ACCSCIENCE PUBLISHING

International Journal of Population Studies

RESEARCH ARTICLE

Association between food insecurity severity and major depression: Findings from the United States National Health and Nutrition Examination Survey

Elizabeth Ann Luke, Josh Wallace, and Roger Wong*

Department of Public Health and Preventive Medicine, Norton College of Medicine, SUNY Upstate Medical University, Syracuse, New York, USA

Abstract

Food insecurity and mental health disorders have been increasing in all populations globally due to a variety of sociopolitical factors. Our study examines how the severity of food insecurity is associated with major depression in adults. We analyzed data from the 2017–2018 National Health and Nutrition Examination Survey, which includes a nationally representative sample from households across the United States. Our sample was restricted to adults aged 18 and older, resulting in a sample size of 5856 participants. We used a multiple logistic regression with sampling weights applied to evaluate whether adult food insecurity severity is associated with major depression. Overall, higher severity of food insecurity was associated with increased odds of depression. Specifically, adults with very low food security had a 315% significantly increased odds of depression compared to those with full food security (adjusted odds ratio [aOR] = 4.15, 95% CI = 3.09 – 5.64, $p < 0.05$). Females also had a 60% significantly higher odds of depression (aOR = 1.60, 95% CI = 1.12 – 2.30, $p < 0.05$) and higher income levels were significantly associated with lower odds of depression (aOR = 0.90, 95% CI = 0.83–0.97, $p < 0.05$). Our study supports prior research that food insecurity has adverse effects on mental health. These results can be used to inform public health research and interventions for food insecurity and mental health moving forward.

Keywords: Depression; Food insecurity; Hunger; Mental health; Prevention; Public health

***Corresponding author:**
Roger Wong
(WongRo@upstate.edu)

Citation: Luke, E.A., Wallace, J., & Wong, R. (2023). Association between food insecurity severity and major depression: Findings from the United States National Health and Nutrition Examination Survey. *International Journal of Population Studies,* 9(1): 435
https://doi.org/10.36922/ijps.435

Received: January 1, 2023

Accepted: April 13, 2023

Published Online: April 27, 2023

1. Introduction

Food insecurity is a public health concern that has been investigated widely over the past few decades. Food insecurity is defined as a disruption in the intake or eating patterns due to cost or other access barriers (Jones *et al*., 2013). According to the United States Department of Agriculture Economic Research Service (USDA ERS), 10.2% of U.S. households were food insecure at some point in 2021, with 3.9% experiencing very low food security. Food insecurity is not uniform across America and has a higher prevalence in southern states. For example, Mississippi had a 15.3% rate of food insecurity compared to New Hampshire's 5.4% (USDA ERS, 2022).

In recent years, as there has been a cultural shift toward discussing and destigmatizing mental health and mental illness, more studies have sought to investigate a link between food insecurity and mental health disorders. Several studies have found that food insecurity is associated with lower quality of life and increased prevalence of mental health issues or increased likelihood of seeking mental health services (Chung *et al*., 2016; Hatsu *et al*., 2017; Nagata *et al*., 2019; Pound & Chen, 2021; Tarasuk *et al*., 2020; Tarasuk *et al*., 2018). In particular, depression is a debilitating disorder that affects five percent of adults worldwide (Institute for Health Metrics and Evaluation, 2022). Those suffering from depression will often experience lower function at work and poorer personal relationships. Depression can also lead to suicide in worst-case scenarios. Recent studies showed that 9.2% of Americans 12 years and older experienced a major depressive episode within the past year (Goodwin *et al*., 2022). The economic burden due to depression in U.S. adults was approximately $236 billion in 2018 (Greenberg *et al*., 2021). Despite the breadth and severity of depression, the amount spent on direct treatment was only 11.2% of the total economic burden.

In a study on food security and quality of life in individuals living with HIV, Hatsu *et al*. (2017) found that participants who reported experiencing very low food security had significantly lower mental component summary scores, indicating food insecurity had serious adverse mental health effects in their sample.

