

Relationship Between Food Insecurity and Negative Mental Health: Does Enrollment in the Double Up Food Bucks Program Moderate this Relationship?

by

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Abstract

Food insecurity affects mental health, making it a serious public health crisis in the US. The influence of dietary patterns on psychological well-being has been well-documented. The Double Up Food Bucks (DUFEB) program incentivizes the purchase of fresh fruits and vegetables by low-income SNAP households. This study aims to investigate the relationship between food insecurity and psychological distress and determine whether DUFEB enrollment moderates this relationship by leveraging primary cross-sectional dataset. The findings showed that food insecurity was significantly associated with psychological distress in the Alabama context. The enrollment in the DUFEB program significantly moderated the association between food insecurity and psychological distress. This suggests that the DUFEB enrollment attenuated the association between food insecurity and psychological distress. Future studies using the panel dataset and expanding to more states can provide better insights into the moderating effect of the DUFEB enrollment on the association between food insecurity and psychological distress.

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In the preparation of this thesis, no Artificial Intelligence (AI) tools were used.

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List of Abbreviations

COVID-19	Coronavirus disease
DASS-10	Depression Anxiety and Stress Scale
DUFEB	Double Up Food Bucks
Exp	Exponential
FINI	Food Insecurity Nutrition Incentive
GusNIP	Gus Schumacher Nutrition Incentive Program
Log	Logarithm
Max	Maximum
Min	Minimum
MS	Master of Science
Obs	Observation
pr	Probability
PhD	Doctor of Philosophy
PTSD	Post-Traumatic Stress Disorder
QR	Quick Response
SNAP	Supplemental Nutrition Assistance Program
Std. dev.	Standard Deviation
U.S.	United States
USDA	United States Department of Agriculture

1. Introduction

Food insecurity affects both physical health and psychological well-being of millions of Americans everyday (Harvey et al., 2022), highlighting its importance as a public health issue in the United States (Holben, 2010). Food insecurity is defined as limited or uncertain access to sufficient, safe, and nutritionally adequate food or the lack of consistent ability to obtain food in socially acceptable manner (U.S. Department of Agriculture [USDA], 2025). It is a multidimensional experience that includes 4 key dimensions at an individual level: inadequate food intake (quantity), insufficient nutrient intake (quality), feelings of deprivation (psychological acceptability), and disrupted eating patterns such as reducing meal size or skipping meals (social acceptability) (Bergmans et al., 2019).

Statistics indicate that in 2023, 13.5% of U.S. households (18 million) were food insecure representing a significant increase from 12.8% (17 million households) in 2022 and 10.2% (13.5 million households) in 2021 (Rabbitt et al., 2024). Also, in 2023 about 5.1% (6.8 million households) experienced very low food security, characterized by reduced food intake or meal skipping (Rabbitt et al., 2024). Alabama is also one of the food insecure states in the Southern region of U.S where food insecurity rate in 2023 was 11.5% which was nearly equal to national average of 13.5% (Rabbitt et al., 2024).

The fact that food insecurity exists in millions of households in the U.S. is concerning, but more concerning is its consequences on health. Existing evidence suggests that food insecurity is associated with greater health care expenditures (Berkowitz et al., 2017) and adverse health outcomes among children, adults, and seniors (Gunderson & Ziliak, 2015). A large body of literature has documented the negative physical, emotional, and mental health outcomes associated with food insecurity (Florez et al., 2015; Gunderson & Ziliak, 2015; Heflin et al., 2005; Heflin & Ziliak, 2008).

Food insecurity has been linked to a wide range of adverse physical health outcomes, including metabolic and cardiovascular conditions such as diabetes, obesity, cardiovascular disease, hypertension, inflammation, chronic diarrhea, and certain cancers (Gunderson & Ziliak, 2015; Holben, 2010; Li et al., 2025; Ostrer et al., 2025). In addition, it has been associated with other health complications such as asthma, impaired cognitive abilities, reduced activity levels, fatigue, and overall poor health (Gunderson & Ziliak, 2015; Hamelin et al., 2002; Polivy, 1996; Vozoris & Tarasuk, 2003).

The objective of this paper is to investigate the relationship between food insecurity and psychological distress and to determine whether the enrollment in the DUFEB program moderates the relationship between food insecurity and psychological distress among SNAP households in Alabama.

Since we are interested in investigating food insecurity and mental health relationships, it is better to delve into 2 potential pathways that explain how food insecurity may influence mental health. First, food insecurity may affect dietary quality, as individuals experiencing limited access to food tend to consume a lower amount of vegetables, fruits, dairy products, and lower vitamins and minerals. Second, food insecurity may contribute to psychological stress, as food insecure individuals engage in coping behaviors such as seeking different food resources like food banks, free food, food assistance programs, and foregoing necessary healthcare services which can create additional psychological burden (Bergmans et al., 2019).

A plethora of literature has documented the relationship between food insecurity and mental health outcomes. Food insecurity has been consistently associated with a range of adverse psychological conditions such as increased irritability, stress, anxiety, depression, and social isolation (Casey et al., 2005; Heflin et al., 2005; Heflin & Ziliak, 2008; Jones, 2017; Leung et al., 2015; Sharkey et al., 2011). Further evidence supports its association with depression, anxiety, and stress (Arenas et al., 2019; Bateson et al., 2025; Cain et al., 2022; Fang et al., 2021; Nagata et al., 2019; Pourmotabbed et al., 2020; Saputra et al., 2025; Tribble et al., 2020). In addition, food insecurity has been linked to insomnia (Poulos et al., 2025), hyperactivity in children (Cain et al., 2022), and suicidal thoughts in adults (Nagata et al., 2019). Importantly, evidence suggests that this relationship is bidirectional, whereby food insecurity elevates the risk of poor mental health and poor mental health increases the likelihood of food insecurity (Bruening et al., 2017; Brown et al., 2025).

Reflecting food insecurity is related to negative mental health from previous studies, policy level interventions aimed at alleviating food insecurity may play a critical role in mitigating negative mental health outcomes. However, whether such interventions effectively reduce the adverse mental health outcomes among food insecure households remains a critical question. There are programs to combat food insecurity such as the Supplemental Nutrition Assistance Program (SNAP), but the consumption of nutritious foods is low primarily due to the cost of purchasing fresh fruits and vegetables (Harvey et al., 2022).

Different nutrition incentive programs like Gus Schumacher Nutrition Incentive Program (GusNIP) have been implemented to decrease the cost barrier for consumption of healthy fruits and vegetables (Harvey et al., 2022). In particular, Alabama GusNIP is a federally funded point-of-purchase program that incentivizes locally grown or regionally produced fresh fruits and vegetables at partnering with independent grocery stores and farmers market in Alabama. The fruit and vegetable incentive program run by Alabama GusNIP is titled “Double Up Food Bucks (DUFb) Alabama”.

