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An Examination of the Relationship Between Levels of Food Security and Depression

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AN EXAMINATION OF THE RELATIONSHIP BETWEEN LEVELS OF FOOD SECURITY AND DEPRESSION

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ABSTRACT
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Prior research has identified a variety of common correlates between food security and depression but oftentimes the data used in these analyses are not representative of the US or do not consider multiple categorical levels of the focal variables. Using data from the 2009-2010 National Health and Nutrition Examination (NHANES), this study sought to examine the relationship between four levels of food security - full, marginal, low and very low - and depression. The findings indicate low and very low food security are significantly related to an increased risk of depression, while marginal food security is not significantly different from full food security. Inclusion of interaction effects between food security and gender as well as food security and having a child/children were not found to be a significant improvement to the model.

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INTRODUCTION

Research into depression and levels of food security is not new. Around the turn of the century a variety of analyses were produced that sought to model this relationship (e.g. Casey et al., 2004; Seifert, Heflin, Corcoran & Williams, 2001; Seifert, Heflin, Corcoran & Williams, 2004; Vozoris & Tarasuk, 2003). These studies found a significant, negative relationship between food security and depression but they also had a number of notable limitations. Often food security was dichotomized between food secure and insecure (e.g. Seifert et al., 2001), which produced analyses that failed to consider the various degrees to which an individual or household might have difficulty accessing food. Other times the research focused on very small subpopulations such as assistance-receiving persons in Montreal (Caron, 2012), those from the Mississippi Delta (Stuff et al., 2004) or mothers of young children (Casey et al., 2004). What has come from this focus of inquiry is strong evidence suggesting the relationship between levels of food security and depression is modified by other variables such as gender and parental status but these patterns have yet to be tested on a national scale within the US. Some research has used a nationally representative sample (e.g. Carter et al., 2011; Vozoris & Tarasuk, 2003; Wu & Schimmele, 2005) but these were done in Canada and New Zealand.

The Centers for Disease Control and Prevention (CDC) (2012) finds approximately 1 out of every 10 American adults reports symptoms consistent with depression. In addition to general depression, approximately 4% of adults have symptoms of major depression (CDC, 2012). A report published by Harvard University for the World Health Organization identified depression as the fourth-leading cause of

disability in 1990 and predicts it will be the leading cause by 2020 (Murray & Lopez, 1996).

According to Pearlin, Menaghan, Lieberman and Mullan (1981), depression is a manifestation of life's stressors. The effects of depression are manifold and have both personal and societal consequences. The National Institute of Mental Health (2011), a division of the National Institute of Health, suggests sufferers may experience sadness, hopelessness, irritability, fatigue, sleeplessness, difficulty concentrating, changes in appetite, physical pain or thoughts of suicide. Depression is also related to absenteeism from work, decreased productivity and short-term disability (CDC, 2012). In this way, depression is both an individual illness and a condition that places strain on societal resources.

Like depression, levels of food security affect a significant number of Americans. The United States Department of Agriculture (USDA) defines food security as, "access by all people at all times to enough food for an active, healthy life" (2013). There are four categories used to describe the levels of food security in the US: high food security, marginal food security, low food security and very low food security (USDA, 2013). The USDA (2012) estimates that in 2012, approximately 14.5% of households failed to be fully food secure at some point during the year. An additional 5.7% of American households experienced very low food security at some point during the year (USDA, 2012).

Varying levels of food security affect both physical and mental health of the individual as well as society at large. Seligman, Laraia and Kushnel (2010) found the non-fully food secure to have a positive correlation with hypertension (high blood

pressure) and hyperlipidemia (high cholesterol). In other words, these lower levels of food security are related to risk factors for cardiovascular disease. They also found very low food security to be related to diabetes (Seligman et al., 2010). Ashiabi and O"Neal (2007) found low levels food security were positively correlated with parental emotional distress. They identified a connection between those parents who experienced increased stress and problems the parents' adolescent children had with adjusting to change. This suggests both the mental health of both parents and children can be affected by low levels of food security.

Low levels of food security also have a number of societal implications. According to a study conducted by Hamelin, Habicht and Beaudry (1999), they are related to increased use of healthcare resources and decreased social engagement. They also found a relationship with absenteeism and loss of productivity at school and work. Work done by the Partnership for America's Economic Success suggests economic success in the form of human capital is significantly reduced by low levels of food security (Murphy et al., 2008).

Both depression and low levels of food security affect a significant number of Americans. Both have deleterious effects on their host as well as negative consequences for the larger society. Both have a relationship to stress where it appears low levels of food security acts as a stressor and depression is an outcome of stress. While the scholarship about the connections between the levels of food security and depression are compelling, their limitations suggest analyses that consider a nationally representative sample of the US population is warranted. Additionally, the literature points to moderating effects of gender and parental status that impact the relationship between low

levels of food security and depression. As previously noted, however, these studies have been limited by their small, homogenous populations. Addressing these gaps is the purpose of the present analyses.

BACKGROUND

Depression

In order to understand the relationship food security has to depression, it is important to examine the historical context within which each vein of research developed and, eventually, converged. Much of the early research on depression focused on various facets of distress (e.g. Good, 1945; Israeli, 1935; Lipman, Rickles, Covi, Derogatis & Uhlenhuth, 1969). This early work paved the way for later research into a stress-based model of depression. There are also a number of other proposed models of depression, as research has been unable to definitively explain its causal mechanism(s). One of these other models explains depression in terms of genetic predisposition where some people are more likely to experience depression, or more severe depression, based on their genetic makeup (Tsuang, Bar, Stone & Faraone, 2004). According to the National Institute of Mental Health (NIMH), a division of the National Institutes of Health (NIH), another path of depression research has noted changes in levels of neurotransmitters as well as brain structure in those who are depressed, which has lead to the theory that after an inciting event that causes an initial depressive episode, subsequent episodes are more likely because of the changed chemistry and structure (NIMH, 2011). While these alternative models of depression are important to note, only a stress-based model is being considered for this investigation.

With respect to the stress-based model that arose out of early distress research, Pearlin, Menaghan, Lieberman and Mullan (1981) were some of the first to implement a longitudinal design with the specific purpose of observing the range of conditions that coalesce to create or mitigate stress over time (p 337). They suggest stressors operate in a dynamic although broadly predictable progression, the stress process (p 338-41). Stressors such as job disruption (i.e. being fired or demoted), illness, children and inflation were considered for constructing the stress process model. According to Pearlin et al. (1981) depression is one of the most significant manifestations of this process, which occurs when stressors are unable to be balanced by coping strategies and social support (p 341-2).

Other stress research distinguished between the outcomes of different types of stressors (e.g. Monroe et al., 1983; Oatley & Bolton, 1985; Wheaton, 1985). The underlying theory of this research is a variety of events cause stress but the outcome of that stress is different based on the context within which it is viewed (Monroe et al., 1983). For example, while a marriage may be a stressful event, it is generally recognized as a joyous, positive occasion. A minor medical illness may put a similar "amount" of strain on a person but this sort of event is viewed negatively. The theory suggests those having negative (or more negative than positive) stressors will have differential rates of a given outcome compared to those who experience positive (or more positive than negative) stressors (Monroe et al., 1983). Monroe et al.(1983) confirmed their theory. They found those who experienced more stressors perceived as negative were more likely to report symptoms that met the criteria for depression, whereas those who experienced more stressors perceived as positive tended to report symptoms that did not meet the

criteria (Monroe et al., 1983). This is a critical distinction when considering a phenomena such as low levels of food security, which would be difficult to frame as anything but a negative stressor.

Research during this time also sought to determine what sociodemographic variables affected stress. This included considering the relationship between social class, as measured by occupation and education, and distress (e.g. Kessler & Cleary, 1980; Vanfossen, Spitzer & Jones, 1981). Others looked at race and stress (e.g. Kessler & Neighbors, 1986; Ulbrich, Warheit & Zimmerman, 1989). About this focus of the research, Pearlin (1989) says:

> Many stressful experiences…don't spring out of a vacuum but typically can be traced back to surrounding social structures and people's locations within them. The most encompassing of these structures are the various systems of stratification…such as those based on social and economic class, race and ethnicity, gender and age (p 242).

What Pearlin seems to be suggesting by this is in order to understand how stress operates, it is necessary to consider both the stressor itself as well as the social structures that it is bounded by. Since depression is a manifestation of stress, to fully understand depression factors such as class, race/ethnicity, age and gender must be considered and controlled for.

Many researchers have sought to link depression to the various structural stratifiers Pearlin mentions. A number (e.g. Briones, Heller, Chalfant, Roberts, Aguirre-Hauchbaum & Farr, 1990; Lenzi, Lazzerini, Marazziti, Raffaelli, Rossi & Cassano, 1993; Roy, 1981) found significant relationships between SES or social class and depression.

Lenzi et al. (1993), for example, found clinical depression symptoms are significantly correlated with low social class categorization. Roy (1981) found a similar relationship when looking at subjects hospitalized for depression symptoms.

A study conducted in the Netherlands had similar findings but also determined there are differential rates and types of stressors for those at the various socioeconomic levels (Stronks, Van de Mheen, Looman & Mackenbach, 1998). They distinguish between long term and acute stressors with respect to perceived health generally as well as emotional/psychological health specifically. They found long term stressors have a greater effect with respect to depression. Financial problems in particular were identified as being the most significant of long term stressors, as well as being strongly correlated with low SES (Stronks et al., 1998).[1] A more recent study by Turner and Avison (2003) had similar findings. They divided SES into three categories: upper, middle and low. They determined being classified as part of the low SES significantly increased the likelihood of experiencing chronic stressors as well as stress in general (Turner & Avison, 2003). What these studies indicate is differential rates of stress for those at various levels of SES.

Another focus of social stratification and depression research has been conducted with respect to race and ethnicity. Briones et al. (1990) found a significant relationship between ethnicity and depression, where Mexican-Americans experience greater rates of depression than non-Hispanic whites when controlling for SES.[2] When comparing white and black mothers, Smith-McKeever, Rowe and Gao (2012) found African-Americans experience significantly lower rates of depression when controlling for SES, child's

[1] SES measured by educational attainment.
[2] SES measured by education and income.

behavior problems, criminality and substance abuse.[3] Cotton (1999) found nonwhites have significantly higher levels of depression than whites. Given the mixed findings with respect to depression and race/ethnicity, race/ethnicity will be important to control for when considering the relationship depression may have with other phenomena.