One potential mechanism between food insecurity and depression is the stress response pathway. An increase in allostatic load due to food insecurity can raise cortisol and norepinephrine levels which have been associated with depression (McClain *et al*., 2018). An increase in allostatic load is also accompanied by chronic issues such as inflammation, unhealthier cholesterol levels, and hypertension. Each of these issues can create or contribute to ongoing medical issues, creating a positive feedback loop for stress.

Another study focusing on food insecurity and maternal outcomes in Ontario found that the prevalence of postpartum mental health disorders was higher among women who experienced food insecurity (34.8%) compared to those who experienced marginal (15.2%) or no food insecurity (20.6%) (Tarasuk *et al*., 2020).

Food insecurity may also increase the risk of depression through social support. Food insecurity has been shown to lead to social isolation in older adults, which, in turn, is associated with depression (Burris *et al*., 2021). Likewise, Ashe & Lapane (2018) found that those who were food insecure were 80% less likely to have strong social support compared to those who were fully food secure (Ashe & Lapane, 2018).

Tarasuk *et al*. (2018) examined the relationship between food security and utilization of public mental health care services in Ontario, Canada. They found that over the past year of the study, 40.4% of adults in severely food-insecure households had received treatment for their mental health compared to 15.6% of adults in food-secure households (Tarasuk *et al*., 2018). Several additional studies determined that young adults experiencing food insecurity had increased odds of mental health issues and poorer sleep (Nagata *et al*., 2019). Individuals experiencing food insecurity also had a significantly higher prevalence of perceived poor or fair mental health status (Pound & Chen, 2021). Other research has shown an association of food insecurity with nutritional deficiencies, adverse mental health, and overall lower quality of life (Chung *et al*., 2016).

The purpose of our present study was to examine how the severity of food insecurity is associated with major depression in adults using a nationally representative U.S. sample. The previous studies have focused on examining the relationship between food insecurity and utilization of mental health treatment or poorer mental health status in general, but few have examined the specific association with major depressive disorder. Due to the often more severe outcomes that result from major depressive disorder, it would be prudent to explore any factors related to the condition. We hypothesized that those individuals experiencing more severe food insecurity would be more likely to experience depression. Results from this study may provide further insight into the relationship between food insecurity and depression and may be used to identify preventable social risk factors for depression.

2. Data and methods

2.1. Data source

We used the National Health and Nutrition Examination Survey (NHANES) 2017–2018 data for our analysis. Although the most recent 2019–2020 data is available, we opted not to analyze this wave as the NHANES stated data collection was halted in March 2020 due to the COVID-19 pandemic, which subsequently led to the 2019–2020 data being neither nationally representative nor generalizable to the U.S. population. As of January 2023, the NHANES 2021–2022 data have not been released as well. Thus, the NHANES 2017–2018 data set includes a nationally representative sample of 5856 individuals aged 18 years or older.

2.2. Major depression

Our outcome of interest was major depression. We constructed this variable using the Patient Health Questionnaire-9 (PHQ-9), a nine-question depression module with each question ranging from a frequency of zero (not at all) to three (nearly every day) in the past 12 months. The aggregate score had a range of 0–27 and we followed guidance on classifying individuals with major depression using a cutoff of 10 or greater, which has a high sensitivity and specificity of 88% (Kroenke *et al.*, 2001).

2.3. Food insecurity severity

Our main predictor variable was the severity of adult food insecurity derived from a 10-question NHANES algorithm that queried adult households with no children. The NHANES uses the standardized 10-item food security module developed by the USDA, which has been extensively tested for validity and reliability (Bickel *et al.*, 2000). The 10 questions in the module assess three situations: (1) Anxiety or perception that the food budget or food supply was inadequate, (2) perceptions that the food eaten was inadequate in quality, and (3) reported instances of reduced food intake or consequences of reduced intake. Based on USDA methodology, the NHANES algorithm classifies adults into four categories: (1) Full food security (had no problems, or anxiety about, consistently accessing adequate food), (2) marginal food security (had problems at times, or anxiety about, accessing adequate food, but the quality, variety, and quantity of their food intake were not substantially reduced), (3) low food security (reduced the quality, variety, and desirability of their diets, but the quantity of food intake and normal eating patterns were not substantially disrupted), and (4) very low food security (at times during the year, eating patterns were disrupted, and food intake reduced due to lack of money and other resources for food) (Bickel *et al.*, 2000).