Enrollment in the DUFb program might reduce psychological distress. The underlying mechanism is that the DUFb program improves the affordability and access to fresh fruits and vegetables by offering a dollar-for-dollar match on fruits and vegetables purchase (Valentine & Gibson, 2025). Bergmans et al. (2019) found that increased proximate access to fruits and

vegetables moderated the food insecurity's relationship with mental health i.e. increased proximate access to fruits and vegetables attenuated the link between food insecurity and poor mental health. Fruit and vegetables consumption influence mental health through several biological pathways. First, fruits and vegetables are rich in some nutrients which have been linked to psychological health (Rooney et al., 2013). For example, fruits and vegetables are packed with nutrients like Vitamin C and B vitamins such as folate that play a key role in neurotransmitter synthesis, which plays a central role in mood regulation (Conner et al., 2015). Second, fruits and vegetables are rich in antioxidants such as vitamins C, E, and phytochemicals that may reduce inflammation and oxidative stress, processes associated with poor mental health (Rooney et al., 2013).

Previous studies on the DUFB program have focused on fruits and vegetables intake, food security status, and overall health. For instance, Atoloye et al. (2021) examined whether participation in the DUFB program was associated with increased fruits and vegetables consumption among the SNAP users and found no evidence supporting this relationship. Durward et al. (2019) evaluated the effects of the DUFB program on fruit and vegetables intake and food security status among the SNAP users and reported that the participation in DUFB program was associated with increased fruits and vegetables consumption and decrease in food insecurity.

To the best of our knowledge, there are limited studies that shed light on the impact of the DUFB programs on health among SNAP users. Valentine and Gibson (2025) used a qualitative approach to examine the impact of the DUFB program among the SNAP participants and reported that participants had positive perception of better physical and mental health outcomes from this incentive program through its support on purchase of more fruits and vegetables as well as building healthy eating habits.

It is evident from the literature that prior DUFB studies focus on food or dietary outcomes and overall health, but not on psychological distress or negative mental health, especially using validated scales like DASS-10. This study intends to fill this literature gap by investigating whether enrollment in the DUFB program moderates the relationship between food insecurity and psychological distress among the SNAP households in Alabama using the DASS-10 measure. First, we estimate the relationship between food insecurity and psychological distress or negative mental health. Second, we assess the interaction effect of food insecurity and enrollment in the DUFB program on psychological distress. Our main contribution is an empirical examination of whether enrollment in the DUFB program might alleviate psychological distress associated with food insecurity in the Alabama context.

To the best of our knowledge, this is the first study to investigate whether enrollment in the DUFB program moderates the relationship between food insecurity and psychological distress or negative mental health. The findings from this study can inform state and federal stakeholders whether the DUFB program is likely to reduce psychological distress associated with food insecurity among the SNAP households for policy-level interventions to alleviate the psychological distress associated with food insecurity.

This study is divided into 6 sections, structured as follows: section 2 reviews the existing related literature on food insecurity, mental health, and the DUFB program. Section 3 describes the data and measurement strategies used in our empirical analysis. Section 4 shows empirical specifications of the Ordered Logit Model. Section 5 presents the results and discussion on the relationship between food insecurity and psychological distress and whether enrollment in the DUFB program moderates this relationship in the context of Alabama. Section 6 concludes.

2. Literature Review

2.1. A Brief Overview of Food Insecurity Prevalence in the United States

The U.S. Department of Agriculture (USDA) classifies food insecurity into 2 levels of severity: low food security and very low food security. Low food security is primarily characterized by reductions in dietary quality and variety while very low food security is characterized by reduced food intake and skipped meals (USDA, 2025). In 2023, 13.5% of U.S. households were food insecure at least some time during the year and 5.1% of households were very low food secure. Food insecurity is unevenly distributed across demographic and geographic groups in the U.S. In 2023, households with children had significantly higher rates of food insecurity (17.9%) compared to those without children (11.9%). By race or ethnicity, food insecurity was more prevalent among Black, Non-Hispanic households (23.3%), and Hispanic households (21.9%) compared to White, Non-Hispanic (9.9%). Regionally, food insecurity was most prevalent in the South (14.7%) while the Northeast reported the lowest prevalence (12%). With respect to the location, households in principal cities (15.9%) and nonmetropolitan areas (15.4%) saw a significantly higher rate of food insecurity than in suburban metropolitan areas (11.7%) (Rabbitt et al., 2024).

2.2 A Brief Overview of Mental Health Status in the United States

Like food insecurity, mental health has also become a serious issue in the U.S. Mental health disorders such as depression and anxiety are the third leading causes of hospitalization in the U.S. (Kessler et al., 2007; Parks et al., 2006). According to the State of Mental Health in America 2025 report, 23% of U.S. adults (over 60 million) experienced a mental illness in the past year. The higher prevalence of mental illness was in Alabama, Arizona, and Nevada states (Reinert et al., 2025). Although mental health among youth (ages 12-17) significantly improved from 2023 to 2024, 11.3% of youth (2.8 million) experienced a major depressive episode which significantly impaired their functioning (Reinert et al., 2025). Similarly, the data from the National Center for Health Statistics show that between August 2021 and August 2023, 13.1% of adolescents and adults aged 12 years and older experienced depression during given 2-week period representing a substantial increase from 8.2% in 2013-2014 (Brody & Hughes, 2023). Though the mental health is a serious concern in youth and adults in the U.S., still 25% of the adults with any mental illness reported mental health care was out of access when they needed it (Reinert et al., 2025). These studies highlight the worsening situation of mental health status in the U.S.

2.3 Relationship Between Food Insecurity and Mental Health

Meta-analytical evidence provides strong support for the association between food insecurity and adverse mental health outcomes. Tribble et al. (2020) synthesized data from 110 articles examining

depressive symptoms, Post-Traumatic Stress Disorder (PTSD), anxiety, psychosocial stress, and unspecified common mental disorders. Their findings showed that food insecure individuals were 2.35 times more likely to experience depressive symptoms, 1.81 times more likely to experience PTSD, 1.78 times more likely to experience anxiety, 2.39 times more likely to experience psychosocial stress, and 2.40 times more likely to experience unspecified common mental disorders as compared to food secure individuals. Similarly, Arenas et al. (2019) conducted a meta-analysis of 57 studies on depression, 13 on anxiety and psychological distress, and 8 on sleep disorders. Their findings revealed that food insecure adults were 2.74 times more likely to experience depression, 2.41 times more likely to experience anxiety, and 1.80 times more likely to experience sleep disorders.

Few studies have also analyzed this relationship within specific populations. For instance, Nagata et al. (2019) found that food insecure young adults were 1.67 times more likely to experience depression, 1.47 times more likely to experience anxiety or panic disorder, and 2.76 times more likely to report suicidal ideation. Cain et al. (2022) systematically reviewed food insecurity and mental health relationships on both parents and children and found significant relationships between food insecurity and different mental health outcomes in both parents and children.

