Mental Health Scores Impact on Specific Micro and Macronutrients Intake

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Research Question

Do mental health scores impact dietary intake of specific micro and macronutrients among adults in NHANES 2009-2010 and 2011-2012 cycles?

Objectives

1. To examine the demographic characteristics of adult NHANES 2009-2010 and 2011-2012 participants.
    a. To examine the association between depression scores and demographic variables (gender, age, marital status, education level, and annual household income).
2. To determine if depression (defined as scores from Patient Health Questionnaire) impacts dietary intake of various micro and macronutrients including total folate, zinc, magnesium, total polyunsaturated fatty acids and monounsaturated fatty acids, and vitamin B12.
3. To compared the dietary intake of various micro and macronutrients including total folate, zinc, magnesium, total polyunsaturated fatty acids and monounsaturated fatty acids, and vitamin B12 to the Estimated Average Requirements (EAR) for men and women in both depressed and not depressed groups.

Introduction

Depression is a common physiological disorder that affects nearly 121 million people globally (Reddy, 2010). Depression is strongly associated with chronic diseases such as obesity, diabetes, and metabolic syndrome and is also associated with an increased risk of developing Alzheimer's dementia, cardiovascular disease, stroke, and cancer (Lang et al, 2015). Unhealthy consumption of foods such as fried and refined foods, sweetened beverages, processed meats, and high fat intake has been previously related to increased risk of developing depression. However, other healthy foods such as fruits, legumes, unprocessed meats, fish, and olive oil have been found to decrease the risk of developing depression (Lang et al, 2015). Diagnosing and treating depression can be difficult for medical providers (Reddy, 2010), and since depression is associated with numerous chronic diseases, it is imperative that effective prevention and treatment are available. A lot of attention has been on nutrition the relationship with chronic disease; however, little research is being done on the impact nutrition has on mental health (Sanchez-Villegas et al., 2015). Therefore, the objective of this study is to examine the relationship between various micronutrient intakes and mental health scores (defined here as depressed or not depressed). Also, further analysis will be done to determine if there is a difference in meeting the Estimated Average Requirements (EAR) in those with and without depression.

Methods

Study Population

Data were obtained from the 2010-2009 and 2011-2012 National Health and Nutrition Examination Survey (NHANES) (Centers for Disease Control and Prevention). NHANES is a program composed of cross-sectional studies using a nationally representative population to examine the health status of U.S. citizens. For this study, the data set was composed of both 2009-2010 and 2011-2012 cycles. The data files utilized for the analyses included demographic variables, total nutrient intakes, and mental health-depression screener. In order for participants from these cycles to be included, they must have been 20 years old or older, completed the first and second dietary interviews, and completed the Mental Health Screener Those participants who answered "refused" or "don't know" or had missing information on the mental health-depression screener were excluded in the analysis (see **Appendix A** for population schematic).

Outcome Variables

Demographic variables used for analysis included gender, age, race, marital status, education level, and annual household income (see **Appendix B** for variable definitions). Depression was operationally defined as results from the Patient Health Questionnaire (PHQ-9), which included 9 questions about depressive symptoms over the past 2 weeks. Responses were scored 0-3 based answers in the following categories: not at all (0), several days (1), or more than half the days (2), and nearly half the day (3). The total score ranged from 0-27. According to Kroneke et al. (2001) and Spitzer et al. (1999), a score of 10 or higher has been validated to be defined as depression and will be

used to define depression in this analysis as well (Kroneke et al., 2001) (Spitzer et al., 1999).

Two dietary interviews were conducted to obtain the total nutrient intakes. The first interview is gathered in the Mobile Examination Center (MEC) and the second interview is conducted via telephone between 3-10 days after the first interview (Centers for Disease Control and Prevention). Values of the various nutrients were obtained for the following: total folate, zinc, magnesium, total polyunsaturated fatty acids, total monounsaturated fatty acids, and vitamin B12. First day and second day recalls were averaged to provide a more accurate representation of actual intake. The averaged values were then converted and expressed as percent of calories or per 1,000 calories (see **Appendix B** for calculations) to correct for potential difference of men consuming more calories than women. The nutrient values for total folate, zinc, magnesium, and vitamin B12 were compared to the Estimated Average Requirements (EAR) (Food and Nutrition Board, Institute of Medicine, National Academies). The polyunsaturated and monounsaturated fatty acid nutrient intakes were compared to the Therapeutic Lifestyle Changes (TLC) recommendations (National Center for Chronic Disease Prevention and Health Promotion).