2.4. Covariates

The regression model was adjusted for the following covariates: Age, income, race/Hispanic origin, sex, education level, and access to care. Age was a continuous variable ranging from 18 and top-coded at 80 years to protect respondent anonymity. For income, we specifically analyzed the ratio of family income to poverty, which was calculated by dividing family or individual income by the poverty guidelines specific to the survey year. This variable is continuous with a range of zero and top-coded to five to protect respondent anonymity. Race/Hispanic origin is nominal, and responses included Mexican American, other Hispanic, non-Hispanic White, non-Hispanic Black, and other races. Sex includes male and female. Education level is ordinal and includes the following responses: <9th grade, 9–11th grade, high school graduate/General Educational Development, some college, and college graduate or above. Access to care is a binary yes or no response based on the question, "Have you seen a mental health professional in the past year?".

2.5. Statistical analysis

A Pearson Chi-square test was conducted to test for an association between adult food security and depression. A weighted multiple logistic regression was run to evaluate the relationship between food insecurity and depression after adjusting for covariates. The NHANES sampling weights were calculated based on the probability of selection at each stage of the sampling process, which included stratification, clustering, and multistage sampling. To make sure that the sample was representative of the population of interest, the sampling weights were adjusted for nonresponse by demographic factors such as age, sex, race/ethnicity, and poverty status. This ensures that the data are representative of the U.S. civilian, non-institutionalized population. We used IBM SPSS statistical software version 28 and SAS Studio 3.81 for all statistical analyses with a 0.05 significance level and two-tailed tests.

3. Results

3.1. Sample characteristics

In our study sample of 5,856 U.S. adults, the average age of participants was 49.9 years (SD = 18.8) and the majority of participants identified as female (51.5%) (Table 1). The average ratio of family income to poverty was 2.52 (SD = 1.61), indicating mid-level socioeconomic status. Most of the participants identified as non-Hispanic White (34.7%), while those who identified as other Hispanic made up the lowest proportion of study participants. The highest proportion of study participants reported an education level of some college (32.0%). Participants who reported only having a 9–11th grade or <9th grade education level represented the lowest proportion of our sample. When examining measures of health, 89.7% of participants reported that they had not seen a mental health professional in the last year. In addition, 63.3% of participants were categorized as experiencing full food security, while only 9.6% of participants experienced very low food security. About 8% of the NHANES participants met the criteria for major depression based on the PHQ-9.

3.2. Bivariate results

There was a statistically significant relationship between food insecurity severity and major depression (χ^2 [3] = 197.9, p < 0.001) (Table 2). In general, more severe food insecurity trended with a higher prevalence

Table 1. Sample characteristics for respondents in the 2017–2018 National Health and Nutrition Examination Survey

Characteristic	Mean (SD) or % (n)
Age (range 18–80 years)	49.89 (18.78)
Ratio of income to poverty (range 0 – 5)	2.52 (1.61)
Race/Hispanic origin	
Mexican American	13.50% (792)
Other Hispanic	9.30% (543)
Non-Hispanic White	34.70% (2,032)
Non-Hispanic Black	22.90% (1,343)
Other races	19.60% (1,146)
Sex	
Male	48.50% (2,840)
Female	51.50% (3,016)
Education level	
<9th grade	8.60% (479)
9 – 11th grade	11.50% (638)
High school graduate/GED	23.80% (1,325)
Some college	32.00% (1,778)
College graduate or above	24.00% (1,336)
Seen mental health professional in past year	
Yes	10.30% (605)
No	89.70% (5,250)
Food insecurity severity	
Full food security	63.30% (3,488)
Marginal food security	14.20% (785)
Low food security	12.90% (711)
Very low food security	9.60% (527)
Major depression	
No	92.10% (5,395)
Yes	7.90% (461)

Note: GED: General educational development.

of depression. For example, most respondents with full food security did not have depression (65.3%) compared to those with depression (40.0%). In contrast, those who experienced very low food security had a higher proportion of depression (27.0%) compared to no depression (8.1%).