Some studies have specifically examined the relationship between food insecurity and mental health during the COVID-19 pandemic. Fang et al. (2021) empirically found that food insecurity was associated with 257% higher odds of anxiety and 253% higher odds of depression compared to food secure individuals. Similarly, Nagata et al. (2021) reported adjusted relative risks ranging from 1.16 to 1.42 for mental distress such as anxiety, worry, anhedonia, and depression among individuals who experienced food insufficiency in the past 7 days. In addition, Bruening et al. (2017) conducted a systematic narrative review of longitudinal studies on causal directionality and found a bidirectional association between food insecurity and poor emotional health suggesting that food insecurity increases the risk of poor emotional health and conversely, poor emotional health increases vulnerability to food insecurity.

2.4 Association Between Dietary Pattern and Mental Health

Dietary patterns have a substantial impact on the mental well-being of an individual. There are some studies that highlight the role of dietary patterns in mental health. For example, Jacka et al. (2010) found that traditional diet which include fruits, vegetables, meats, and whole grains were associated with low risk for anxiety and depression in women. Similarly, in another study, authors found that unhealthy diet that includes fast food, sweets, refined grains, and energy drinks was associated with higher risk of depressive symptoms in pregnant woman (Baskin et al., 2017). Moreover, another study documented that healthy diet patterns such as consumption of fish, fruit, and vegetables were associated with less cognitive and depressive symptoms in older people (Samieri et al., 2008). These studies highlight the importance of quality diet patterns in the mental health of an individual.

2.5 DUFB Program in the Context of Alabama

The 2008 Farm Bill allocated \$20 million to support pilot initiatives aimed at encouraging SNAP participants to purchase more fruits and vegetables to improve dietary quality. In response, the DUFB program was launched in Detroit, Michigan in 2009 and with its expansion to more than 150 locations across Michigan, served as a national model for nutrition incentive programs (Dsouza et al., 2025). Beginning in 2013, DUFB also began its expansion in grocery stores in 2013 as the first pilot program in the US. In 2018, the support by USDA for Gus Schumacher Nutrition Incentive Program (GusNIP) which funds the DUFB program, was increased to \$250 million over a 5-year period (National Institute of Food and Agriculture [NIFA], 2020).

In the context of Alabama, Hunger Solutions Institute at Auburn University launched Double Up Food Bucks Alabama at 4 independent grocery stores and 8 farmers markets to offer incentives for fruit and vegetable purchase throughout Alabama. Since cost is one of the main challenges for low-income SNAP users to purchase fruits and vegetables, the DUFB Alabama aims to reduce cost barrier by incentivizing the cost through additional funds or Double Up tokens which are available in retailers participating in the DUFB program throughout Alabama. Currently in Alabama, 4 independent grocery stores, 2 community supported agricultural programs, 2 farm stands, and 8 SNAP authorized farmers market participate in the DUFB program. Counties such as Chilton, Dallas, Jefferson, Lee, Madison, Marshall, Mobile, Sumter, and Tuscaloosa have one or more DUFB retailers to increase the accessibility for SNAP users across Alabama.

According to the 2-year overview report, the economic impact of the DUFB in Alabama was \$375,868. The report further documented that on average 21% of fruits and vegetables brought by SNAP users were purchased with the DUFB program (Hunger Solutions Institute, 2023).

2.6 Prior Studies on DUFB Program with respect to Diet, Food Security and Health

There are few studies that have worked on the DUFB program in the past. These studies have primarily focused on whether enrollment in the DUFB program influences fruits and vegetables intake, food security status, and overall health. Atoloye et al. (2021) examined whether participation in the DUFB program was associated with increased fruits and vegetables consumption and found that their result did not support the hypothesis. Similarly, Steele-Adjognon and Weatherspoon (2017) evaluated the effects of the DUFB program on fresh fruits and vegetables purchase in low-income community and found that the DUFB program increased spending on vegetables, shares of spending on fruits and vegetables, and the variety of fruits and vegetables purchased. Durward et al. (2019) examined the effects of the DUFB program on fruits and vegetables intake and food security status among the SNAP users. They found that the DUFB program was associated with increased fruits and vegetables consumption and decreased food insecurity.

Relatively little research has been done on whether enrollment in the DUFB program moderates food insecurity and mental health relationships. To the best of our knowledge, there are

limited studies that shed light on the influence of the DUFB program on health. Valentine and Gibson (2025) conducted a qualitative analysis of the DUFB enrollment among SNAP users and their findings show that participants experienced positive effects on their eating habits and health from the DUFB program. Harvey et al. (2022) investigated the influence of the DUFB program on food security, fruit and vegetable intake, and health-related quality of life among SNAP users enrolled in the DUFB program. They found that participants experiencing food insecurity reported greater benefits from the DUFB program compared to food-secure participants. Both studies are deficient in the investigation of whether enrollment in the DUFB program moderates the relationship between food insecurity and mental health.

2.7 Literature Gap

While prior studies on the DUFB program focused on fruit and vegetable intake, food security status, and to some extent overall health, there are no studies that investigated whether enrollment in the DUFB program might decrease psychological distress or negative mental health, specially using validated DASS-10 measure. Addressing this literature gap could provide critical insights into the potential of nutrition-based interventions to alleviate negative mental health linked with food insecurity. Empirical evidence could inform policymakers to make strategies that address the rising concern of negative mental health arising from food insecurity.

3. Methodology

3.1 Data Collection

We used the cross-sectional dataset collected in GusNIP Participant Survey in 2024 to investigate whether enrollment in the DUFEB program moderates the relationship between food insecurity and negative mental health or psychological distress among SNAP households in Alabama. This survey was conducted by Auburn University among SNAP households in 6 counties of Alabama (Jefferson, Madison, Mobile, Sumter, Tuscaloosa, and Lee). Alabama is one of the highly food insecure states in the Southern region of United States. Food insecurity rate in Alabama in 2023 was 11.5% which was close to the national average of 13.5% (Rabbitt et al., 2024).

All individuals at least 18 years of age in SNAP households in the 6 Alabama counties listed above were eligible to take an online survey. All SNAP households in the 6 Alabama counties were mailed an 8 × 11.5-sized paper (“mailer”) from Alabama DHR. Most of the part of the paper included information about the Alabama GusNIP incentive program, like what it is and where the household can access the incentives. At the bottom of the mailer, there was a short invitation to take the survey, a Quick Response (QR) code, and a simple link that both directs to the survey on Qualtrics.