Another vein of depression research has focused on differences between men and women. Early work by Pearlin (1989) asserts women are more likely than men to show symptoms of emotional distress and depression. MacIntyre, Hunt and Sweeting (1996) found psychological distress and depression were the only illnesses for which there were significant gender differences at all stages of life. Their findings are consistent with others indicating women are more likely than men to have (or report) psychological distress and depression. For example, in their study of British young adults, Matthews, Manor and Power (1999) found similar gender differences in psychological distress when socioeconomic status was considered. In a comparable study in US, Turner and Lloyd (1999) found gender operates through SES in a mediating relationship to affect depression. In their 2002 comorbidity study for the Diagnostic and Statistical Manual IV (DSM-IV) of major depressive disorder (MDD), Kessler et al. (2003) found a number of important correlates to MDD. They found women, homemakers and those who have never married or were previously married are more likely to have MDD in their lifetime.

Other studies attempt to explain why there is a gender difference with respect to depression. Some suggest women tend to ruminate on problems more. As a result they suffer from a perceived sense of loss of locus of control, which in turn increases rates of depression (Nolen-Hoeksema, Larson & Grayson, 1999). Maier et al. (1999) performed a multi-national study using data from 14 nation-states to determine whether social and

[3] SES measured by income and education.

cultural dynamics account for gender differences in rates of depression. At the beginning of their study they note a 2:1 female to male ratio of instances of depression. This was reduced by approximately 50% when they controlled for "social role" variables such as responsibility for childcare, occupational status and marital status (Maier et al., 1999). From this they conclude social dynamics play a partial role in the gender differences noted for depression (Maier et al., 1999). A more recent study suggests gender differences in depression are actually a result of differential rates of the two major forms of depression (Silverstein et al., 2013). The two types are somatic depression, which is depression accompanied by physical symptoms such as fatigue, headaches or insomnia and true depression, which is depression without physical symptoms (Silverstein et al., 2013). Silverstein et al. (2013) found the differential rates of depression are a result of greater numbers of women reporting somatic depression.

Age also stratifies people and is a factor researchers have considered with respect to depression. Mirowsky and Ross (1992) found depression and age to be significantly related. Their findings indicated as one ages depression rates drop until approximately age 45. After age 45, the likelihood of experiencing depression increases to its highest point at age 80 and above, where one's risk for depression is increased approximately twofold compared to those under 30 (Mirowsky & Ross, 1992). When looking at age and depression in Canada, Wu, Schimmele and Chappell (2012) found a relationship between those 65 and older and depressive symptoms, where as one ages their risk of depression increases, but only when including medical comorbidity. This study suggests that not only should age be included in models of depression but health may need to be considered as well.

A number of researchers have looked at the relationship a person's health has to their likelihood of depression. One study found a negative relationship between self-rated health and depression, where those who rated their overall health the best tended to show the fewest signs of depression when controlling for SES (Kosloski, Stull, Kercher & Van Dussen, 2005).[4] A similar study was conducted in Toronto, Canada and also found self-rated overall health to be negatively correlated with depression (Perruccio, Badley, Hogg-Johnson & Davis, 2010). While this study controlled for education, other SES measures such as income were not accounted for. Since most research uses both education and income (see footnotes 2-8) as measures of SES, this seems to be a limitation that should be addressed when controlling for health with respect to depression.

In addition to the stratification attributes Pearlin (1989) mentioned, there are a number of other lines of inquiry depression scholarship suggests are important to consider. One of these is marital status. Early research showed married people tend to experience lower rates of psyhological distress and depression than the single, divorced and widowed (e.g. Gove, 1972; Malberg, 1964). Later studies found similar results. For example, Earle, Smith, Harris and Longino (1998) also found the married to be significantly less depressed than the non-married (including divorced, widowed and separated), when controlling for SES.[5]

Another focus of the scholarship has been on parental status. Bures, Koropeckyj-Cox and Loree (2009) found childless adults to have lower levels of depressive symptoms compared to adults with children. Similar research also suggests parents have

[4] SES measured by income and education.
[5] SES measured by income and education.

differentially higher rates of depression than non-parents, when controlling for SES (Evenson & Simon, 2005).[6] Zhang and Hayward (2001), on the other hand, found childless, divorced men to report more symptoms of depression compared to similarly statused women and men of different parental and marital statuses.

As did Zhang and Hayward (2001), often this research connects marital and parental statuses. For example, McLanahan (1983) determined there are differential levels of distress between those heading two-parent households and female-headed, single-parent households, where those heading the single parent household experiene the greatest amount of distress. Gallagher, Hobfill and Ritter (1997) found married and cohabiting women experienced significantly lower rates of depression during and after pregnancy compared to unmarried and noncohabiting women when controlling for race/ethnicity and income. Similar research done in Mexico found women from dual parent families had significantly lower rates of depression as compared to women from single parent families (Hernández, 2009). Much of the research surrouding marital and parental statuses focuses on women. Lack of consideration for single fathers and, more generally, men's depression is a limitation of this scholarship.

Another stressor research shows is related to depression is pain. In their comorbidity study of pain and depression amongst low income women, Poleshuck, Gile and Tu (2006) found those reporting pain were significantly more likely to also have symptoms of depression. Others have similar findings (e.g. Campbell, Clauw & Keefe, 2003; Chopra & Arora, 2014; Nicolson, Caplan, Williams & Stern, 2009). von Knorring and Ekselius (1994) attempt to explain this realtionship by suggesting pain and depression may have related biological mechanisms. They point to a potential genetic

[6] SES measured by income and education.

link as well as the fact that some chronic pain may be partially relieved by treatment with antidepressants.

A final stressor identified as being strongly predictive of depression is anxiety. According to a variety of studies, anxiety is highly correlated with depression (e.g. Brown. Schulberg, Madonia & Shear, 1996; Rief, hiller, Geissner & Fichter, 1995). Mineka, Watson and Clark (1998) found increased anxiety to be correlated with increased levels of depression. Additionally, pain, anxiety and depression are also strongly related to each other. Research into a sample of women found the presence of anxiety increases the risk for comorbid pain and depression (Poleshuck et al., 2009)

Taken together, this early depression research paints a picture that becomes important for future scholarship as well as the investigation herein. It suggests depression is directly related to life's stressors. It also says the relationship between distress and stressors may be mitigated or, potentially, exacerbated when the modeling considers moderating variables. As such, SES, race/ethnicity, gender, age, health, marital status, parental status, pain and anxiety must each be controlled for when considering the relationship depression may have to another phenomenon.

Food Security

The Food Security Measurement Project, established in 1992, was designed to bridge research on food security between the US Census Bureau and those making parallel efforts in the private sector (Bickel, 2000). It was not until 1995, however, that food security became a major focus of federal research. This happened following welfare reform, specifically the Personal Responsibility, Work and Reconciliation Act (PRWORA). PRWORA changed eligibility requirements for food stamp benefits, among

other things (Van Hook & Balistreri, 2005). It was during this time that the Food Security Supplement was added to the Current Population Survey (CPS) with the purpose of determining levels of food security in the US and, more specifically, changes to these levels following the implementation of PRWORA (Bickel, 2000).

As food security became of increasing interest and data about the topic became more widely available, new paths of research began to emerge. In its broadest terms, much of the foundational exploration into food security was with regards to its primary correlates. Countless studies identified relationships between low levels of food security and low income or socioeconomic status (e.g. Heflin & Ziliak, 2008; Martin, Rogers, Cook & Joseph, 2004; Sharkey, Johnson & Dean, 2011; Seifert, Heflin, Corcoran & Williams, 2004). The finding from this food security scholarship is a primary, negative relationship between income/SES and food security.

The similarity in the association between depression and low levels of food security to a number of covariates provides further motivation for analyzing this relationship. One such variable is gender. The literature has established a relationship between gender and low levels of food security, with women more likely to lack food security than men (e.g. Aliamo et al., 1998; Carter, Kruse, Blakley & Collings, 2011; Martin & Lippert, 2012; Wu & Schimmele, 2005). Wu and Schimmele (2005) found a significant relationship between low levels of food security and gender, where women are more likely to lack food security. Martin and Lippert (2012) attempt to explain the relationship between gender and the levels of food security while controlling for socioeconomic status and overall, self-rated health.[7] They argue gendered parenting expectations are responsible for the differences noted between men and women with

[7] SES measured by income and education.

regards to food security. Martin and Lippert (2012) suggest it is gendered expectations such as that is a mother's responsibility, as opposed to the father's, to provide food for her children. They also argue women are more likely to alter their food choices and intake in order to ensure there is enough for their children (Martin & Lippert, 2012). Other research conducted in Canada had similar findings (McIntyre et al., 2003). Seifert, Heflin, Corcoran and Williams (2004) concur saying women are generally the ones most responsible for making household food choices via purchasing and cooking when controlling for education, poverty status and overall, self-rated health.

Like depression, numerous studies have documented a relationship between food security and parental or marital status. For example, research using the National Health and Nutrition Examination Survey (NHANES) III, which covers the years 1988 through 1994, shows a significant difference between single-parent households headed by men and women (Alaimo, Briefel, Frongillo & Olson, 1998). Those headed by women were less likely to be food secure. Tarasuk (2005) points to a similar correlation. This research, however, was done in Canada. In their 2008 Household Food Security Report commissioned by the USDA, Nord, Andrews and Carlson (2009) found a relationship between household composition and food security. Specifically, they note 37.2% of female-headed single-parent households with children had low levels of food security compared with 27.6% of male-headed single-parent households. These numbers may be compared with the 2008 national food security average of 14.6% of households with two adults and one or more children being categorized as having low food security (Nord et al., 2009). Like much of the research before it, this study did not find a significant difference between single men and women with respect to food security, which suggests

the addition of children plays significant role in the relationship. A limitation to note, however, is while this study controlled for income the researchers did not include other socioeconomic variables such as education to fully control for SES.