3.3. Multiple logistic regression results

Our regression model predicting major depression was statistically significant ($F[6, 97] = 22.36$, $p < 0.001$]. The regression model correctly predicted 77.2% of cases, indicating a good model fit. There are no independent variables with a variance inflation factor (VIF) >10 and the average VIF for the regression model is approximately 1.4, which indicates there is no multicollinearity (Kutner *et al.*, 2004).

Table 2. Bivariate association between food insecurity severity and major depression

Food insecurity severity	No depression (N=5,395)	Depression (N=461)	Chi-square test
Full food security	65.3% (3316)	40.0% (172)	Σ^2 (3)=197.9, P<0.001
Marginal food security	14.2% (721)	14.9% (64)	
Low food security	12.5% (633)	18.1% (78)	
Very low food security	8.1% (411)	27.0% (116)	

Overall, as food insecurity severity increases, the odds ratio of experiencing major depression increases and is statistically significant for all severity categories (Table 3). For example, respondents who experienced very low food security had a 318% significantly increased odds of major depression compared to participants who experienced full food security after adjusting for age, sex, race-ethnicity, education, income, and mental healthcare (adjusted odds ratio [aOR] = 4.18, 95% confidence interval [CI] = 3.09 – 5.64, $p < 0.05$).

Several of our covariates in the regression model were also significantly associated with depression. Those who were female had a 60% significantly increased odds of major depression compared to males (aOR = 1.60, 95% CI = 1.12 – 2.30, $p < 0.05$). Every one-point increase in the income-to-poverty ratio significantly decreased the odds of major depression by 10% (aOR = 0.90, 95% CI = 0.83 – 0.97, $p < 0.05$). Finally, those who reported not seeing a mental health professional in the past year had an 81% significantly decreased odds of major depression compared to those who did (aOR = 0.19, 95% CI = 0.12 – 0.28, $p < 0.05$).

4. Discussion

Our results showed a positive association between food insecurity and major depression. Higher severity of food insecurity corresponded with higher odds of individuals experiencing depression. This association was statistically significant for every severity category, and especially pronounced for those in the category "very low food security," which the USDA defines as those with disrupted eating patterns and reduced food intake due to a lack of money and other resources for food (Bickel *et al.*, 2000). These findings are consistent with the previous research on the relationship between food insecurity and poor mental health (Chung *et al.*, 2016; Hatsu *et al.*, 2017; Nagata *et al.*, 2019; Pound & Chen., 2021; Tarasuk *et al.*, 2020).

Table 3. Weighted multiple logistic regression examining the association between food insecurity severity and major depression

	aOR	*p*-value	95% CI
Food insecurity severity			
Full food security	Reference	Reference	Reference
Marginal food security	2.14	<0.05	1.21 – 3.79
Low food security	2.66	<0.05	1.42 – 4.95
Very low food security	4.18	<0.05	3.09 – 5.64
Age	1.00	0.36	0.98 – 1.01
Sex			
Male	Reference	Reference	Reference
Female	1.60	<0.05	1.12 – 2.30
Race/Hispanic origin			
Mexican American	0.52	0.09	0.24 – 1.11
Other Hispanic	0.73	0.36	0.37 – 1.43
Non-Hispanic White	Reference	Reference	Reference
Non-Hispanic Black	0.71	0.05	0.51 – 1.00
Other Race	1.25	0.30	0.82 – 1.87
Education level			
<9th grade	1.21	0.52	0.68 – 2.15
9–11th grade	1.47	0.16	0.86 – 2.50
High school graduate/GED	1.03	0.79	0.83 – 1.27
Some college	Reference	Reference	Reference
College graduate or above	0.67	0.21	0.36 – 1.25
Ratio of income to poverty	0.90	<0.05	0.83 – 0.97
Seen mental health professional in past year			
Yes	Reference	Reference	Reference
No	0.19	<0.05	0.12 – 0.28

Note: GED: General educational development; aOR: Adjusted odds ratio.