SNAP participants of the 6 Alabama counties could fill out an online survey in Qualtrics by either scanning a QR code linked to the survey with their phone or tablet or clicking a direct link to the online survey. The survey questionnaire administered asked participants about their participation in SNAP, their grocery shopping habits, their use of Alabama GusNIP incentives (if any), food security status, mental health status, fruits and vegetables consumption, and demographics characteristics. The time anticipated to complete the survey was 15 minutes.

Since we were interested in investigating whether enrollment in the DUFEB program moderates the relationship between food insecurity and negative mental health, we mostly focused on the questionnaire section that elicited data on participants’ food security and mental health status. The outcome variable of interest was psychological distress or negative mental health; independent variables of interest were food insecurity and the DUFEB use. We used control variables to better estimate our model. The variables of interest in our study are described below:

3.2 Dependent Variable

Psychological distress or negative mental health was the dependent variable in our study. Mental health status of the participants was assessed using Depression, Anxiety, and Stress Scale (DASS-10). DASS-10 is a brief, reliable, and valid instrument for assessing symptoms of depression, anxiety, and stress (Halford & Frost, 2021; Love et al., 2024). It consists of 10 self-assessed scales rated on 4 frequency scales “never applied to me” (0), “sometimes applied to me” (1), “often applied to me” (2), and “almost always applied to me” (3) reflecting mental health experiences of an individual in the “past week” (Lovibond & Lovibond, 1995).

Scales assessing anxiety and stress captured experiences of an individual such as “felt close to panic”, “found oneself getting impatient when got delayed in anyway (e.g., elevators, traffic

lights, being kept waiting etc.)”, “overreacted to the situations”, “felt scared without any good reason”, “worried about the situations in which one might panic”, and “found it difficult to relax”. Similarly, scales assessing depressive symptoms capture experiences of an individual such as “felt downhearted and blue”, “felt to have nothing to look forward to”, “found it difficult to work up the initiative to do things”, and “couldn’t experience any positive feelings”. Total raw scores range from 0-30 for an individual (Love et al., 2024).

Based on raw scores, depression, anxiety, and stress, collectively known as psychological distress, was categorized into 4 levels: no psychological distress (raw score equal to 0), mild psychological distress (raw score greater than 0 and equal to 6), moderate psychological distress (raw score greater than 6 and equal to 12), and severe psychological distress (raw score greater than 12 and equal to 30). Cut points of 0, 6, and 12 were used to distinguish these severity levels (Love et al., 2024).

Table 1 reports on the distribution of respondents by severity level of mental health. About 32% of respondents experienced no psychological distress, 28% experienced mild psychological distress, 25% experienced moderate psychological distress, and 14% experienced severe psychological distress.

Table 1: Distribution of Respondents by Severity Level of Psychological Distress.

Psychological distress	Frequency	Percentage
No psychological distress	503	32.37%
Mild psychological distress	440	28.31%
Moderate psychological distress	390	25.10%
Severe psychological distress	221	14.22%

3.3 Independent Variables

Food insecurity was one of the key independent variables in our study. To identify participants who were food insecure, we first assessed their food security status using USDA’s “U.S. Household Food Security Survey Module: 6-Item Short Form”, the standard form and a reliable

substitute for the 10 items and 18 items Food Security Modules. The 6 items HH3, HH4, AD1, AD1a, AD2, and AD3 asked respondents about household food conditions in the “last 30 days”. Response of “often true” or “sometimes true” to items HH3 and HH4 and “yes” to items AD1, AD2, and AD3 were coded as affirmative for computing raw score. Similarly, for item AD1a, the response of “3 days or more” was coded as an affirmative for computing raw scores. The sum of affirmative responses yields a raw score ranging from 0-6. Now, following USDA guidelines, respondents’ food security status was classified into 3 levels based on the raw score: “high or marginal food security” (raw score = 0-1), “low food security” (raw score = 2-4), or “very low food security” (raw score = 5-6). We defined “high or marginal food security” as food secure, while a combination of “low food security” and “very low food security” as food insecure (USDA, Economic Research Service [ERS], 2012). Finally, food insecure individual was coded as 1 and 0 otherwise.

DUFB use was another independent variable of interest in our study. For measuring this, we asked the respondents “Have you used the DUFB coupons or tokens to purchase fruits and vegetables?”. For analysis purposes, we made it binary: DUFB use = 1 if an individual used the DUFB coupons or tokens to purchase fruits and vegetables and 0 otherwise.

Table 2 reports on the distribution of respondents by food insecurity and DUFB use. It shows that 4% of the respondents were food secure and enrolled in the DUFB program. About 6% of the respondents were food insecure and enrolled in the DUFB program.

Table 2: Distribution of Respondents by Food Insecurity and DUFB Use.

	Food insecurity (Food insecure = 0)	Food insecurity (Food insecure = 1)
DUFB use	N = 589	N = 965
No (0)	95.93%	93.99%
Yes (1)	4.07%	6.01%

3.4 Control Variables

Demographic control variables included age categories (18-39 years), (40-59 years), (at least 60 years), gender (man or woman), race or ethnicity categories (White, Black or African American, Asian, American Indian, Native Hawaiian, and Pacific Islander). Socioeconomic control variables included education level categories (some high school, high school graduate, some college, college graduate, MS degree, and terminal degree (PhD), categories for number of children in the

household: household has no children, household has few children (1-4), and household has many children (at least 5).

3.5 Definition of Variables used in Ordered Logit Model

Table 3 describes the definition of variables used in our Ordered Logit Model which included dependent variable (psychological distress), independent variables (food insecurity and use of DUFB program) followed by control variables such as age categories, gender, race or ethnicity categories, education level categories, and categories for number of children in the household.

Table 3: Definition of all Variables Used in Ordered Logit Model.

Variable	Definition
<p>Dependent variable (Psychological distress or Negative mental health)</p>	<p>Negative mental health includes experiences of depression, anxiety, and stress collectively known as psychological distress, which is classified into 4 levels.</p> <ol style="list-style-type: none"> i. No psychological distress ii. Mild psychological distress iii. Moderate psychological distress iv. Severe psychological distress
Independent variables	
Food insecurity	Food insecurity was defined as combination of “low food security” and “very low food security” as defined by USDA’s “U.S. Household Food Security Survey Module: 6-Item Short Form”.
High or marginal food security	Raw score=0-1
Low food security	Raw score = 2-4
Very low food security	Raw score = 5-6
Food insecure	=1 if the individual has experienced food insecurity as defined above, 0 otherwise
DUFB use	= 1 if the individual has used DUFB coupons or tokens to purchase fruits and vegetables,0 otherwise
Control variables	