Research shows a number of similarities with respect to the relationship gender, marital and parental statuses have with food security and depression. Both sets of scholarship show differential rates for men and women; women tend to be more depressed and they tend to be less food secure. This literature also suggests an additional path of inquiry into the moderating affect of parenthood and marital status.

Low Levels of Food Security as a Stressor Related to Depression

It is important to note not all research considers food security as necessarily antecedent to depression. For example, Melchior et al. (2009) found those who are depressed are 2.82 times as likely to have low levels of food security. Wehler et al. (2004) also found mental health, as defined by depression, anxiety, post-traumatic stress disorder (PTSD) and drug/alcohol abuse, to be significantly predictive of food security. Both of these studies are cross sectional and make no claims about establishing a specific causal relationship. Cross sectional analyses by their definition are able to establish correlations, not causation. Modeling depression as dependent on food security or food security dependent upon depression will both indicate a correlation but neither definitively point to a causal direction. What seems to suggest one direction over the other is the theoretical mechanism by which the relationship works. Proponents of depression first modeling explain the relationship saying depression causes disruptions to school, work and social/familial bonds (Wehler et al., 2004). These disruptions lead to increased volatility in those systems that influence food security. For example, a

depressed person may be unable to concentrate in school. Without adequate schooling the person may be unable to obtain a job that pays well or may be unable to hold a steady job. The variability in employment and income then result in the inability to secure adequate amounts of food. Alternatively, the food security first model suggests having inadequate amounts of food is a stressor and stressors cause depression (Pearlin et al., 1981). Ignoring for a moment that the vast majority of research into this relationship takes the latter approach, either explicitly or implicitly via model design, it would seem the stressor mechanism possess greater parsimony than the relatively complicated social disruption mechanism. For this reason, and to be consistent with the majority of existing scholarship, food security is considered antecedent to depression in the analyses herein.

According to the 2012 USDA report on household food security, those households classified as having very low food security generally experienced difficulty in obtaining enough food at some point during the month for at least 7 months out of the preceding 12 (USDA, 2012). This type of prolonged exposure to a problem seems consistent with the definition by Stronks et al. (1998) for a long term, as opposed to an acute, stressor. As such, work that finds a connection between the levels of food security, distress and depression is not unexpected.

A variety of research shows this correlation between levels of food security, distress and depression. Caron, Latimer and Tousignant (2007) looked at the relationship between low food security and distress in the low-income population of Montreal. They considered 30 variables when trying to model the predictors of distress. When controlling for SES, having low food security was one of 5 of the covariates that

significantly predicted psychological distress (Caron et al., 2007).[8] Later research done by Caron (2012) found amongst those in Montreal who were receiving some form of social assistance, food security was positively correlated with quality of life scores. The analysis went on to find a negative relationship between quality of life scores and mental health symptoms. Caron (2012) controlled for the amount of social assistance but not income, which is a limitation of this research. Education was also controlled for. While this research did not consider depression per se, prior scholarship clearly shows a relationship between stress/distress and depression (e.g. Monroe et al., 1983; Pearlin et al., 1981).

A study conducted by Stuff et al. (2004) also concentrated on a particular region, although this was done in the US. They sampled participants from the Mississippi Delta and looked at the relationship between household food security and mental health. They found those adults who came from households that lacked food security scored significantly lower on a mental health scale where 0 = worse health and 100 = best health (Stuff et al., 2004). Stuff et al. (2004) controlled for income and overall, self-rated health but did not include a measure of education as many prior studies did.

Other research takes the next step of establishing a relationship between food security and depression. For example, Siefert et al. (2001) looked at mental health and food security amongst low-income women. They limited their sample to women who were either current or former welfare recipients. When controlling for education, poverty status and self-rated, overall health, they found depression was significantly predicted by food security status, where those categorized as lacking food security were more likely to

[8] SES measured by income and education.

report symptoms of depression (Siefert et al., 2001).[9] Other research uses a more specific sample, like mothers of young children, to show a significant relationship between food security and maternal depression (e.g. Casey et al., 2004; Whitaker, Philips & Orzol, 2006).

Vozoris and Tarasuk (2003) noted the limitation of prior work that failed to consider a nationally representative sample. To fill this gap, their study looked at the relationship of mental and physical health measures to household food security in a nationally representative sample of Canadians. They found those in a food insecure, compared to secure, household were 3.5 times more likely to show symptoms of major depression. Additionally, those who lacked food security were 2.9 times more likely to report symptoms of distress (Vozoris & Tarasuk, 2003). While Vozoris and Tarasuk (2003) controlled for income, they did not include a measure of education, as many researchers have.

Muldoon, Duff, Fielden and Anema (2013) also addressed limitations of prior scholarship. They noted previous work only distinguished between the food secure and insecure and sought to see if there were differences between gradations of food security. As such, they limited their sample to only those who had low levels of food security but compare two of these levels: with hunger and without hunger.[10] They found low food security with hunger increases the odds of having depression and/or an anxiety disorder 1.69 times over low food security without hunger, when controlling for other

[9] Poverty status determined as a ratio of income to poverty line, based on household size. This variable was dichotomized to distinguish between those who were at or below the poverty line and those who were above it (Seifert et al., 2001).

[10] Similar terminology was used in the US until 2006 when "food insecurity with hunger" was replaced by "very low food security" and "food insecurity without hunger" was replaced by "low food security" (USDA, 2013).

sociodemographic variables including income and education as a measure of SES (Muldoon et al., 2013).

While this breadth of research points to a well-established relationship between food security and depression, there are a number of limitations which should be noted. The majority of the research into the relationship between food security and depression is a decade or more old. One reason for this is the divergent paths food security and depression research have independently taken. Much of the more recent depression research focuses on differential demographic indicators (e.g. Botoff et al., 2014; Schwarz, McVeigh, Hoven & Kerker, 2012) or its relationship to other health metrics (e.g. Holbrook & Kaltenbach, 2012; Lennon, uedo-Medina, Gerwin & Johnson, 2012) whereas much of the recent food security scholarship is concentrated on international issues (e.g. Lopes, Sichieri, Salles-Costa & Viega, 2013; Nanama & Frongillo, 2012) or its relationship to physical health outcomes such as obesity (e.g. Franklin et al., 2012; Nackers & Appelhans, 2013). This general lack of new examination into the relationship between food security and depression is a limitation the analyses herein are able to address.

There are other limitations to note. Much of the research (e.g. Caron, 2012; Siefert et al., 2001; Stuff et al., 2004) dichotomizes food security instead of using the USDA guidelines, which produce 4 distinct levels of food security. This results in analyses that are unable to model the potential differences between those moderately food secure, those with low food security and those with very low food security in addition to showing a difference between the fully food secure. Although Muldoon et al.,(2013) performed an analysis to address this very problem, they only compared the two lowest

levels of food security and the data were nationally representative of Canada, not the US. None of the aforementioned scholarship is nationally representative of the US. This foundational scholarship and its limitations motivate the primary analysis made herein and the first hypothesis:

> H_1: Ceteris paribus, self-reported depression symptomatology will vary with respect to household food security category. The relationship will be negative; those with greater levels of food security are expected to report lower levels of depression.

Beyond the primary relationship between depression and food security, research shows it is important to consider potential moderators. In the early 2000's, research into food security, depression and their moderators began to converge. Instead of seeing these as separate phenomena, researchers started looking at how social issues such as low levels of food security link to depression and how they are moderated by a variety of factors. Some examples of this research are focused on the inverse relationship between food security and depression amongst women (e.g. Sharkey, Johnson & Dean, 2011) while others focus specifically on a particular subset, such as female welfare recipients (e.g. Siefert, Heflin, Corcoran & Williams, 2004).

This vein of research also saw two major studies that act as the primary motivators and a framework for the analysis herein. One of these studies was conducted in New Zealand and asked whether gender played a moderating role in the relationship between food security and depression (Carter et al., 2011). They found gender played a significant moderating role with women experiencing the greatest effect, meaning the

relationship between low levels of food security and depression was greater amongst women than it was men (Carter et al., 2011).

The second study was done in Canada and looked at gender and gender-based parenting status (i.e. women vs. men and co-parent mother vs. co-parent father vs. single-parent mother vs. single-parent father) as moderating the relationship between food security status and depression while controlling for socioeconomic status (Wu & Schimmele, 2005). When looking at gender only as a dichotomy of male vs. female, they found a strong moderating role, where being female significantly increased a negative relationship between food security and depression. When comparing all the gender-based parenting statuses, however, they found single fathers experience the greatest effect of low levels of food security on depression (Wu & Schimmele, 2005). While both sets of results are compelling, neither study uses US data. In fact, it would appear no nationally representative US data have been used to answer the question of whether gender plays a moderating role in the relationship between depression and food security. Neither have questions been answered about what role other moderators such as parental status may play in the relationship. As such, from this literature and its limitations, two additional hypotheses are proposed:

H_2: Ceteris paribus, the relationship between food security and depression will be moderated by gender.

H_3: Ceteris paribus, the relationship between food security and depression will be moderated by parental status.

METHODS

Data

Data from the public release version of the 2009-2010 National Health and Nutrition Examination Survey (NHANES) (N=10,537) are used for this analysis. The NHANES uses a complex, multistage probability design (Johnson, Paulose-Ram & Ogden et al., 2013). The first stage identifies PSU, which are counties or groups of counties. The second stage identifies segments within the PSU. The third identifies dwelling units (DU) or households within the segments. The fourth and final stage identifies individuals within the DU or household. The NHANES is nationally representative of the US non-institutionalized, resident, civilian population (Johnson, Paulose-Ram & Ogden et al., 2013). Administration takes two forms, a computer assisted personal interview (CAPI) home interview and a physical exam in a mobile examination center (MEC). The majority of the variables in the analysis are taken from the in-home CAPI. The depression screener was done via CAPI at the MEC. Approximately 6,000 of the approximately 10,000 total persons are sampled during each of the years in the two-year cycle (Johnson, Paulose-Ram & Ogden et al., 2013). Those identifying as Hispanic were oversampled in order to produce reliable estimates for the Hispanic population (Johnson, Paulose-Ram & Ogden et al., 2013). The NHANES includes two population weights. The first population weight is for those analyses primarily based around the home interview variables. The second is for those analyses based around MEC variables (Johnson, Paulose-Ram & Ogden et al., 2013). Because depression is the dependent variable in these analyses, the MEC weight will be used.