A variety of socioeconomic and physiological factors may contribute to this outcome. One potential explanation is that the impact nutritional deficiency has on antidepressant drugs. Individuals with low folate levels have demonstrated a lower treatment response to selective serotonin reuptake inhibitor antidepressants (Alpert *et al.*, 2002). In tandem with these findings, it has also been noted that increased serum levels of Vitamin B_{12} and folic acid supplementation can strengthen antidepressant therapy (Hintikka *et al.*, 2003; Roberts *et al.*, 2007). Low Vitamin B_{12} levels have been observed in the American population and varied by age, with adults 70 years and older being the most impacted at about 6% of prevalence (Allen, 2009).

The regression model also indicated that females, individuals with lower income, and those who had seen a mental health professional in the past year also had significantly increased odds of depression. Several reasons for higher rates of depression among females have been discussed in the literature, such as higher exposure to stressors and adverse conditions than males, leading to depression. Some of these stressors include lower income and higher strain from their caregiving roles (Hammen, 2018). Another source of added stress may stem from a lack of social support which can contribute to depression. Previous finings have shown that women with low food security are 80% less likely to have social support compared to their food-secure counterparts (Ashe & Lapane, 2018). Similarly, poor health and physiological stress are commonly purported to be the key mediators for the association between low income and depression (Patel *et al.*, 2018). Our regression model also adjusted for visit to a mental health professional, in which this association is logical due to individuals with depression who are more likely to seek support from a health professional. When the dependent variable is replaced with the variable "visit to a mental health professional," those with very low food security had significantly lower odds of visiting a professional, which held true in both unadjusted and adjusted weighted regression models. Previous research using a national U.S. sample found that depression is more prevalent among adults who self-identified as multi-racial or White, and less prevalent among Black and Hispanic respondents (Substance Abuse and Mental Health Services Administration, 2019), which aligns with the racial-ethnic disparities in depression that we observed in our study.

Our results have several implications for public health research and practice. Despite a plethora of literature demonstrating that food insecurity is associated with poorer mental health, future studies should investigate other specific mental health disorders, such as generalized anxiety disorder, and how they may be affected by food insecurity. Public health professionals should continue to work on implementing interventions to reduce food insecurity by increasing access to nutritious food options and decreasing costs. For example, one intervention could be the development of local community gardens in vacant neighborhood spaces, which have been reported to offer numerous benefits such as affordable food, community building, healthy and fresh food, and exercise for community residents (Wong *et al.*, 2018). In addition, as we saw in our results, individuals with a higher income relative to the poverty threshold were less likely to experience depression. Alleviating poverty and income disparities is an ongoing focus of public health work and other fields, and poverty plays an important role in an individual's experiences with food security and mental health. Policies aimed at reducing poverty through

universal basic income, increasing minimum wage, and increasing job opportunities at the local, state, and federal level should be considered to reduce depressive symptoms across all populations (Patel *et al.*, 2018).

Our study has several limitations. First, the NHANES is a cross-sectional data set, which limits our ability to establish causality that food insecurity leads to depression. Second, we restricted our sample to only household adults without children because the NHANES and the USDA provide a different food insecurity module measuring child food insecurity, which cannot be merged with our 10-item food security questionnaire for adults. Despite these limitations, our study has some noteworthy strengths. In particular, we utilized a nationally representative sample with sampling weights applied, which enables our results to be generalizable to the entire U.S. adult population. In addition, we used standardized measures for both food insecurity and depression, which have both been tested extensively to have high psychometric properties.

5. Conclusions

Our study supports prior literature that experiencing food insecurity has adverse effects on mental health, specifically in the context of depression. Interventions are therefore essential to address household food insecurity, especially during the era of the COVID-19 pandemic, given that recent research has also identified that food insecurity is significantly associated with increased COVID-19 risk (Searles & Wong, 2022). Future work should expand on these findings and examine whether the association between food insecurity and depression may be moderated by sex and income, which we identified were also significantly associated with depression. Our results can be used to inform public health research and interventions for food security and mental health moving forward.

Acknowledgments

None.

Funding

None.

Conflict of interest

The authors declare no competing of interests.

Author contributions

Conceptualization: Elizabeth Ann Luke, Roger Wong
Formal analysis: Elizabeth Ann Luke, Josh Wallace
Supervision: Roger Wong
Writing – original draft: Elizabeth Ann Luke, Josh Wallace, Roger Wong
Writing – review & editing: Elizabeth Ann Luke, Josh Wallace, Roger Wong

Ethics approval and consent to participate

This study was approved by the SUNY Upstate Institutional Review Board for the Protection of Human Subjects (#1999060-2).