Age group	
Youngest respondents ^a (18-39 years)	= 1 if the individual is between 18 and 39 years old, 0 otherwise
Middle-aged respondents (40-59 years)	= 1 if the individual is between 40 and 59 years old, 0 otherwise
Senior or old age respondents (at least 60 years)	= 1 if the individual is at least 60 years old, 0 otherwise
Gender	
Man	= 1 if the individual belongs to gender male, 0 otherwise
Woman ^a	= 1 if the individual belongs to gender female, 0 otherwise
Race or ethnicity	
Asian	= 1 if the race of the individual is Asian, 0 otherwise
Black or African American	= 1 if the race of the individual is Black/African American, 0 otherwise
American Indian	= 1 if the race of the individual is American Indian, 0 otherwise
Native Hawaiian	= 1 if the race of the individual is Native Hawaiian, 0 otherwise
Other Pacific Islander	= 1 if the race of the individual is Other Pacific Islander, 0 otherwise
White ^a	= 1 if the race of the individual is White, 0 otherwise
Highest educational level	
Some high school	= 1 if the individual has attended a high school education, 0 otherwise
Graduated high school	= 1 if the individual has attended a high school education and graduated, 0 otherwise
Some college ^a	= 1 if the individual has attended a college education, 0 otherwise

Graduated college	= 1 if the individual has attended a college education and graduated, 0 otherwise
MS degree	= 1 if the individual has attended a graduate school and holds an MS degree, 0 otherwise
Terminal degree (PhD)	= 1 if the individual has attended a graduate school and holds a Terminal degree (PhD), 0 otherwise
Number of children in the household	
Household has no children ^a	= 1 if there are no children in the household, 0 otherwise
Household has few children (1-4)	= 1 if the number of children in the household is 1-4, 0 otherwise
Household has many children (at least 5)	= 1 if the number of children in the household is at least 5, 0 otherwise

^aReference category.

3.6 Distribution of Food Insecurity Across Variables

Table 4 reports the distribution of food insecurity among the respondents. It shows that among food insecure respondents, 6% were enrolled in the DUFEB program, about 47% belong to age group 40 to 59 years, and about 7% belong to age group 60 years and above. Also, among food insecure respondents, approximately 13% were male, approximately 40% were Black, 1% were Asian, 1% were American Indian, and 0.52% were Pacific Islander. Also, among the food insecure respondents, 25% had some high school education, about 30% graduated from high school, 13% graduated from college, and 2% had MS degree. Among the food insecure respondents, about 59% belong to households with few children and about 3% belong to households with many children.

Table 4: Distribution of Food Insecurity Across Variables.

Variable	Food secure (%)	Food insecure (%)
	N = 589	N = 965
DUFEB use	4.07%	6.01%
Age 40-59 years	27.84%	47.05%
Age at least 60 years	5.60%	7.05%

Male	9%	12.95%	
Black or African American	30.73%	40.31%	
Asian	1.53%	1.14%	3.7
American Indian	0.68%	1.24%	
Other Pacific Islander	0.00%	0.52%	
Some high school	15.96%	25.08%	
Graduated high school	21.39%	30.16%	
Graduated college	8.83%	12.95%	
MS degree	2.04%	2.49%	
Household has few children (1-4)	41.26%	59.26%	
Household has many children (at least 5)	3.57%	3.42%	

Note: The control variables Native Hawaiian and Terminal degree (PhD) were not included in the table since no responses were recorded for that variable.

Data Analysis

Data were analyzed using Stata. Responses were first recorded in Qualtrics. Then, those responses were exported from Qualtrics in the Excel file. Then, the Excel file was imported into Stata. Finally, data were coded and analyzed using Stata version 18.

4. Empirical Specification

4.1 Ordered Logit Model

When the dependent variable consists of multiple outcomes that follow a natural ordering, ordered models are appropriate for estimation in empirical analysis (Cranfield & Magnusson, 2003). In our study, the dependent variable “psychological distress” is polychotomous and ordinal in nature, thus we used an Ordered Logistic Regression (Fang et al., 2021). Logit model is widely used in discrete choice analysis as one of the several approaches for modeling categorical dependent variables (Davidson & MacKinnon, 1993). The multinomial logit model takes the standard form as follows:

$$\log[pr/(1 - pr)] = \beta_0 + \sum\beta_iX_i + \varepsilon \quad (1)$$

Where pr is the probability that the dependent variable $Y = 1$; $(1-pr)$ is the probability that $Y = 0$; β 's are parameter estimates for the independent variable, X_i which influences the dependent variable; and ε is the unexplained random component.

The choice between ordered logit and ordered probit model depends on the assumed distribution of the error term. When the cumulative distributive function is specified as logistic, the model is referred to as an ordered logit; whereas assumption of standard normal distribution leads to an ordered probit. Both models ordered logit or ordered probit generally yield similar results due to their similar distribution (Cranfield & Magnusson, 2003).

Ordered logit is an extension of the multinomial logit model designed to account for dependent variable Y to have more than 2 possible outcomes that are ordered (Ascough et al., 2002).

As cited by (Ascough et al. 2002), the latent model for Ordered Logit according to Greene (1999) is:

$$Y^* = \beta_0 + \sum\beta_iX_i + \varepsilon \quad (2)$$

Where Y^* is unobserved (or latent) outcome variable.

Based on this already built latent model, Ordered Logit Model in our study is specified as:

$$Y^*_i = \beta_0 + \beta_1 \text{Food insecurity}_i + \beta_2 \text{DUFB use}_i + \beta_3 (\text{Food insecurity}_i \times \text{DUFB use}_i) + X_i \gamma + \varepsilon_i \quad (3)$$

where, Y_i^* is the latent psychological distress experienced by an individual i , β 's are parameters of explanatory variables reflecting the relationship between psychological distress experienced by an individual and explanatory variables (*food insecurity* and *DUFB use*), X_i is the vector of control variables thought to influence psychological distress experienced by an individual besides explanatory variables, γ is the vector of coefficients for control variables, and ε_i is an

independently and identically distributed error term with mean 0 and variance 1. If the latent psychological distress falls within certain range, the psychological distress Y_i is assigned a numerical value that reflects the category in which the latent psychological distress experienced by an individual lies.

In our case, the observed psychological distress Y_i has j categories and ($j \in 0,1,2,3$). Numerical values 0,1,2, and 3 correspond to no psychological distress, mild psychological distress, moderate psychological distress, and severe psychological distress. The classes of observed psychological distress mapped in our study based on the cut-off points are given as:

$$Y_i = \begin{cases} 0 & \text{if } Y^*_i = 0 & \text{(no distress)} \\ 1 & \text{if } 0 < Y^*_i \leq \mu_1 & \text{(mild distress)} \\ 2 & \text{if } \mu_1 < Y^*_i \leq \mu_2 & \text{(moderate distress)} \\ 3 & \text{if } \mu_2 < Y^*_i & \text{(severe distress)} \end{cases} \quad (4)$$

where μ 's are category threshold parameters or cut-off points to distinguish the classes of observed psychological distress.