Sparse cell counts prevent the complex survey design of this dataset from being accounted for in these analyses.[11]

Imputation and Sample Size

The analytic sample is obtained from the original sample of 10,537. The sample was initially reduced because the nine-item depression screener was only asked of 6,360 adults, ages 18 and over. The nine depression questions were also missing a total of 814 (approximately 7.7% of the total sample) individual observations. Without a good logic upon which to impute a response to questions about depression symptomatology, those cases with missing data were listwise deleted. Education was missing 276 cases (approximately 4.97% of the reduced sample), which were listwise deleted. Martial status was missing 4 cases, which were also listwise deleted.

From this reduced sample, annual household income was missing complete data for 237 cases and had partial data (i.e. "over $20,000 per year" or "under $20,000 per year") for 293 cases. Those cases with completely missing data were imputed using hotdeck procedures with race/ethnicity and education as the stratification variables. Following this imputation, a new income variable was created that sorted all the income into over or under $20,000 a year categories. Hotdeck procedures were then used with this sorted income variable and race/ethnicity to impute annual household income for the partially missing cases. Finally, income was transformed from category ranges (i.e. $10,000 - $14,999) to the midpoint of each range (i.e. $12,499.50).

[11] Caluclation of the design effects (not shown) was done by comparing the average standard error of a model that considered the complex survey design to the same model that was only weighted. This comparison indicates the actual standard errors are larger than those calculated only using weighting by a factor of 1.023.

The ratio of household income to the poverty line variable was missing 454 cases (approximately 8.6% of the reduced sample). These were imputed using hotdeck procedures with household size and race/ethnicity as stratification variables. Household food security was missing 41 cases, which were imputed using hotdeck procedures with income and race/ethnicity as stratification variables. Overall health was missing a single case, which was listwise deleted. Number of days of anxiety was missing one case, which was listwise deleted. This variable was then transformed from continuous to categorical because its distribution was not approximately normal. The three categories are: no days, some days and every day. Number of days pain limited daily activities was also transformed, for the same reason, into the same categories.

A parental status variable was created using answers from child food security status. All those respondents who had any status for child food security were classified as "with child(ren)" since only those respondents with a child/children were asked to complete the questions that were scaled to create the child food security categories. All those respondents who were missing data for child food security category were classified as "without child(ren)".

Because individuals with large incomes are unlikely to be categorized as anything but fully food secure, the sample is limited to only those cases whose annual household income fell within 200% of the 2010 poverty line. The household income as a ratio to the poverty line variable was used to sort the cases and all those beyond 200% were listwise deleted. This resulted in a final analytic sample of N = 2,590.

Measures

The dependent variable for this analysis is a scale of depression symptomatology. The scale was created from a nine-item depression screener. These particular nine items are known as the Patient Health Questionnaire-9 or PHQ-9 (National Health and Nutrition Examination Survey Depression Screener, 2011). The questions are:

Over the last 2 weeks how often have you been bothered by the following problems…

1) Have little interest in doing things

2) Feeling down, depressed or hopeless

3) Trouble sleeping or sleeping too much

4) Feeling tired or having little energy

5) Poor appetite or overeating

6) Feeling bad about yourself

7) Trouble concentrating on things

8) Moving or speaking slowly or too fast

9) Thought you would be better off dead

The response options for each of the 9 items are: not at all, several days, more than half the days and nearly every day. A scale was created from the screener by summing the 9 items. The scale range is 0, answering "not at all" to every question to 27, answering "nearly every day" to every question. According to a validation study performed by Kroenke and Spitzer (2002), the PHQ-9 is a highly reliable measure of depression (p 2). Additionally, the study by Kroenke and Spitzer (2002), performed with over 6,000 validation subjects, provides specific cut points for mild depression (5-9 points) and

clinical depression (10 points or greater) (p 4). These cut points are the basis for determinations made regarding no depression (i.e. less than 5 points), mild and clinical depression herein (see table 1).[12]

The focal independent variable in this analysis is household food security category. This variable is also a scale, included in the dataset, measured by the number of affirmative responses to 10 food security questions for those households without children and an additional 9 child/children food security questions for those household with them (National Health and Nutrition Examination Survey Food Security, 2011). Zero affirmative response classifies a household as fully food secure, 1-2 is classified as marginal food security, 3-5 (or 3-7 in households with children) as low food security and 6-10 (or 8-19 in households with children) as very low food security. The classifications of food security, while included in the NHANES dataset, are based on USDA definitions (USDA, 2013). Unless otherwise indicated, the response options for the food security questions were "yes" or "no". The questions in the food security screen are listed in Appendix B.

The distribution of the dependent variable, depression category, is heavily skewed towards no depression. This group accounts for approximately 68% of the total sample (see Table 1). Mild depression and clinical depression are approximately evenly distributed. The distribution of household food security category is also heavily skewed towards fully food secure households, accounting for approximately 50% of adults. The other three categories are evenly distributed (see Table 1).

[12] A factor analysis (not shown) was performed in order to confirm this scale. This analysis suggested there were two factors instead of the single factor Kroenke & Spitzer (2002) validated. Because of the robustness of the Kroenke & Spitzer validation study, their single depression scale will be used despite the results of the factor analysis performed as part of this study.

[Insert Table 1 Here]

A number of control variables are considered as well (see Table 1; for coding see Appendix E). SES is captured in a way consistent with the literature (see footnotes 2-7), using income and education. Income is measured as the annual household income with a mean of approximately $27,000 and a standard error of $623. Education is measured by 5 categories: less than 9th grade, 9th-12th grade without diploma, diploma or GED, some college or AA degree, and college graduate or above. Ninth through twelfth grade, diploma or GED and some college/AA degree are approximately evenly distributed with 21-27% of the sample. The remaining 25% of the sample is split approximately evenly between the other two categories.

Race/ethnicity is also controlled for (as motivated by Briones et al., 1990; Cotton, 1999; Smith-McKeever et al., 2012). Non-Hispanic whites make up 50% of the sample. Hispanics represent approximately 26%. Non-Hispanic blacks make up approximately 16% and the remaining 7% of the sample is represented by other races/ethnicities and those who identify as multi-racial/ethnic. Household size (as motivated by Heflin & Ziliak, 2008) is measured as the number of persons within the household, with a mean of 3.42 and standard error of 0.11. Gender is approximately evenly distributed with 53% female and 46% male. Age is included based on the findings of Mirowsky and Ross (1992) and Wu et al. (2012). The mean age is 46.2 years with a standard error of 0.85 years.

Based on studies that found primary correlations with self-rated, overall health (e.g. Kosloski et al., 2005; Perruccio et al., 2010) as well as those that included it as a control (e.g. Martin & Lippert, 2012; Seifert et al., 2001; Seifert et al., 2004, Stuff et al.,

2004), this variable is used in these models. Those rating their overall health as good represent the largest category at 40%. Very good and fair each represent just over 20% of the sample. Those rating their health as excellent represent 8% and poor just under 5%.

As motivated by research finding a relationship between pain and anxiety with depression (e.g. Poleshuck, Giles & Tu, 2006; Mineka, Watson & Clark, 1998; Poleshuck et al., 2009), both variables are included in this model. Pain is measured as the number of days in the past 30 the respondent's regular activities were limited by pain. Pain is heavily skewed towards no days, at 64%. Some days of pain is 27% and every day represents just under 9%. Anxiety is measured as the number of days in the past 30 the respondent experienced anxiety. No days of anxiety represents approximately 38%, some days 50% and every day slightly under 13% of the sample.

Marital statuses are divided into 6 categories: married, widowed, divorced, separated, never been married and living with a partner. The largest category is married persons, representing 40% of the sample. The next largest are the never been married at just under 23%. Separated are the smallest category, representing less than 4%. Those who are widowed, divorced or living with a partner are approximately evenly distributed with about 10% each.

The final variable being considered is parental status. Respondents with a child or children represent approximately 52% while those without make up about 48%. Appendix C shows the distributions of the continuous variables household size, annual household income and age.

Analytic Technique

This analysis involved using ordinal logistic regression with nested models in order to address the hypothesis that lower levels of food security are positively correlated with more severe symptoms of depression. The reduced model looks at the relationship between household food security and depression. The control model includes all of the control variables. Finally, the interaction model adds the interaction terms of food security category by gender as well as food security by parental status.

Post hoc Wald tests were conducted to inform model selection. Predicted probabilities for categorical variables are included for comparison. Additionally, the change in predicted probability is used to compare continuous variables.

RESULTS

Bivariate Analyses

Table 2a shows the crosstabulation between the dependent variable, depression category and the focal independent variable, household food security category. It clearly indicates a pattern of an increasing percentage of the sample reporting symptoms of clinical depression when moving from full food security down to very low food security.

[Insert Table 2a Here]

For example, 76% of the sample who have full food security report no symptoms of depression. This drops to about 69% of the marginally food secure, 58% of those who have low food security and only 49% with very low food security. Conversely, just under 9% of those with full food security report symptoms of clinical depression, compared to 13% with marginal food security, about 20% with low food security and

approximately 26% with very low food security. The chi-square statistics indicate there is a significant relationship between food security category and depression ($p<0.0001$).

Table 2b shows the odds ratios for the ordinal logistic relationship between depression and food security. This bivariate model indicates a primary, significant relationship between each of the food security levels and depression ($p<0.0001$).

[Insert Table 2b Here]

The odds ratios suggest those who are marginally food secure versus fully food secure have 1.46 times greater odds of being mildly depressed compared to no depression and 1.46 times greater odds of being clinical depressed as compared to both of the other categories of depression: no and mild ($p<0.05$). When looking at low food security this risk is changed to 2.34 times greater odds and is 3.34 times greater for very low food security ($p<0.001$). The findings of this model are consistent with the literature suggesting lower levels of food security are associated with increased risk of depression. This indicates additional analyses to address H_1 are warranted.

