether you choose to participate or not. There will be no penalty or loss of benefits to which you are otherwise entitled if you choose not to participate or discontinue participation. Whether or not you take this survey will have no impact on your access to Grove Grocery's resources, including meal swipes and groceries.

- **Purpose.** The purpose of this research is to analyze the effectiveness of Grove Grocery's resources so that they can be improved.

- **Duration.** It is expected that your participation will last 5–10 minutes.
- **Incentives.** There are no incentives to participating in this research.
- **Risks and Benefits.** There are no anticipated risks from participating in this study. You should not expect benefits from participating in this study. However, you might experience satisfaction from contributing to fighting food insecurity.
- **Confidentiality.** All information in the study will be collected from you anonymously: it will not be possible for anyone, even the researchers, to associate you with your responses.

### **What you will do for this study**

If you participate, you will fill out a survey asking about your experience with food insecurity, which takes about 15 minutes. The survey will not ask for your name or other identifying language.

### **IRB Approval**

This study has been reviewed by The University of Mississippi's Institutional Review Board (IRB). If you have any questions, concerns, or reports regarding your rights as



a participant of research, please contact the IRB at (662) 915-7482 or [irb@olemiss.edu](mailto:irb@olemiss.edu).

**By continuing with this survey, I acknowledge my consent for participating.**

## Screening

Are you 18 years or older?

You must be 18 years or older to participate in this survey.

- Yes
- No

Are you a student, faculty, or staff at the University of Mississippi?

You must be affiliated with the University of Mississippi in order to participate in this survey.

- Student
- Faculty
- Staff
- None of the above

# Pantry

Have you visited Grove Grocery: The UM Food Pantry (formerly known as the Ole Miss Food Bank)?

The Food Pantry is located in Kinard Hall, Room 213.

- Yes
- No
- Don't know

How many times have you visited Grove Grocery?

Has visiting Grove Grocery helped you in any of the following ways? Please select all that apply.

- Relieved stress
- Made it easier to focus on school/improved academic performance
- Made a short-term improvement in your quality of life
- Made a long-term improvement in your quality of life
- Other (please specify)

Visiting Grove Grocery has not helped me in any way

What are some things you **liked** about your experience at Grove Grocery? Please be as specific as possible.

What are some things you **didn't like** about your experience at Grove Grocery? How could we improve? Please be as specific as possible.

## **Meal swipes**

Have you ever applied for meal swipes from Grove Grocery?

Meal swipes are loaded onto student IDs

Yes

No

Don't know

Have you ever received meal swipes from Grove Grocery?

Yes

No

How many times have you received meal swipes from Grove Grocery?

This question is asking about the number of times you have had a block of meal swipes loaded onto your ID, not the total number of meal swipes you've received. For example, meal swipes are generally distributed in blocks of 5 or 10.

Has receiving meal swipes from Grove Grocery helped you in any of the following ways? Please select all that apply.

- Relieved stress
- Made it easier to focus on school/improved academic performance
- Made a short-term improvement in your quality of life
- Made a long-term improvement in your quality of life

Other (please specify)

Receiving meal swipes from Grove Grocery has not helped me in any way

What are some things you **liked** about your experience receiving meal swipes? Please be as specific as possible.

What are some things you **didn't like** about your experience receiving meal swipes? How could we improve this service? Please be as specific as possible.

**Grocery order form**

# Have you ordered groceries from Grove Grocery?

Grocery orders are requested via a Google Form and left outside the pantry

- Yes
- No
- Don't know

How many times have ordered groceries from Grove Grocery?

Has receiving groceries from Grove Grocery helped you in any of the following ways? Please select all that apply.

- Relieved stress
- Made it easier to focus on school/improved academic performance
- Made a short-term improvement in your quality of life
- Made a long-term improvement in your quality of life
- Other (please specify)

- Receiving groceries from Grove Grocery has not helped me in any way

What are some things you **liked** about your experience receiving groceries from Grove Grocery? Please be as specific as possible.

What are some things you **didn't like** about your experience receiving groceries from Grove Grocery? How could we improve the service? Please be as specific as possible.

## **Grab and Go bags**

Have you used a Grab and Go Bag from Grove Grocery?