Statistical Analysis

Statistical analysis was conducted using SPSS Version 22 (IBM, Chicago IL). Descriptive statistics were used to analyze the demographic variables. The demographic categorical variables (gender, age, race, marital status, education level and annual household income) were analyzed using frequency distribution (n,%). For continuous variables such as age and nutrient values, normally distributed variables are expressed as

mean ± standard deviation (SD) and non-normally distributed variables are expressed as median ([IQR]). Normality data output is location in **Appendix D**. To meet objective 1, frequencies were utilized to determine the prevalence of depression among demographic variables. Also, chi-square analyses were conducted to determine the association between depression scores and demographic variables. To meet objective 2, Mann Whitney U analyses were conducted to test for significant differences in dietary intake of various micro and macronutrients between those depressed and not depressed. Also, Mann Whitney U analyses were conducted to test for significant differences in nutrient intake between those depressed and not depressed by gender. To meet objective 3, frequencies were utilized to compare the participant's nutrient intake to the EAR. Frequencies were also utilized to compare the participant's nutrient intake by gender to the EAR. Significance levels were set at $p<0.05$.

Results

Overall Sample Characteristics

The sample used for the analysis was composed of 4,838 (or 24%) of the 20,293 participants in the NHANES 2009-2010 and 2011-2012 cycles. The demographic characteristics of these participants are described below in **Table 1**. An additional table with further expanded variables is available in **Appendix C**. There was an even amount of males (48.6%) and females (51.4%) and the average age was 48.3 ± 18.5 years old. Half of the participants were non-Hispanic white and 61.4% of participants were married or living with a partner. For education, 49% were high school graduates or GED equivalent or below and 51% received some college or AA degree and above. There were more participants who made an annual household income of $35,000 and over (56.5%) compared to those who made under $34,999 (43.5%).

Characteristics of Those Depressed vs Not Depressed

The demographic characteristics of the NHANES 2009-2010 and 2011-2012 participants between those not depressed and depressed are further described below in **Table 1**. Using a chi-square analysis, a significant association was determined between those who were depressed and not depressed in that more women reported being depressed then men ($X^2 = 34.104$, $p < 0.001$). For age, those who reported being depressed were younger than those who reported not being depressed ($X^2 = 20.157$, $p < 0.001$). For race, more non-Hispanic whites reported being not depressed than Mexican/other Hispanic, non-Hispanic black, and other race participants ($X^2 = 10.705$, $p = 0.030$). More participants who were married reported being not depressed compared to those participants who were not married ($X^2 = 39.787$, $p < 0.001$). A higher amount of

participants who had a college degree or above reported being not depressed when compared to those participants who were a high school graduate/GED equivalent or lower ($X^2 = 19.199$, $p < 0.001$). For annual household income, a higher amount of those who reported being not depressed made $35,000 and above when compared to those who made less than $34,999 ($X^2 = 91.241$, $p < 0.001$).

Table 1: Demographic Characteristics of NHANES 2009-2010 and 2011-2012 Participants above Age 18				
Demographic Variable	Total	Not Depressed*	Depressed*	P value**
Gender, n (%)	*(n=4,838)*	*(n=4,392)*	*(n=446)*	p<0.001
Female	2487 (51.4%)	2199 (50.1%)	288 (64.6%)	
Male	2351 (48.6%)	2193 (49.9%)	158 (35.4%)	
Age (yrs)	*(n=4,838)*	*(n=4,392)*	*(n=446)*	
Total, mean±SD	48.3±18.5	48.5±18.7	47.0±16.1	p<0.003
20-30	1056 (21.8%)	963 (21.9%)	93 (20.9%)	
31-50	1570 (32.5%)	1400 (31.9%)	170 (38.1%)	
51-70	1479 (30.6%)	1332 (30.3%)	147 (33.0%)	
> 70	733 (15.2%)	697 (15.9%)	36 (8.1%)	
Race, n (%)	*(n=4,838)*	*(n=4,392)*	*(n=446)*	p=0.03
Mexican American	874 (18.1%)	781 (17.8%)	93 (20.9%)	
Other Hispanic	485 (10.0%)	429 (9.8%)	56 (12.6%)	
Non-Hispanic White	2420 (50.0%)	2228 (50.7%)	192 (43.0%)	
Non-Hispanic Black	837 (17.3%)	755 (17.2%)	82 (18.4%)	
Other, including multiracial persons	222 (4.6%)	199 (4.5%)	23 (5.2%)	
Marital Status, n (%)	*(n=4,608)*	*(n=4,176)*	*(n=432)*	p<0.001
Married	2829 (61.4%)	2626 (62.9%)	203 (47.0%)	
Not Married	1779 (38.6%)	1550 (37.1%)	229 (53.0%)	
Education (grade or level of school completed), n (%)	*(n=4,602)*	*(n=4,170)*	*(n=432)*	p<0.001
High school graduate/GED equivalent or below	2256 (49.0%)	1999 (47.9%)	257 (59.5%)	
Some college or AA degree and above	2346 (51.0%)	2171 (52.1%)	175 (40.5%)	
Annual household income, n (%)	*(n=4,389)*	*(n=3,988)*	*(n=401)*	p<0.001
Under $34,999	1911 (43.5%)	1646 (41.3%)	265 (66.1%)	
$35,000 and over	2478 (56.5%)	2342 (58.7%)	136 (33.9%)	

*Depression score based on the results of the Patient Health Questionnaire (PHQ-9), which included 9 questions about depressive symptoms over the past 2 weeks. The total score ranged from 0-27, with a score of ≥ 10 previously validated to be defined as depression.