Multivariate Analyses

The two multivariate models are shown in Table 3. When adding the controls (Model 2), the relationship between depression and the categories of food security change. Marginal food security is no longer significantly different from full food security. Both low and very low food security remain significant ($p<0.001$) although the associated risk is reduced to 1.91 times greater odds of being mildly or clinically depressed with low food security and 1.99 times greater for very low food security. This indicates some of the initially estimated relationship between food security and depression is captured in these other variables. Additionally, running the regression with

very low food security as the reference category (not shown) indicates the difference in risk between low and very low food security is not significant (p=0.832).

[Insert Table 3 Here]

The controls in model 2 suggest a number of important findings. Ceteris paribus, females have 1.30 times greater odds of being in a more depressed category than males ($p<0.05$). Those of Hispanic ethnicity have a 31% decreased risk of being in a more depressed category than non-Hispanic Whites ($p<0.05$). Those who are separated, as opposed to married, have 2.21 times greater odds of being in a more depressed category ($p<0.01$) while those who have never been married have 1.69 times greater odds ($p<0.01$). Running the regression with never been married as the reference category (not shown) suggests the difference in risk between never been married and separated is not significant (p=0.385).

This model also suggests those who report fair or poor health have 2.62 and 5.01 times greater odds of being in a more depressed category compared to those reporting excellent health ($p< 0.01$ and <0.001). Running the regression with poor overall health as the reference category (not shown) indicates the difference in depression risk between fair and poor health is a significant one ($p<0.05$).

Number of days in the past month where activity was limited by pain and experiencing anxiety also have a significant relationship with depression. Those experiencing pain some days compared to no days, have 2.56 times greater odds of being more depressed ($p<0.001$). Having activity limited by pain every day increases this risk to 4.45 times greater odds ($p<0.001$). Running the regression with every day limited

by pain as the reference category (not shown) suggests the difference between some days and every day is significant ($p<0.05$).

Reporting anxiety is significant for some days and every day ($p<0.001$). Some days of anxiety is predicted to increase the associated odds for depression 4.89 times while every day changes the risk to 19.89. Running the regression with every day experiencing anxiety indicates the difference in depression risk between some days and every day is significant ($p<0.001$). Counter to the literature, parental status, education, household size, income and age are not significantly related to depression.

Model 3 includes the same controls as model 2 as well as the interaction effects of gender by food security and parental status by food security. Like the reduced and control models, model 3 is significant ($p<0.0001$). A post hoc analysis was conducted to evaluate the models and their implications for predictions of depression. The Wald test suggests the control model is a significant improvement over the reduced model ($\chi^2(25) = 511.24, p<0.0001$) (not shown). When comparing the control and interaction models, however, the change is not significant ($\chi^2(6) = 4.41,\ p=0.6217$). This points to model 2 being the best for predicting the relationship between food security and other covariates with depression. Because model 3 included the interaction terms, this lack of a significant model improvement also suggests H_2 and H_3 should be rejected.

In order to confirm ordered logistic regression is an appropriate technique, a Brant test of parallel regression assumptions was run on model 2 (not shown). This test was not significant ($\chi^2(28) = 21.76,\ p=0.792$). The non-significant result means there is no violation of the assumption of parallel regressions and, as such, indicates ordered logit is an appropriate analytic technique for the data.

A chi-square test (not shown) shows model 2's cut points are significantly different from each other (χ^2 (1)=411.86, p<0.0001). This indicates there are in fact three distinct categories of depression and means the model in its current state is appropriate. Mild depression as the middle category should not be eliminated.

The predicted probabilities of the categorical variables are shown in Table 4. Each category has a corresponding probability for a given level of depression when all other categories are held constant and continuous variables are held at the mean, with the exception of household size. Therefore, these predicted probabilities are for a White female with low food security who is married, has a child(ren), a high school diploma/GED, reports good overall health, some days of activity limited by pain, some days of anxiety and is in a household of four persons.

[Insert Table 4 Here]

The effect of the level food security on depression risk is clearly evident from the comparisons made in Table 4. The same White, married female with children, a high school diploma, good overall health, some days of pain, some of anxiety and in a household of four has approximately a 13% likelihood of being clinically depressed if she is fully food secure. She has a 12% chance if she is marginally food secure, a 19% chance at low food security and an 22% chance if she has very low food security. Her risk for mild depression is similarly marked. She goes from a 28% likelihood at full food security to 35% at very low food security.

Perhaps even more striking are the changes in depression risk this particular woman is predicted to have if her overall health, pain or anxiety change significantly. For example, her risk of clinical depression is 14% at excellent health, 19% at good and

46% at poor. This can be compared to the change that takes place moving from no days of pain (8%), to some days (19%) and every day (29%). Most impressive is the effect of changes in the amount of anxiety. At no days of anxiety her risk for clinical depression is 4.5%. This jumps to just under 19% if she has some days of anxiety. Finally, her risk for clinical depression is almost a coin toss, 48.25%, if she reports anxiety every day.

The change in predicted probabilities are shown in Table 5. This table shows the change in the probability of being in each depression category based on going from the minimum to maximum value of each continuous variable, holding all other continuous variables (except household size) at their mean as well as the marginal effect of the variable averaged across all categories of depression. All categorical variables are defined the same way as with the predicted probabilities of categorical variables in order to make these comparisons more meaningful.

[Insert Table 5 Here]

The predicted probability of being clinically depressed compared to the other levels of depression is increased a mere 0.3% when household size changes from 1 to 7 persons. The marginal effect of household size suggests adding, for example, 3 persons to the household increases the risk of being more depressed by 0.15% (3 * 0.0005). An annual income change from $2,500 to $100,00 or more decreases the risk of mild depression by 0.13%, indicating little bang for the buck with respect to depression. Clinical depression risk is decreased by 2.8% for those at age 80 and above compared to 18. This table shows relatively little marginal effect changes to the continuous variables have on the associated risk of depression.

Because of the relatively large effect of anxiety and literature pointing to potential evidence of its comorbidity with depression (e.g. Brown, Harris & Eales, 1996; Hirschfield, 2001; Klein, Lewinsohn, Rohde, Seeley & Shankman, 2003), although not specifically with respect to low levels of food security, anxiety was removed from model 2. Table 6 shows a comparison of the control model with and without anxiety.

[Insert Table 6 here]

The model without anxiety remains significant ($p<0.0001$) but there are a number of important differences to note. Marginal food security is significant in this model and indicates 1.63 times greater odds of depression compared to full food security ($p<0.01$). While still significant, the magnitude of the odds ratios for low and very low food security change from 1.91 to 2.14 times greater odds for low food security and 1.99 to 2.68 times greater odds of depression for very low food security ($p<0.001$). Running this regression with marginal as the reference category (not shown) indicates it is not significantly different from low food security ($p=0.116$) but is significantly different from very low food security ($p<0.01$). Running the regression with very low food security as the reference category (not shown) suggests it is not significantly different from low food security ($p=0.207$).

A number of covariates also change in their significance and magnitude of effect once anxiety is removed. Identifying as female changes from 1.30 to 1.49 times greater odds of depression ($p<0.01$). Identifying as non-Hispanic Black becomes marginally significant and results in 23% lower risk of depression compared to non-Hispanic White ($p<0.10$). Having a marital status of divorced becomes significant in this model and is related to 1.47 times greater odds of depression compared to married persons ($p<0.05$).

The effect of overall health on risk of depression changes dramatically. Good health, compared to excellent, is marginally significant ($p<0.10$). Fair health nearly doubles in magnitude from 2.62 to 4.21 times greater odds of depression ($p<0.001$). Poor health changes from 5.01 to 8.39 times greater odds ($p<0.001$). Finally, the effect of age is significant in this model, with each additional year correlating to a 1% decrease in risk of depression.

DISCUSSION AND LIMITATIONS

The study herein attempted to address a number of limitations with existing scholarship surrounding the relationship between food security and depression. In order to fill gaps, these analyses utilized nationally representative US data and modeled the four levels of food insecurity in addition to including a variety of controls and interaction terms. From the results, H_1 is partially supported. Model 2 shows lower levels of food security is related to an increased risk of depression. That is, when comparing low and very low food security to full food security, there is an increased risk of depression. This finding is consistent with prior literature that dichotomized food security (e.g. Caron, 2012; Siefert et al., 2001; Stuff et al., 2004). As this prior research implicitly argues, these results do not indicate a risk for depression that is significantly increased at each level of food security. This points to a similarity between marginal and full food security and low and very low food security with respect to depression risk such that food security could be dichotomized as food secure and insecure (with marginal counting as "secure"). This means occasionally going without food or feeling occasionally worried about not having enough food has the same relationship with depression as never going without or worrying about food. Likewise, those indicating affirmative responses on three of the

food security questions have no significantly different risk of depression as those indicating ten (or 19 in households with children) affirmative responses.

In practical terms these findings are important. They suggest any food security intervention that seeks (or effectively results in) the elimination of only a few food security problems is not predicted to decrease the risk of depression for those most in need. That is, aiding in a person's transition from very low to low food security is not predicted to significantly reduce the risk of depression. Alternatively, however, the results suggest an intervention only need to effectively move a person from low or very low food security to marginal food security in order to reap the same benefits of full food security with respect to risk of depression. This points to the potential utility of efforts to ameliorate difficulty accessing food, as opposed to the necessity of eliminating the difficulty altogether. These sorts of findings can help guide intervention programs and resource allocation for programs such as food stamps. Moreover, the significant relationship between these levels of food security and depression suggest joint efforts may be warranted. In other words, an effort to provide depression assistance may not be as effective as one that addresses both depression and lack of food security.

While gender was significantly predictive of depression risk, the change in the level of significance and magnitude of the effect once anxiety was removed is suggestive. Like the findings of Silverstein et al. (1999), which indicated much of the gender difference in depression was actually a result of women and men having (reporting) different types of depression (i.e. somatic versus true depression), it is also possible some of the gender difference other researchers (e.g. Maier et al., 1999; Carter et al., 2011; Wu & Schimmele, 2005) have noted is as a result of anxiety being captured in the depression

measure. Evidence of this potentiality is seen in this analysis by the effect of gender changing from 1.30 to 1.49 times greater odds of depression and the significance changing from $p<0.05$ to $p<0.01$ for women compared to men when anxiety is removed from the model. Though not conclusive, this does point to a line of future inquiry.