Consent for publication

Not applicable.

Availability of data

This study uses public data, which may be obtained through the NHANES website: https://www.cdc.gov/nchs/nhanes/index.htm

References

Allen, L.H. (2009). How common is Vitamin B-12 deficiency? *American Journal of Clinical Nutrition*, 89(2): 693S-696S.

https://doi.org/10.3945/ajcn.2008.26947A

Alpert, J.E., Mischoulon, D., Rubenstein, G.E.F., Bottonari, K., Nierenberg, A.A., & Fava, M. (2002). Folinic acid (Leucovorin) as an adjunctive treatment for SSRI-refractory depression. *Annals of Clinical Psychiatry*, 14(1): 33-38.

https://doi.org/10.1023/a:1015271927517

Ashe, K.M., & Lapane, K.L. (2018). Food insecurity and obesity: Exploring the role of social support. *Journal of Womens Health* (*Larchmt*), 27(5): 651-658.

https://doi.org/10.1089/jwh.2017.6454

Bickel, G., Nord, M., Price, C., Hamilton, W., & Cook, J. (2000). Guide to Measuring Household Food Security, Revised 2000. US Department of Agriculture, Food and Nutrition Service, p.52. Available from: https://fns-prod.azureedge.us/sites/default/files/fsguide.pdf [Last accessed on 2023 Dec 31].

Burris, M., Kihlstrom, L., Arce, K.S., Prendergast, K., Dobbins, J., McGrath, E., Renda, A., Shannon, E., Cordier, T., Song, Y., & Himmelgreen, D. (2021). Food insecurity, loneliness, and social support among older adults. *Journal of Hunger and Environmental Nutrition*, 16(1): 29-44.

https://doi.org/10.1080/19320248.2019.1595253

Chung, H.K., Kim, O.Y., Kwak, S.Y., Cho, Y., Lee, K.W., & Shin, M.J. (2016). Household food insecurity is associated with adverse mental health indicators and lower quality of life among Koreans: Results from the Korea National Health and Nutrition Examination Survey 2012-2013. *Nutrients*, 8(12): 819.

https://doi.org/10.3390/nu8120819

Goodwin, R.D., Dierker, L.C., Wu, M., Galea, S., Hoven, C.W., & Weinberger, A.H. (2022). Trends in U.S. depression

prevalence from 2015 to 2020: The widening treatment gap. *American Journal of Preventive Medicine*, 63(5): 726-733.

https://doi.org/10.1016/j.amepre.2022.05.014

Greenberg, P.E., Fournier, A.A., Sisitsky, T., Simes, M., Berman, R., Koenigsberg, S.H., & Kessler, R.C. (2021). The economic burden of adults with major depressive disorder in the United States (2010 and 2018). *Pharmacoeconomics*, 39(6): 653-665.

https://doi.org/10.1007/s40273-021-01019-4

Hammen, C. (2018). Risk factors for depression: An autobiographical review. *Annual Review of Clinical Psychology*, 14: 1-28.

https://doi.org/10.1146/annurev-clinpsy-050817-084811

Hatsu, I., Hade, E., & Campa, A. (2017). Food security status is related to mental health quality of life among persons living with HIV. *AIDS and Behavior*, 21(3): 745-753.

https://doi.org/10.1007/s10461-016-1573-9

Hintikka, J., Tolmunen, T., Tanskanen, A., & Viinamäki, H. (2003). High Vitamin B12 level and good treatment outcome may be associated in major depressive disorder. *BMC Psychiatry*, 3(1): 17.

https://doi.org/10.1186/1471-244X-3-17

Institute for Health Metrics and Evaluation. (2022). The 2019 Global Burden of Disease (GBD) Study Database. Available from: https://vizhub.healthdata.org/gbd-results [Last accessed on 2022 Dec 27].