Grab and Go Bags contain a recipe and all the necessary ingredients. They can be found outside the pantry at all times.

- Yes
- No
- Don't know

How many times have you used a Grab and Go Bag from Grove Grocery: The UM Food Pantry?

Has using a Grab and Go Bag from Grove Grocery helped you in any of the following ways? Please select all that apply.

- Relieved stress
- Made it easier to focus on school/improved academic performance
- Made a short-term improvement in your quality of life
- Made a long-term improvement in your quality of life
- Other (please specify)

- Using a Grab and Go Bag from Grove Grocery has not helped me in any way

What are some things you **liked** about using a Grab and Go Bag from Grove Grocery? Please be as specific as possible.



What are some things you **didn't like** about using a Grab and Go Bag from Grove Grocery? How could we improve the service? Please be as specific as possible.

## **Final block**

Thank you for your feedback! Our Director will personally look over these responses (which are anonymous) in order to improve our services.

If you would like to learn more about any of the resources mentioned in this survey, please visit [grovegrocery.olemiss.edu](http://grovegrocery.olemiss.edu) or follow @GroveGrocery on Instagram, Facebook, or Twitter.

If you have any questions about our resources and services, please email [grovegrocery@go.olemiss.edu](mailto:grovegrocery@go.olemiss.edu)

After completing this survey, you will be redirected to our website.

Do you have any additional comments or suggestions for Grove Grocery?

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**U.S. Household Food Security Survey Module: Six-Item Short Form**  
**Economic Research Service, USDA**  
**September 2012**

**Revision Notes:** The food security questions in the 6-item module are essentially unchanged from those in the original module first implemented in 1995 and described previously in this document.

***September 2012:***

- Added coding specification for “How many days” for 30-day version of AD1a.

***July 2008:***

- Wording of resource constraint in AD2 was corrected to, “...because there wasn’t enough money for food” to be consistent with the intention of the September 2006 revision.

***January 2008:***

- Corrected user notes for coding AD1a.

***September 2006:***

- Minor changes were introduced to standardize wording of the resource constraint in most questions to read, “...because there wasn't enough money for food.”
- Question numbers were changed to be consistent with those in the revised Household Food Security Survey Module.
- User notes following the questionnaire were revised to be consistent with current practice and with new labels for ranges of food security and food insecurity introduced by USDA in 2006.

**Overview:** The six-item short form of the survey module and the associated Six-Item Food Security Scale were developed by researchers at the National Center for Health Statistics.

**Background:** The six-item short form of the survey module and the associated Six-Item Food Security Scale were developed by researchers at the National Center for Health Statistics in collaboration with Abt Associates Inc. and documented in “The effectiveness of a short form of the household food security scale,” by S.J. Blumberg, K. Bialostosky, W.L. Hamilton, and R.R. Briefel (published by the *American Journal of Public Health*, vol. 89, pp. 1231-34, 1999). ERS conducted additional assessment of classification sensitivity, specificity, and bias relative to the 18-item scale.

If respondent burden permits, use of the 18-item U.S. Household Food Security Survey Module or the 10-item U.S. Adult Food Security Survey Module is recommended. However, in surveys that cannot implement one of those measures, the six-item module may provide an acceptable substitute. It has been shown to identify food-insecure households and households with very low food security with reasonably high specificity and sensitivity and minimal bias compared with the 18-item measure. It does not, however, directly ask about children’s food security, and does not measure the most severe range of adult food insecurity, in which children’s food intake is likely to be reduced.

[Begin Six-Item Food Security Module]

**Transition into Module :**

These next questions are about the food eaten in your household in the last 12 months, since (current month) of last year and whether you were able to afford the food you need.

**NOTE:** If the placement of these items in the survey makes the transition/introductory sentence unnecessary, add the word “Now” to the beginning of question HH3: “Now I’m going to read you....”

FILL INSTRUCTIONS: Select the appropriate fill from parenthetical choices depending on the number of persons and number of adults in the household.

HH3. I’m going to read you several statements that people have made about their food situation. For these statements, please tell me whether the statement was often true, sometimes true, or never true for (you/your household) in the last 12 months—that is, since last (name of current month).