The probability formulation is given by:

$$Pr(Y_i = j | X_i) = F(\mu_j - \eta_i) - F(\mu_{j-1} - \eta_i) \quad (5)$$

where $F(\cdot)$ is the logistic cumulative distributive function of the error term.

$$\eta_i = \beta_1 \text{Food insecure}_i + \beta_2 \text{DUFB use}_i + \beta_3 (\text{Food insecure}_i \times \text{DUFB use}_i) + X_i \gamma$$

$$F(z) = \frac{1}{1 + \exp^{-z}}$$

explicitly written as:

$$P(Y_i = j | X_i) = \frac{1}{1 + \exp^{-(\mu_j - \eta_i)}} - \frac{1}{1 + \exp^{-(\mu_{j-1} - \eta_i)}} \quad (6)$$

4.2 Interaction Effect

The interaction effect cannot be interpreted directly from the estimated coefficient on the interaction term in non-linear models. Rather, they should be computed using cross partial derivatives or by evaluating changes in predicted probabilities with respect to the explanatory variables (Ai & Norton, 2003). Following this, the interaction effect in our study is given by double difference or difference in difference in predicted probabilities i.e. the difference of the marginal

effect of food insecurity when DUFB use = 1 and marginal effect of food insecurity when DUFB use = 0.

5. Results and Discussion

5.1 Summary Statistics

Table 5 shows the summary statistics of a dependent variable, independent variables, and control variables used in our Ordered Logit Model. It shows that on average 62.1% of respondents were food insecure at the time of study. Approximately 5% were enrolled in the DUFEB program. Approximately 40% of respondents belong to middle age group and 6.5% belong to old age group. About 11.5% of respondents were male. Approximately 37% of the respondents were Black, 1% were Asian, 1% were American Indian, and 0.3% were Pacific Islander. Approximately 22% had attained some high school education, 27% graduated from high school, 11% graduated from college, 2% had MS degree, and no one had a terminal degree (PhD). Households with 1-4 children were approximately 52%, and households with at least 5 children were 3.5%.

Table 5: Summary Statistics of Variables used in Ordered Logit Model.

Variable	Obs	Mean	Std. dev.	Min	Max
Psychological distress	1554	1.211	1.048	0	3
Food insecurity	1554	0.621	0.485	0	1
DUFEB use	1554	0.053	0.224	0	1
Age 40-59 years	1554	0.398	0.490	0	1
Age at least 60 years	1554	0.065	0.247	0	1
Male	1554	0.115	0.319	0	1
Black or African American	1554	0.367	0.482	0	1
Asian	1554	0.013	0.113	0	1
American Indian	1554	0.010	0.101	0	1
Native Hawaiian	1554	0	0	0	0
Other Pacific Islander	1554	0.003	0.057	0	1
Some high school	1554	0.216	0.412	0	1
Graduated high school	1554	0.268	0.443	0	1
Graduated college	1554	0.114	0.318	0	1
MS degree	1554	0.023	0.150	0	1
Terminal degree (PhD)	1554	0	0	0	0
Household has few children (1-4)	1554	0.524	0.500	0	1
Household has many children (at least 5)	1554	0.035	0.183	0	1

5.2 Results of Ordered Logit Model

We investigated 2 research questions by employing an Ordered Logit Model. First, we investigated the relationship between food insecurity and psychological distress. Second, we investigated

whether enrollment in the DUFB program moderates the relationship between food insecurity and psychological distress.

5.2.1 Main Effect of Food Insecurity on Psychological Distress

First, we investigate the main effect of food insecurity on psychological distress. Table 6 shows the main effect of food insecurity on psychological distress based on our Ordered Logit Model. The coefficients presented in the table are average marginal effect. Marginal effects are used for interpretation because they can be interpreted with simplicity (Cranfield & Magnusson, 2003). The positive marginal effect of X_k (variable) indicates that the probability of an individual experiencing the particular level of psychological distress increases with X_k while the negative marginal effect indicates the opposite.

Overall results from Table 6 show that food insecurity is significantly associated with psychological distress, which includes no psychological distress, mild psychological distress, moderate psychological distress, and severe psychological distress. The results for each level of psychological distress with its determinant are described below.

5.2.1.1 No Psychological Distress

The marginal effect was negative for food insecurity. On average, food-insecure individuals' probability of experiencing no psychological distress was 48 percentage points lower than it was for food secure individuals.

Similarly, the marginal effect was also negative for the DUFB use. Those who enrolled in the DUFB program had 9 percentage points lower probability of experiencing no psychological distress than those who didn't enroll in the DUFB program.

Marginal effects varied for age categories. The marginal effect was negative for middle-aged respondents. Middle-aged respondents (40-59 years) had 5 percentage points lower probability of experiencing no psychological distress than youngest respondents (18-39 years). The marginal effect was positive for age at least 60 years but not significant.

Marginal effects varied for race or ethnicity category. The marginal effect was positive for Black or African American. The Black's probability of experiencing no psychological distress was 3 percentage points higher than it was for White. The marginal effect was negative for Asian but not significant.

The marginal effect was negative for education level categories. High school graduates had a 7 percentage points lower probability, and college graduates had an 8 percentage points lower probability of experiencing no psychological distress than those with some college education. Marginal effect was not significant for MS degree terminal degree, and some high schools.

Similarly, the marginal effect was negative for categories for the number of children in the household. Households with few children (1- 4) had 3 percentage points lower probability of

experiencing no psychological distress than households with no children. The marginal effect was not significant for households with many children.

5.2.1.2 Mild Psychological Distress

The marginal effect was positive for food insecurity. On average, food-insecure individual's probability of experiencing mild psychological distress was 4 percentage points higher than it was for food-secure individual.

Similarly, the marginal effect was positive for DUFEB use. Those who enrolled in the DUFEB program had a 5 percentage points higher probability of experiencing mild psychological distress than those who didn't enroll in the DUFEB program.

Marginal effects varied for age categories. The marginal effect was negative for middle-aged respondents. Middle-aged respondents (40-59 years) had 1 percentage points lower probability of experiencing mild psychological distress than youngest respondents (18-39 years). The marginal effect was positive for age at least 60 years, but not significant.

Marginal effects varied for race or ethnicity categories. The marginal effect was positive for Black or African American. The Black's probability of experiencing mild psychological distress was 0.5 percentage points higher than it was for White. The marginal effect was negative for Asian but not significant.

Marginal effects were negative for education level categories. High school and college graduates each had 1 percentage points lower probability of experiencing mild psychological distress than those with some college education. Marginal effect was not significant for MS degree terminal degree, and some high schools.

Similarly, the marginal effect was negative for categories of the number of children in the household. Households with few children (1-4) had a 0.6 percentage points lower probability of experiencing mild psychological distress than households with no children. The marginal effect was not significant for households with many children.