These analyses did not find a significant relationship between parental status and depression as did prior research (e.g. Bures et al., 2009; Evenson & Simon, 2005; Zhang & Howard, 2001). This held true across both the control and interaction models, as well as the control model with anxiety removed. An explanation for these findings is not immediately evident and requires additional analysis.

Unlike the findings of Mirowsky and Ross (1992) and Wu et al. (2012), each of whom found age, after 45 and 65 respectively, to be related to an increased risk of depression, these analyses found no such relationship. Model 2 suggests age is not significantly related to risk of depression. Furthermore, when anxiety was removed from model 2, the relationship between age and depression was significantly negative. These findings are anomalous in light of prior literature and warrant further exploration.

The findings regarding marital status were consistent with prior literature (e.g. Gallagher et al., 1997; Gove, 1972; Earle et al., 1998; Zhang & Howard, 2001), which suggests being married correlates with a lower risk of depression compared to other marital statuses. In the control model, a difference was noted between married and never been married as well as married and separated. When anxiety was removed from this model, however, being divorced also became significant. As with a number of other covariates, this suggests some of the relationship other research has identified may have been as a result of capturing anxiety in the depression measure, particularly those noting

a difference between married and divorced persons and their differential risk of depression (Gove, 1972; Earle et al., 1998). These findings are also interesting in that cohabiting (i.e. "living with partner") is not significantly different from married concerning depression risk. This confirms the results of Gallagher et al. (1997) but is also suggestive of a mechanism of depression risk in the context of interpersonal/romantic relationships. It seems to say it is not the institution or "commitment" of marriage itself but rather the practical function of two people living within the same household that effects the risk of depression. Since the martial status question is asked in the context of a romantic relationship, future researchers may want to determine whether the romantic bond is what alters the risk of depression or whether any cohabiting persons could garner these benefits.

In addition to the primary hypothesis, two others were posited and tested. While the interaction effect of marginal food security and children was significant in model 3, none of the other interaction terms were. Additionally, because the interaction model was not a significant improvement over the control model, as the less parsimonious it was rejected. This results in a rejection of both H_2 and H_3. These findings are contrary to prior literature (Carter et al., 2011; Wu & Schimmele, 2005) suggesting gender and parental status should moderate the relationship between food security and depression. One possibility for these results is the fact that this prior research was based outside the US. It appears neither gender nor parental status act as moderators for this relationship when considering a US population. This may serve as a reason for caution when considering non-US data and analyses as sources for US policy and interventions

concerning food security and depression. It suggests, at least in some respects, these seemingly similar societies may not serve as sound informants.

Another path for additional analyses is with respect to potential mediation. The change in predicted probabilities when moving around within the various categories of overall health, pain and anxiety indicate a strong relationship between these variables and depression. Furthermore, because the level of significance and the magnitude of depression risk for marginal, low and very low food security change with the addition of controls, overall health, pain and anxiety being included in these, analyses regarding their potential mediating effects on the relationship between food security and depression is warranted. If such an effect were to be identified, it would indicate low levels of food security are related to depression to the extent they increases anxiety, for example.

An alternative explanation for these findings being proposed is a potential comorbidity between anxiety and depression. Removing anxiety from model 2 and the changes this results in is not in itself evidence of comorbidity. Rather, it is suggestive of two things. First, it offers an explanation for the findings of the research cited herein that looked at the relationship between food security and depression and found both the focal relationship and that with covariates such as gender, race/ethnicity, education and age to be significant (e.g. Carter et al., 2011; Siefert et al., 2004; Sharkey et al., 2011; Wu & Schimmele, 2005). This literature did not control for anxiety as was originally done in this analysis. In this way, the control model without anxiety is consistent with much of the literature identifying a strong relationship between the levels of food security and depression as well as the significance of a variety of covariates. Second, this points to a heretofore unidentified limitation of prior research. Without controlling for anxiety, or

considering it as a second outcome variable, as is the suggestion being made, some of the complexity in the focal relationship between food security and depression may actually have been as a result of capturing part of the relationship between food security and anxiety. These findings, coupled with the medical and psychological/psychiatric literature pointing to comorbidity (e.g. Brown et al., 1996; Hirschfield, 2001; Klein et al., 2003), are suggestive of one path for future inquiry. In other words, it will be important for researchers to measure what part the relationship identified between food security and depression is actually a relationship between food security and anxiety and vise versa. To this end, analyses that consider both depression and anxiety as outcome variables will help to better quantify these relationships and their potentially comorbid nature.

While the results are compelling, there are a number of important limitations to note. The timeframe of the data is somewhat unique. The survey was conducted right after the 2008 recession. It is possible some of the primary relationship between food security and depression is actually a period effect resulting from the recession. Additional analyses using data before and after the recession would help to parse out any period effects in play with this particular 2009-2010 data.

Another limitation is the choice of controls used in the modeling. While every control was motivated by prior scholarship, it is possible some stressors related to depression were missing. As such, the model may be underspecified. Future study should seek to identify a robust pool of stressors in order to increase confidence in the primary relationship.

Related to this are the findings of Pearlin et al. (1981), which suggest depression risk may be moderated by coping strategies and social support. The analyses presented

did not consider coping strategies or social support because good measures of these concepts did not exist within the NAHANES dataset. Using other data that are able to operationalize these concepts will allow for more complete modeling of the focal relationship.

Finally, this analysis only considers those within 200% of the poverty line. This was done because statuses other than full food security were unlikely at high levels of income. However, numerous studies show a negative relationship between income and depression (e.g. Briones et al., 1990; Turner & Lloyd, 1999; Kosloski et al., 2005). This suggests the relationship between the levels of food security and depression have the potential to be different when considering the entire population and is a possible explanation for the non-significant findings of income in these analyses.

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Appendix A: Tables

Table 1. Descriptive Statistics of Analytic Sample (weighted)

	Percent	Mean (SE)
Dependent Variable		
Depression Category		
No Depression	68.38%	
Mild Depression	18.02%	
Moderate to Severe, Clinical Depression	13.60%	
Independent Variables		
Household Food Security Category		
Full Food Security	54.25%	
Marginal Food Security	14.81%	
Low Food Security	18.46%	
Very Low Food Security	12.49%	
Gender		
Female	53.79%	
Male	46.21%	
Parental Status		
Child(ren)	51.81%	
No Child(ren)	48.19%	
Race/Ethnicity		
Hispanic	26.09%	
non-Hispanic White	50.08%	
non-Hispanic Black	16.72%	
Other, Including Multi Racial/Ethnic	7.11%	
Education		
Less Than 9th Grade	13.16%	
9th-12th Grade (no diploma)	21.53%	
High School Diploma/GED	26.41%	
Some College or AA Degree	27.54%	
College Graduate or Above	11.36%	
Marital Status		
Married	40.59%	
Widowed	8.47%	
Divorced	12.27%	
Separated	3.62%	
Never Been Married	22.90%	
Living With Partner	12.15%	

Source: 2009-2010 NHANES (N=2,590)

Appendix A: Tables, cont'd

Table 1. Descriptive Statistics of Analytic Sample (weighted), cont'd

	Percent	Mean (SE)
Overall Health		
Excellent	8.19%	
Very Good	22.56%	
Good	40.77%	
Fair	23.53%	
Poor	4.93%	
Activity Limited by Pain (in past 30 days)		
No Days	64.11%	
Some Days	27.09%	
Every Day	8.80%	
Anxiety (in past 30 days)		
No Days	37.63%	
Some Days	49.72%	
Every Day	12.65%	
Household Size (in number of persons)		3.42 (0.11)
Annual Household Income (in dollars)		27,096 (623.49)
Age (in years)		46.20 (0.85)

Source: 2009-2010 NHANES (N=2,590)

Appendix A: Tables, cont'd

Bivariate Relationship Between Depression Household Food Security

Table 2a: Crosstabulation
Depression Category and Household Food Security Category

	Full FS	Marginal FS	Low FS	Very Low FS
No Depression	76.16%	68.84%	58.16%	49.18%
Mild Depression	14.99%	18.02%	22.01%	25.30%
Clinical Depression	8.85%	13.14%	19.82%	25.52%

chi-squared (6) = 128.94 p<0.0001

Table 2b. Ordered Logit Model of Depression and Food Security

	Model 1** Odds Ratio**	**(Robust SE)**
Household Food Security Category		
Full Food Security	---	
Marginal Food Security	1.46*	(0.22)
Low Food Security	2.34***	(0.30)
Very Low Food Security	3.34***	(0.47)

Source: 2009-2010 NHANES (N=2,590)
$^{+}$p<0.10 *p<0.05 **p<0.01 ***p<0.001 ****p<0.0001

Appendix A: Tables, cont'd

Table 3. Ordered Logit Models of Depression, Food Security and Controls

	Model 1**** Odds Ratio (Robust SE)	Model 2**** Odds Ratio (Robust SE)	Model 3**** Odds Ratio (Robust SE)
Household Food Security Category			
Full Food Security	---	---	---
Marginal Food Security	1.46 (0.22)*	1.30 (0.22)	1.79 (0.56)$^{+}$
Low Food Security	2.34 (0.30)***	1.91 (0.32)***	2.08 (0.70)*
Very Low Food Security	3.34 (0.47)***	1.99 (0.35)***	2.30 (0.62)**
Gender			
Female		1.30 (0.16)*	1.31 (0.23)
Male		---	---
Parental Status			
Child(ren)		0.96 (0.15)	1.16 (0.24)
No Child(ren)		---	---
Race/Ethnicity			
Hispanic		0.69 (0.11)*	0.70 (0.11)*
non-Hispanic White		---	---
non-Hispanic Black		0.87 (0.14)	0.86 (0.14)
Other, Including Multi Racial/Ethnic		1.08 (0.29)	1.07 (0.29)
Education			
Less Than 9th Grade		1.12 (0.30)	1.13 (0.30)
9th-12th Grade (no diploma)		1.14 (0.27)	1.14 (0.27)
High School Diploma/GED		0.82 (0.18)	0.81 (0.18)
Some College or AA Degree		0.89 (0.19)	0.90 (0.19)
College Graduate or Above		---	---
Marital Status			
Married		---	---
Widowed		0.91 (0.20)	0.90 (0.20)
Divorced		1.25 (0.25)	1.24 (0.25)
Separated		2.21 (0.66)**	2.24 (0.67)**
Never Been Married		1.69 (0.27)**	1.70 (0.28)**
Living With Partner		1.26 (0.26)	1.27 (0.26)
Overall Health			
Excellent		---	---
Very Good		0.86 (0.26)	0.86 (0.25)
Good		1.41 (0.40)	1.42 (0.39)
Fair		2.62 (0.76)**	2.63 (0.75)**
Poor		5.01 (1.83)***	5.17 (1.87)***