Jones, A.D., Ngure, F.M., Pelto, G., & Young, S.L. (2013). What are we assessing when we measure food security? A compendium and review of current metrics. *Advances in Nutrition*, 4(5): 481-505.

https://doi.org/10.3945/an.113.004119

Kroenke, K., Spitzer, R.L., & Williams, J.B. (2001). The PHQ-9: Validity of a brief depression severity measure. *Journal of General Internal Medicine*, 16(9): 606-613.

https://doi.org/10.1046/j.1525-1497.2001.016009606.x

Kutner, M.H., Nachtsheim, C.J., Neter, J., & Wasserman, W. (2004). Applied Linear regression Models. Vol. 4. New York: McGraw-Hill/Irwin, p.563-568.

McClain, A.C., Xiao, R.S., Gao, X., Tucker, K.L., Falcon, L.M., & Mattei, J. (2018). Food insecurity and odds of high allostatic load in Puerto Rican adults: The role of participation in the supplemental nutrition assistance program during 5 years of follow-up. *Psychosomatic Medicine*, 80(8): 733-741.

https://doi.org/10.1097/PSY.0000000000000628

Nagata, J.M., Palar, K., Gooding, H.C., Garber, A.K., Whittle, H.J., Bibbins-Domingo, K., & Weiser, S.D. (2019). Food insecurity is associated with poorer mental health and sleep outcomes in young adults. *Journal of Adolescent Health*, 65(6): 805-811.

https://doi.org/10.1016/j.jadohealth.2019.08.010

Patel, V., Burns, J.K., Dhingra, M., Tarver, L., Kohrt, B.A., & Lund, C. (2018). Income inequality and depression: A systematic review and meta-analysis of the association and a scoping review of mechanisms. *World Psychiatry*, 17(1): 76-89.

https://doi.org/10.1002/wps.20492

Pound, C.M., & Chen, Y. (2021). Female sex and food insecurity in relation to self-reported poor or fair mental health in Canadian adults: A cross-sectional study using national survey data. *Canadian Medical Association Journal*, 9(1): E71-E78.

https://doi.org/10.9778/cmajo.20200112

Roberts, S.H., Bedson, E., Hughes, D., Lloyd, K., Menkes, D.B., Moat, S., Pirmohamed, M., Slegg, G., Thome, J., Tranter, R., Whitaker, R., Wilkinson, C., & Russell, I. (2007). Folate augmentation of treatment-evaluation for depression (FolATED): Protocol of a randomised controlled trial. *BMC Psychiatry*, 7(1): 65.

https://doi.org/10.1186/1471-244X-7-65

Searles, M., & Wong, R. (2022). Food insecurity and COVID-19 diagnosis: Findings from a national United States sample. *Journal of Hunger and Environmental Nutrition*, 1-16.

https://doi.org/10.1080/19320248.2022.2128961

Substance Abuse and Mental Health Services Administration. (2019). Key Substance Use and Mental Health Indicators in the United States: Results from the 2018 National Survey on Drug Use and Health. United States: Substance Abuse and Mental Health Services Administration. Available from: https://www.samhsa.gov/data/sites/default/files/cbhsq-reports/nsduhnationalfindingsreport2018/nsduhnationalfindingsreport2018.pdf [Last accessed on 2023 Dec 31].

Tarasuk, V., Cheng, J., Gundersen, C., de Oliveira, C., & Kurdyak, P. (2018). The relation between food insecurity and mental health care service utilization in Ontario. *The Canadian Journal of Psychiatry*, 63(8): 557-569.

https://doi.org/10.1177/0706743717752879

Tarasuk, V., Gundersen, C., Wang, X., Roth, D.E., & Urquia, M.L. (2020). Maternal food insecurity is positively associated with postpartum mental disorders in Ontario, Canada. *Journal of Nutrition*, 150(11): 3033-3040.

https://doi.org/10.1093/jn/nxaa240

USDA ERS-Food Security and Nutrition Assistance. (2022). Available from: https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/food-security-and-nutrition-assistance [Last accessed on 2022 Dec 26].

Wong, R., Gable, L., & Rivera-Núñez, Z. (2018). Perceived benefits of participation and risks of soil contamination in St. Louis urban community gardens. *Journal of Community Health*, 43(3): 604-610.

https://doi.org/10.1007/s10900-017-0459-8