The first statement is, “The food that (I/we) bought just didn’t last, and (I/we) didn’t have money to get more.” Was that often, sometimes, or never true for (you/your household) in the last 12 months?

- Often true
- Sometimes true
- Never true
- DK or Refused

HH4. “(I/we) couldn’t afford to eat balanced meals.” Was that often, sometimes, or never true for (you/your household) in the last 12 months?

- Often true
- Sometimes true
- Never true
- DK or Refused

AD1. In the last 12 months, since last (name of current month), did (you/you or other adults in your household) ever cut the size of your meals or skip meals because there wasn't enough money for food?

- Yes
- No (Skip AD1a)
- DK (Skip AD1a)

AD1a. [IF YES ABOVE, ASK] How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?

- Almost every month
- Some months but not every month
- Only 1 or 2 months
- DK

AD2. In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food?

- Yes
- No
- DK

AD3. In the last 12 months, were you every hungry but didn't eat because there wasn't enough money for food?

- Yes
- No
- DK

**[End of Six-Item Food Security Module]**

## User Notes

### **(1) Coding Responses and Assessing Households' Food Security Status:**

Responses of “often” or “sometimes” on questions HH3 and HH4, and “yes” on AD1, AD2, and AD3 are coded as affirmative (yes). Responses of “almost every month” and “some months but not every month” on AD1a are coded as affirmative (yes). The sum of affirmative responses to the six questions in the module is the household’s raw score on the scale.

Food security status is assigned as follows:

- Raw score 0-1—High or marginal food security (raw score 1 may be considered marginal food security, but a large proportion of households that would be measured as having marginal food security using the household or adult scale will have raw score zero on the six-item scale)
- Raw score 2-4—Low food security
- Raw score 5-6—Very low food security

For some reporting purposes, the food security status of households with raw score 0-1 is described as food secure and the two categories “low food security” and “very low food security” in combination are referred to as food insecure.

For statistical procedures that require an interval-level measure, the following scale scores, based on the Rasch measurement model may be used:

Number of affirmatives	Scale score
0	NA
1	2.86
2	4.19
3	5.27
4	6.30
5	7.54
6 (evaluated at 5.5)	8.48

However, no interval-level score is defined for households that affirm no items. (They are food secure, but the extent to which their food security differs from households that affirm one item is not known.)

**(2) Response Options:** For interviewer-administered surveys, DK (“don’t know”) and “Refused” are blind responses—that is, they are not presented as response options but marked if volunteered. For self-administered surveys, “don’t know” is presented as a response option.

**(3) Screening:** If it is important to minimize respondent burden, respondents may be screened after question AD1. Households that have responded “never” to HH3 and HH4 and “no” to AD1 may skip over the remaining questions and be assigned raw score zero. In pilot surveys intended to validate the module in a new cultural, linguistic, or survey context, however, screening should be avoided if possible and all questions should be administered to all respondents.

**(4) 30-Day Reference Period:** The questionnaire items may be modified to a 30-day reference period by changing the “last 12-month” references to “last 30 days.” In this case, item AD1a must be changed to read as follows:

AD1a. [IF YES ABOVE, ASK] In the last 30 days, how many days did this happen?

\_\_\_\_\_ days

[ ] DK

Responses of 3 days or more are coded as “affirmative” responses.

**(5) Self Administration:** The six-item module has been used successfully in mail-out, take-home, and on-site self-administered surveys. For self-administration, question AD1a may be presented in one of two ways:

- Indent AD1a below AD1 and direct the respondent to AD1a with an arrow from the “Yes” response box of AD1. In a parenthetical following the “No” response box of AD1, instruct the respondent to skip question AD1 and go to question AD2.
- Present the following response options to question AD1 and omit question AD1a:
  - Yes, almost every month
  - Yes, some months but not every month
  - Yes, only 1 or 2 months
  - No

In this case, either of the first two responses is scored as two affirmative responses, while “Yes, only 1 or 2 months” is scored as a single affirmative response.

The two approaches have been found to yield nearly equal results. The latter may be preferred because it usually reduces the proportion of respondents with missing information on how often this behavior occurred.