Source: 2009-2010 NHANES (N=2,590)

$^{+}$p<0.10 *p<0.05 **p<0.01 ***p<0.001 ****p<0.0001

Appendix A: Tables, cont'd

Table 3. Ordered Logit Models of Depression, Food Security and Controls, cont'd

	Model 1**** Odds Ratio (Robust SE)	Model 2**** Odds Ratio (Robust SE)	Model 3**** Odds Ratio (Robust SE)
Activity Limited by Pain			
No Days		---	---
Some Days		2.56 (0.34)***	2.55 (0.34)***
Every Day		4.45 (0.94)***	4.56 (0.98)***
Anxiety			
No Days		---	---
Some Days		4.89 (0.76)***	4.91 (0.77)***
Every Day		19.98 (3.77)***	19.70 (3.75)***
Household Size (in number of persons)		1.01 (0.05)	1.00 (0.05)
Annual Household Income (in dollars)		1.00 (0.00)	1.00 (0.00)
Age (in years)		1.00 (0.00)	1.00 (0.00)
Interaction Gender by Food Security			
Female-Marginal			0.99 (0.33)
Female-Low			1.08 (0.34)
Female-Very Low			0.88 (0.29)
Interaction Parental by Food Security			
Child(ren)-Marginal			0.52 (0.17)*
Child(ren)-Low			0.76 (0.25)
Child(ren)-Very Low			0.84 (0.28)
Cut point 1	1.17 (0.08)	3.31 (0.45)	3.38 (0.45)
Cut point 2	2.29 (0.10)	4.87 (0.45)	4.95 (0.44)
Wald chi-squared (df)	89.57 (3)	589.98 (28)	593.30 (34)
Psuedo R-squared	0.0284	0.2366	0.2380

Source: 2009-2010 NHANES (N=2,590)

$^{+}$p<0.10 *p<0.05 **p<0.01 ***p<0.001 ****p<0.0001

Appendix A: Tables, cont'd

Table 4. Predicted Probabilities of Categorical Variables[+]

	No Depression	Mild Depression	Clinical Depression
Household Food Security Category			
Full Food Security	0.5884	0.2840	0.1276
Marginal Food Security	0.6057	0.2745	0.1198
Low Food Security	0.4737	0.3378	0.1885
Very Low Food Security	0.4252	0.3545	0.2204
Gender			
Female	0.4737	0.3378	0.1885
Male	0.5587	0.2996	0.1417
Parental Status			
Child(ren)	0.4737	0.3378	0.1885
No Child(ren)	0.4446	0.3483	0.2071
Race/Ethnicity			
Hispanic	0.5616	0.2981	0.1403
non-Hispanic White	0.4737	0.3378	0.1885
non-Hispanic Black	0.5115	0.3221	0.1664
Other, Including Multi Racial/Ethnic	0.4571	0.3440	0.1989
Education			
Less Than 9th Grade	0.3931	0.3629	0.2440
9th-12th Grade (no diploma)	0.3897	0.3636	0.2467
High School Diploma/GED	0.4737	0.3378	0.1885
Some College or AA Degree	0.4504	0.3463	0.2033
College Graduate or Above	0.4217	0.3555	0.2228
Marital Status			
Married	0.4737	0.3378	0.1885
Widowed	0.4988	0.3276	0.1736
Divorced	0.4209	0.3557	0.2234
Separated	0.2870	0.3711	0.3419
Never Been Married	0.3457	0.3708	0.2835
Living With Partner	0.4143	0.3576	0.2282

Source: 2009-2010 NHANES (N=2,590)

[+]Per each category, for a baseline person who is a white female, low food security, married, has a child/children, a household of 4 persons, has a high school diploma/GED and reports good overall health, some days of pain and some of anxiety while holding all other model variables at the mean

Appendix A: Tables, cont'd

Table 4. Predicted Probabilities of Categorical Variables, cont'd[+]

		No Depression	Mild Depression	Clinical Depression
Overall Health				
	Excellent	0.5614	0.2982	0.1404
	Very Good	0.5977	0.2789	0.1233
	Good	0.4737	0.3378	0.1885
	Fair	0.3270	0.3722	0.3008
	Poor	0.1986	0.3438	0.4577
Activity Limited by Pain				
	No Days	0.6968	0.2198	0.0834
	Some Days	0.4737	0.3378	0.1885
	Every Day	0.3350	0.3717	0.2933
Anxiety				
	No Days	0.8154	0.1394	0.0452
	Some Days	0.4737	0.3378	0.1885
	Every Day	0.1832	0.3343	0.4825

Source: 2009-2010 NHANES (N=2,590)

[+]Per each category, for a baseline person who is a white female, low food security, married, has a child/children, a household of 4 persons, has a high school diploma/GED and reports good overall health, some days of pain and some of anxiety while holding all other model variables at the mean

Appendix A: Tables, cont'd

Table 5. Change in Predicted Probabilities of Continuous Variables[+]

	No Depression	Mild Depression	Clinical Depression	Average Marginal Effect
Household Size (# persons)	-0.0047	0.0019	0.0028	0.0005
Annual Household Income (dollars)	0.0031	-0.0013	-0.0019	0.0000
Age (years)	0.0469	-0.0187	-0.0282	0.0005

Source: 2009-2010 NHANES (N=2,590)

[+]Change based on going from minimum to maximum value of each variable, for a white female, with low food security, who is married, has a child/children, a household of 4 persons, has a high school diploma/GED, some days of pain, some days of anxiety and reports good overall health while holding all other model variables at the mean

Appendix A: Tables, cont'd

Table 6. Ordered Logit Models of Depression, Food Security and Controls - With and Without Anxiety

	Model 2**** With Anxiety	Model 2**** Without Anxiety
	Odds Ratio (Robust SE)	Odds Ratio (Robust SE)
Household Food Security Category		
Full Food Security	---	---
Marginal Food Security	1.30 (0.22)	1.63 (0.27)**
Low Food Security	1.91 (0.32)***	2.14 (0.33)***
Very Low Food Security	1.99 (0.35)***	2.68 (0.43)***
Gender		
Female	1.30 (0.16)*	1.49 (0.17)**
Male	---	---
Parental Status		
Child(ren)	0.96 (0.15)	1.00 (0.16)
No Child(ren)	---	---
Race/Ethnicity		
Hispanic	0.69 (0.11)*	0.70 (0.10)*
non-Hispanic White	---	---
non-Hispanic Black	0.87 (0.14)	0.77 (0.11)$^{+}$
Other, Including Multi Racial/Ethnic	1.08 (0.29)	1.05 (0.25)
Education		
Less Than 9th Grade	1.12 (0.30)	0.87 (0.22)
9th-12th Grade (no diploma)	1.14 (0.27)	1.08 (0.25)
High School Diploma/GED	0.82 (0.18)	0.69 (0.15)$^{+}$
Some College or AA Degree	0.89 (0.19)	0.94 (0.20)
College Graduate or Above	---	---
Marital Status		
Married	---	---
Widowed	0.91 (0.20)	0.98 (0.21)
Divorced	1.25 (0.25)	1.47 (0.28)*
Separated	2.21 (0.66)**	2.14 (0.54)**
Never Been Married	1.69 (0.27)**	1.79 (0.27)***
Living With Partner	1.26 (0.26)	1.24 (0.24)
Overall Health		
Excellent	---	---
Very Good	0.86 (0.26)	1.04 (0.29)
Good	1.41 (0.40)	1.64 (0.42)$^{+}$
Fair	2.62 (0.76)**	4.21 (1.11)***
Poor	5.01 (1.83)***	8.39 (2.92)***

Source: 2009-2010 NHANES (N=2,590)

$^{+}$p<0.10 *p<0.05 **p<0.01 ***p<0.001 ****p<0.0001

Appendix A: Tables, cont'd

Table 6. Ordered Logit Models of Depression, Food Security and Controls - With and Without Anxiety, cont'd

	Model 2**** With Anxiety	Model 2**** Without Anxiety
	Odds Ratio (Robust SE)	**Odds Ratio (Robust SE)**
Activity Limited by Pain		
No Days	---	---
Some Days	2.56 (0.34)***	2.97 (0.37)***
Every Day	4.45 (0.94)***	5.86 (1.15)***
Anxiety		
No Days	---	
Some Days	4.89 (0.76)***	
Every Day	19.98 (3.77)***	
Household Size (in number of persons)	1.01 (0.05)	0.98 (0.05)
Annual Household Income (in dollars)	1.00 (0.00)	1.00 (0.00)
Age (in years)	1.00 (0.00)	0.99 (0.00)*
Cut point 1	3.31 (0.45)	2.18 (0.38)
Cut point 2	4.87 (0.45)	3.54 (0.38)
Wald chi-squared (df)	589.98 (28)	414.38 (26)
Psuedo R-squared	0.2366	0.1519

Source: 2009-2010 NHANES (N=2,590)

$^{+}$p<0.10 *p<0.05 **p<0.01 ***p<0.001 ****p<0.0001

Appendix B: Food Security Screen

In the last 12 months, that is since [ ]….

1) {I/We} worried whether {my/our} food would run out before (I/we) got money to buy more

2) The food that {I/We} bought just didn't last and {I/We} didn't have enough money to get more food

3) {I/We} Couldn't afford to eat balanced meals

4) In the last 12 months, that is since [ ] did [you/your or other adults in your household} ever cut the size of your meals or skip meals because there wasn't enough money for food

5) How often did this happen (almost every month, some months but not every month, only 1 or 2 months)

6) In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money to buy food

7) In the last 12 months were you ever hungry but didn't eat because you couldn't afford enough food

8) In the last 12 months did you lose weight because you didn't have enough money for food

9) In the last 12 months did {you/your or other adults in your household} ever not eat for a whole day because there wasn't enough money for food

10) How often did this happen (almost every month, some months but not every month, only 1 or 2 months)

For those households with children:

In the last 12 months, that is since [ ]….