5.2.1.3 Moderate Psychological Distress

The marginal effect was positive for food insecurity. On average, food-insecure individual's probability of experiencing moderate psychological distress was 25 percentage points higher than it was for food-secure individual.

Similarly, the marginal effect was positive for DUFEB use. Those who enrolled in the DUFEB program had 3 percentage points higher probability of experiencing moderate psychological distress than those who didn't enroll in the DUFEB program, but it was not statistically significant.

Marginal effects varied for age categories. The marginal effect was positive for middle-aged respondents. Middle-aged respondents (40-59 years) had 2 percentage points higher

probability of experiencing moderate psychological distress than youngest respondents (18-39 years). The marginal effect was negative for age at least 60 years but not significant.

Similarly, marginal effects varied for race or ethnicity categories. The marginal effect was negative for Black or African American. Black's probability of experiencing moderate psychological distress was 1 percentage points lower than it was for White. The marginal effect was positive for Asian but not significant.

Marginal effects were positive for all education level categories. High school and college graduates each had a 3 percentage points higher probability of experiencing moderate psychological distress than those with some college education. Marginal effect was not significant for MS degree terminal degree, and some high schools.

Similarly, the marginal effect was positive for all categories of the number of children in the household. Households with few children (1-4) had 1 percentage points higher probability of experiencing moderate psychological distress than households with no children. The marginal effect was not significant for households with many children.

5.2.1.4 Severe Psychological Distress

The marginal effect was positive for food insecurity. On average, food-insecure individual's probability of experiencing severe psychological distress was 18 percentage points higher than it was for food-secure individual.

Similarly, the marginal effect was positive for DUFEB use. Those who enrolled in the DUFEB program had about 1 percentage points higher probability of experiencing severe psychological distress than those who didn't enroll in the DUFEB program, but it was not statistically significant.

Marginal effects varied for age categories. The marginal effect was positive for middle-aged respondents. Middle aged respondents (40-59 years) had 4 percentage points higher probability of experiencing severe psychological distress than youngest respondents (18-39 years). The marginal effect was negative for age at least 60 years but not significant.

Similarly, marginal effects varied for race or ethnicity categories. The marginal effect was negative for Black or African American. Black's probability of experiencing severe psychological distress was 2 percentage points lower than it was for White. The marginal effect was positive for Asian but not significant.

Marginal effects were positive for all education level categories. High school and college graduates had a 5 percentage points higher probability of experiencing severe psychological distress than those with some college education. Marginal effect was not significant for MS degree terminal degree, and some high schools.

Similarly, the marginal effect was positive for all categories of the number of children in the household. Households with few children (1-4) had 2 percentage points higher probability of

experiencing severe psychological distress than households with no children. The marginal effect was not significant for households with many children.

Table 6: Parameter Estimates of Main Effect of Food Insecurity on Psychological Distress.

Dependent variable (Psychological distress)	No psychological distress	Mild psychological distress	Moderate psychological distress	Severe psychological distress
Food insecurity	-0.480*** (0.023)	0.044** (0.014)	0.256*** (0.015)	0.180*** (0.012)
DUFB use	-0.095* (0.039)	0.060** (0.020)	0.034 (0.022)	0.001 (0.025)
Age 40-59 years	-0.058*** (0.017)	-0.011*** (0.003)	0.026*** (0.008)	0.042*** (0.012)
Age at least 60 years	0.004 (0.031)	0.001 (0.006)	-0.002 (0.014)	-0.003 (0.023)
Male	-0.009 (0.025)	-0.002 (0.005)	0.004 (0.011)	0.007 (0.018)
Black or African American	0.032* (0.016)	0.006* (0.003)	-0.015* (0.007)	-0.023* (0.012)
Asian	-0.037 (0.065)	-0.007 (0.012)	0.017 (0.030)	0.027 (0.047)
American Indian	0.090 (0.074)	0.017 (0.014)	-0.041 (0.034)	-0.066 (0.054)
Native Hawaiian	0.000 (.)	0.000 (.)	0.000 (.)	0.000 (.)
Other Pacific Islander	0.085 (0.130)	0.016 (0.024)	-0.039 (0.060)	-0.061 (0.095)
MS degree	-0.071 (0.052)	-0.013 (0.010)	0.033 (0.024)	0.052 (0.038)
Terminal degree	0.000 (.)	0.000 (.)	0.000 (.)	0.000 (.)

Some high school	-0.021 (0.021)	-0.004 (0.004)	0.010 (0.010)	0.015 (0.015)
Graduated high school	-0.076*** (0.020)	-0.014*** (0.004)	0.035*** (0.009)	0.055*** (0.014)
Graduated college	-0.082** (0.026)	-0.015** (0.005)	0.038** (0.012)	0.060** (0.019)
Household has few children (1-4)	-0.037* (0.017)	-0.007* (0.003)	0.017* (0.008)	0.027* (0.013)
Household has many children (at least 5)	-0.035 (0.041)	-0.007 (0.008)	0.016 (0.019)	0.026 (0.030)
Observations	1554	1554	1554	1554

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The outcome variable psychological distress categorized into 4 different levels (no psychological distress, mild psychological distress, moderate psychological distress, and severe psychological distress), is shown in columns 1,2,3, and 4 respectively. The independent variables are food insecurity and DUFB use. The control variables are age group 40 -59 years, age group at least 60 years, Male, Black or African American, Asian, American Indian, Native Hawaiian, Other Pacific Islander, MS degree, Terminal degree (PhD), some high school, graduated high school, graduated college, household has few children, and household has many children. Standard errors are reported in parentheses.

5.2.2 Interaction Effects of Food Insecurity and the Enrollment in DUFB Program on Psychological Distress

Our first investigation showed that food insecurity was significantly associated with psychological distress. Now, we investigate whether enrollment in the DUFB program moderates the relationship between food insecurity and psychological distress.

Table 7 shows the interaction effects of food insecurity and enrollment in the DUFB program on psychological distress. The interaction effect was estimated using the double-difference approach to determine whether enrollment in the DUFB program moderates the relationship between food insecurity and psychological distress.

The results indicate that enrollment in the DUFB program significantly moderates the association between food insecurity and psychological distress. The positive interaction term for no psychological distress indicates the higher magnitude of association between food insecurity and no psychological distress with enrollment in the DUFB program. While the negative interaction term for mild psychological distress, moderate psychological distress, and severe psychological distress indicates a lower magnitude of association between food insecurity and mild

psychological distress, moderate psychological distress, and severe psychological distress respectively with enrollment in the DUFB program.