11) {I/We} relied on only a few kinds of low-cost foods to feed {CHILD'S NAME/the children} because there wasn't enough money for food

12) {I/We} couldn't feed {CHILD'S NAME/the children} a balanced meal, because there wasn't enough money for food.

13) {CHILD'S NAME was/the children were} not eating enough because there wasn't enough money for food

Appendix B: Food Security Screen, Cont'd

14) In the last 12 months since [ ] did you ever cut the size of {CHILD'S NAME/any of the children's} meals because there wasn't enough money for food

15) In the last 12 months {CHILD'S NAME/any of the children} ever skip meals because there wasn't enough money for food

16) How often did this happen (almost every month, some months but not every month, in only 1 or 2 months)

17) In the last 12 months {was CHILD'S NAME/were any of the children} ever hungry but there wasn't enough money for food

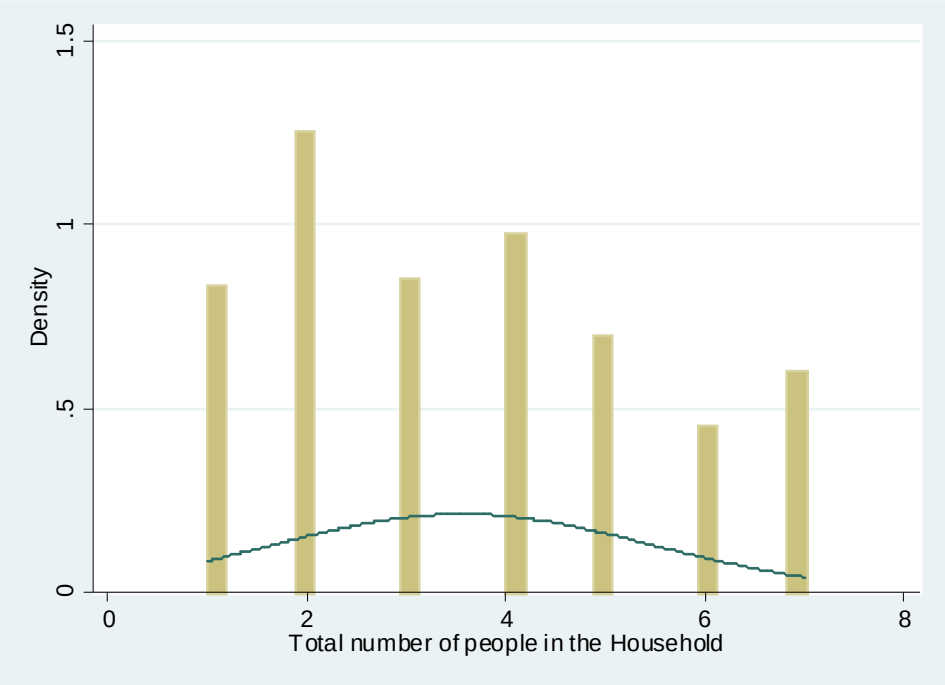
18) In the last 12 months did {CHILD'S NAME/any of the children} ever not eat for a whole day because there wasn't enough money for food

19) In the last 12 months did {you/you or any member of your household} ever get emergency food from a church, food pantry, or a food bank or eat in a soup kitchen

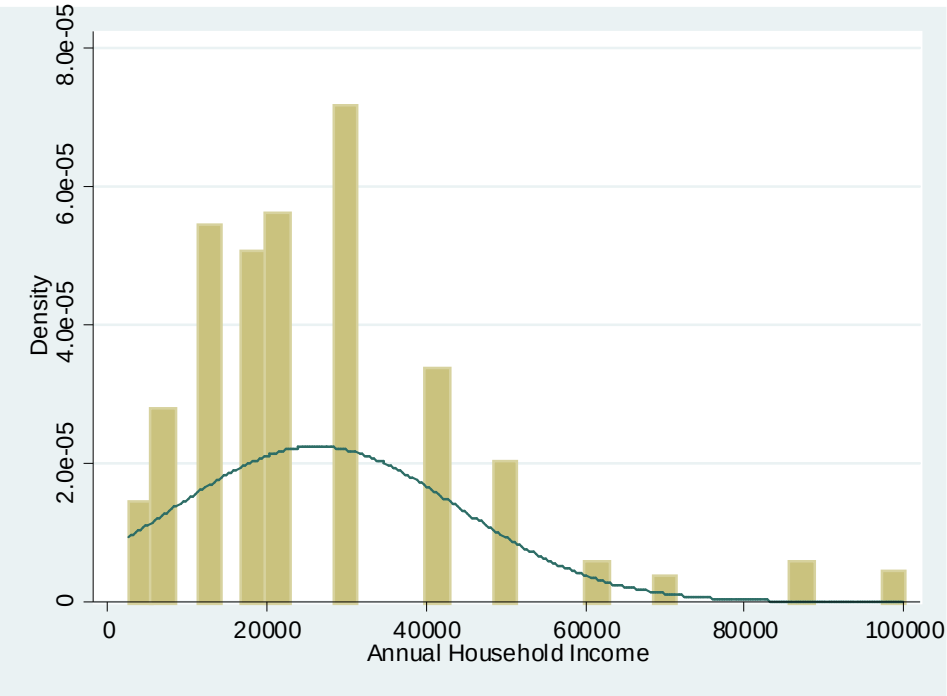
Households without children		**Households with children**	
Number of Affirmative Responses	**Food Security Classification**	**Number of Affirmative Responses**	**Food Security Classification**
0	Full	0	Full
1 to 2	Marginal	1 to 2	Marginal
3 to 5	Low	3 to 7	Low
6 to 10	Very Low	8 to 19	Very Low

Appendix C: Distribution of Continuous Variables

Household Size:

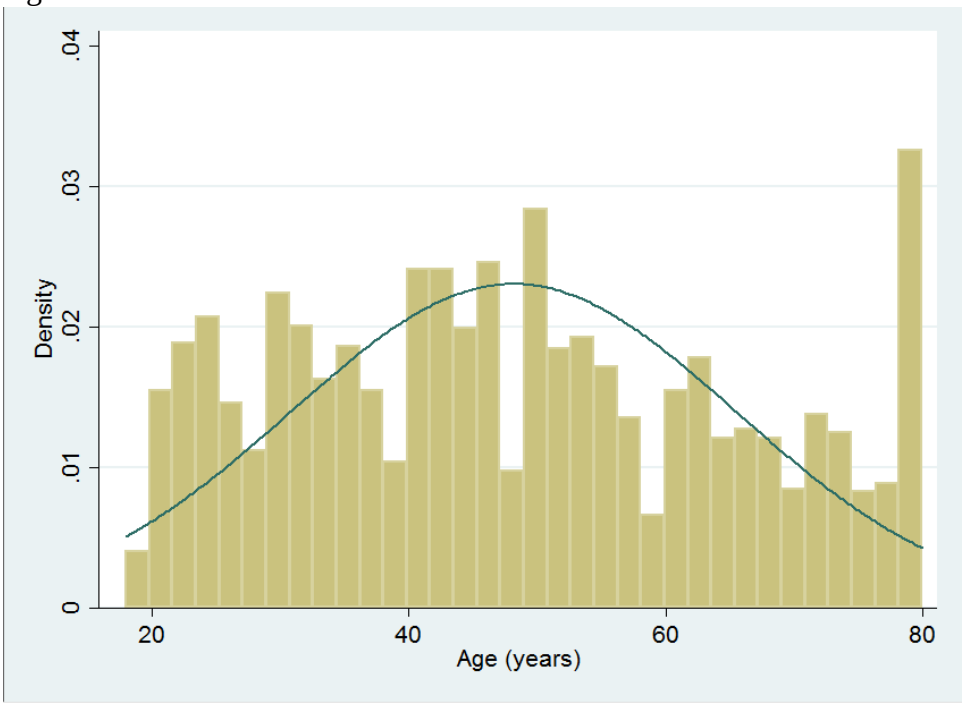


Annual Household Income:



Appendix C: Distribution of Continuous Variables, Cont'd

Age:



Appendix D. Variable Coding

Variable Coding

	Variable Code / Range
Dependent Variable	
Depression Category	
No Depression	1
Mild Depression	2
Moderate to Severe, Clinical Depression	3
Independent Variables	
Household Food Security Category	
Full Food Security	1 (dummy)
Marginal Food Security	2 (dummy)
Low Food Security	3 (dummy)
Very Low Food Security	4 (dummy)
Gender	
Female	1
Male	0
Parental Status	
Child(ren)	1
No Child(ren)	0
Race/Ethnicity	
Hispanic	1 (dummy)
non-Hispanic White	2 (dummy)
non-Hispanic Black	3 (dummy)
Other, Including Multi Racial/Ethnic	4 (dummy)
Education	
Less Than 9th Grade	1 (dummy)
9th-12th Grade (no diploma)	2 (dummy)
High School Diploma/GED	3 (dummy)
Some College or AA Degree	4 (dummy)
College Graduate or Above	5 (dummy)
Marital Status	
Married	1 (dummy)
Widowed	2 (dummy)
Divorced	3 (dummy)
Separated	4 (dummy)
Never Been Married	5 (dummy)
Living With Partner	6 (dummy)

Source: 2009-2010 NHANES (N=2,590)

Appendix E. Variable Coding, cont'd

Variable Coding, cont'd

		Variable Code / Range
Overall Health		
	Excellent	1 (dummy)
	Very Good	2 (dummy)
	Good	3 (dummy)
	Fair	4 (dummy)
	Poor	5 (dummy)
Activity Limited by Pain (in past 30 days)		
	No Days	0 (dummy)
	Some Days	1 (dummy)
	Every Day	2 (dummy)
Anxiety (in past 30 days)		
	No Days	0 (dummy)
	Some Days	1 (dummy)
	Every Day	2 (dummy)
Household Size (in number of persons)		1 - 7 (top coded)
Annual Household Income (in dollars)		$2499.50 - $100,000 (top coded)
Age (in years)		18 - 80 (top coded)

Source: 2009-2010 NHANES (N=2,590)