Among food insecure individuals, those who enrolled in the DUFB program had 30 percentage points higher probability of experiencing no psychological distress than those who didn't enroll in the DUFB program. For mild psychological distress, among food insecure individuals, the probability of experiencing mild psychological distress was about 10 percentage points lower for those who enrolled in the DUFB program than it was for those who didn't enroll in the DUFB program. Similarly, for moderate psychological distress, among food insecure individuals, those who enrolled in the DUFB program had 13 percentage points lower probability of experiencing moderate psychological distress than for those who didn't enroll in the DUFB program. For severe psychological distress, among food insecure individuals, those who enrolled in the DUFB program had 7 percentage points lower probability of experiencing severe psychological distress than those who didn't enroll in the DUFB program.

Table 7: Parameter Estimates of Interaction Effect of Food Insecurity and the Enrollment in DUFB Program on Psychological Distress.

Dependent variable		No distress	Mild distress	Moderate distress	Severe distress
(Psychological distress)					
	Food insecurity	-0.480*** (0.023)	0.044** (0.014)	0.256*** (0.015)	0.180*** (0.012)
Main effect					
	DUFB use	-0.095* (0.039)	0.060** (0.02)	0.034 (0.022)	0.001 (0.025)
Interaction effect	Food insecurity X DUFB use	0.302*** (0.092)	-0.097*** (0.033)	-0.131** (0.053)	-0.073* (0.044)
Observations		1554	1554	1554	1554

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The main effect of food insecurity and DUFB use on psychological distress is shown in (row 2) whose coefficient values represent the average marginal effect. Interaction effect of food insecurity and DUFB use is shown in row 3, where the coefficient of interaction is the difference between marginal effect of food insecurity across two groups (DUFB use and without DUFB use). The control variables were age group 40-59 years, age group at least 60 years,

male, Black or African American, Asian, American Indian, Native Hawaiian, Other Pacific Islander, MS degree, Terminal degree (PhD), some high school, graduated high school, graduated college, household has few children, and household has many children. Standard errors are reported in parentheses.

As expected, our findings showed that food insecurity was significantly associated with psychological distress. Those who were food insecure were less likely to experience no psychological distress and more likely to experience mild psychological distress, moderate psychological distress, and severe psychological distress. Our findings are consistent with previous studies (Arenas et al., 2019; Bergmans et al., 2019; Tribble et al., 2020) where they reported similar findings that food insecurity was associated with higher likelihood of poor mental health. Bergmans et al. (2019) suggest that the association between food insecurity and psychological distress may operate through multiple pathways including diet quality (consumption of fewer fruits, vegetables, and vitamins or minerals), deficiency in particular nutrients, and psychological burden of seeking essential food sources as well as acquiring it. These conditions may contribute to psychological distress through biological mechanisms such as systemic inflammatory processes.

Regarding the interaction effect of food insecurity and DUFB enrollment on psychological distress, our findings showed that enrollment in the DUFB program significantly moderated the association between food insecurity and psychological distress. This suggests that enrollment in the DUFB program might weaken the psychological distress associated with food insecurity. As previously mentioned in the literature review section, there are no prior studies that have either investigated the relationship of DUFB program with psychological distress or the interaction effect between food insecurity and DUFB enrollment on psychological distress. Valentine and Gibson (2025) found indirect improvement on physical and mental health from participation in the DUFB program by supporting to purchase more healthy diets such as fruits and vegetables.

We did not investigate the underlying pathway how enrollment in the DUFB program might have attenuated the association between food insecurity and psychological distress. One underlying pathway might be due to increased access to fruits and vegetables through the DUFB program. Bergmans et al. (2019) reported that improved access to fruits and vegetables attenuates the association between food insecurity and poor mental health.

Overall, our empirical findings with support of previous literature confirmed that food insecurity was significantly associated with psychological distress and that psychological distress was attenuated by enrollment in the DUFB program in the context of food insecure households in Alabama. Based on our scope of research and with empirical evidence, we argue that food insecurity is associated with psychological distress and the introduction of nutrition incentive programs such as DUFB might alleviate the psychological distress associated with food insecurity.

We wanted to point out that the association between food insecurity and mental health could be bidirectional (Bruening et al., 2017), therefore, there might be an issue of reverse causality, i.e. psychological distress may also affect food insecurity and even DUFB enrollment.

Also, we used the short time window “last week” for measuring food insecurity and longtime window “last month” for measuring the psychological distress. Though time windows are different, they are consistent with the original survey design. The recent short time window for measuring food insecurity was used to capture the condition of most current access to food for household, assuming that most recent status of access to food influence their mental health.

DUFB users are different from the normal shoppers in stores. They are low-income households eligible for SNAP, have a limited food budget, and may purchase more fresh fruits and vegetables as compared to normal shoppers.

This study might be useful for policymakers and future researchers working on food insecurity, mental health, and nutrition incentive programs. Although we have novel findings, there are 4 caveats we wanted to clarify for the readers. First, the study is based on the Qualtrics survey; the responses to questions we asked for respondents for measuring mental health status and food security status are purely subjective. Second, we wanted to point out that this study used a cross-sectional dataset and was limited to Alabama only. It is intuitive that the real effect of programs like DUFB on mental health is better captured when empirical analysis is performed with panel dataset so that temporal nature of DUFB program is observed. Third, psychological distress may also affect food insecurity and even DUFB enrollment, causing the issue of reverse causality. We only investigated unidirectional associations between food insecurity and psychological distress, though their associations might be bidirectional (Bruening et al., 2017). Finally, it is difficult to isolate the benefits of the DUFB programs from other programs if in case an individual benefits from other similar programs during study period.

Therefore, future studies may expand this study using panel dataset and including more states where DUFB program has been initiated so that the findings capture temporal nature and more area coverage for the influence of DUFB program to get better insights into moderating relationship between food insecurity and DUFB enrollment on psychological distress. This will inform policymakers to roll the nutrition incentive program to alleviate the psychological distress associated with food insecurity especially in regions which are highly vulnerable to food insecurity such as Southern part of the U.S.

6. Conclusion

The overall objective of this study was to investigate the relationship between food insecurity and psychological distress and to determine whether enrollment in the DUFEB program moderates the relationship between food insecurity and psychological distress. We used the cross-sectional dataset of GusNIP survey conducted among SNAP households in Alabama in 2024. The Ordered Logit Model was employed for the study.

Our empirical analysis showed 2 key findings. First, food insecurity was significantly associated with psychological distress in the context of Alabama. Second, enrollment in the DUFEB program moderated the association between food insecurity and psychological distress which suggests that the magnitude of the association between food insecurity and psychological distress

was weaker with enrollment in the DUFEB program. Overall, findings suggest that food insecurity was significantly associated with psychological distress, and enrollment in the DUFEB program is likely to alleviate the psychological distress associated with food insecurity in the context of Alabama.

Future studies using panel dataset and including more states can capture the temporal nature and more geographic coverage for the influence of the DUFEB program on mental health. This will benefit the concerned stakeholders to get more insights into the moderating association between DUFEB enrollment and food insecurity on psychological distress for policy-level intervention to alleviate the psychological distress associated with food insecurity.

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