Based on chi-square analysis. See **Appendix D for output data.

Corrected Nutrient Intake in Those Depressed vs Not Depressed

Table 2 displays the average nutrient intakes (corrected based on caloric intake) between those not depressed and depressed. Using a Mann Whitney U analysis, a significant association was determined that those who were depressed had a lower intake of total folate ($U = 901387$, $z = -2.78$, $p = 0.005$), magnesium ($U = 846742$, $z = -4.72$, $p < 0.001$), total polyunsaturated fatty acids ($U = 880297$, $z = -3.53$, $p < 0.001$), and zinc ($U = 900342$, $z = -2.81$, $p = 0.005$) compared to those who were not depressed. No differences between those who were depressed and not depressed were found for total monounsaturated fatty acids ($U = 950728$, $z = -1.02$, $p = 0.307$) and vitamin B12 ($U = 974489$, $z = -0.18$, $p = 0.861$).

Table 2. Corrected Nutrient Intake Comparison in those Depressed versus Not Depressed

Nutrient	**Not Depressed*** *(n=4,392)*	**Depressed*** *(n=446)*	**P value****
Total Folate (mcg DFE)[1,2]	20.46 (14.86,24.01)[4]	19.57 (14.12,22.56)	p=0.005
Zinc (mg)[3]	0.57 (0.44,0.65)	0.55 (0.41,0.66)	p=0.005
Magnesium (mg)[3]	14.91 (11.81,17.47)	13.95 (11.19,16.21)	p<0.001
Total polyunsaturated fatty acids (gm)[3]	8.15 (6.22,9.74)	7.71 (5.69,9.30)	p<0.001
Total monounsaturated fatty acids (gm)[3]	13.07 (10.79,15.18)	12.77 (10.67,14.79)	p=0.307
Vitamin B12 (mcg)[2]	0.26 (0.15,0.31)	0.28 (0.14,0.32)	p=0.861

[1]Total Folate includes dietary intake of folic acid, food folate, and supplemental folate and is represented as Dietary Folate Equivalent (DFE) (National Institute of Health)
[2]Represented per 1,000 calories
[3]Represented as percent from calories
[4]Values reported as median (IQR: 25th, 75th percentiles)
*Depression score based on the results of the Patient Health Questionnaire (PHQ-9), which included 9 questions about depressive symptoms over the past 2 weeks. The total score ranged from 0-27, with a score of ≥ 10 previously validated to be defined as depression.
Based on Mann Whitney U Test. **See Appendix D for output data.

Corrected Nutrient Intake in Those Depressed vs Not Depressed by Gender

Table 3 displays the average nutrient intakes (corrected based on caloric intake) between those not depressed and depressed by gender. Using a Mann Whitney U analysis, a significant association was found among those who are not depressed in that women consumed more total folate than men ($U = 2260597$, $z = -3.58$, $p<0.001$), men consumed more zinc than women ($U = 2318871$, $z = -2.20$, $p=0.028$), women consumed more magnesium than men ($U = 2049407$, $z = -8.61$, $p<0.001$), more women consumed total polyunsaturated fatty acids than men ($U = 2199527$, $z = -5.04$, $p<0.001$) and men consumed more monounsaturated fatty acids than women ($U = 2284792$, $z = -3.01$, $p=0.003$). Among those who were depressed, women also consumed more total folate than men ($U = 19591$, $z = -2.43$, $p=0.015$), women also consumed more magnesium than men ($U = 20163$, $z = -1.99$, $p=0.047$), and women also consumed more polyunsaturated fatty acids than men ($U = 19917$, $z = -2.18$, $p=0.029$). No difference was found for vitamin B12 intake between depressed or not depressed men and women.

Table 3. Corrected Nutrient Intake Comparison in those Depressed versus Not Depressed by Gender			
Nutrient	**Not Depressed*** *(n=4,392)*	**Depressed*** *(n=446)*	**P value****
Total Folate (mcg DFE)[1,2]			p=0.005
Male	18.41 (14.46,23.43)[4]	16.67 (12.80,21.53)	
Female	19.18 (15.26,24.50)	18.30 (14.65,23.11)	
	p<0.001	p=0.015	
Zinc (mg)[3]			p=0.005
Male	0.54 (0.44,0.66)	0.49 (0.42,0.63)	
Female	0.52 (0.43,0.64)	0.50 (0.41,0.66)	
	p=0.028	p=0.501	
Magnesium (mg)[3]			p<0.001
Male	13.66 (11.39,16.82)	13.00 (10.69,15.03)	
Female	14.86 (12.20,18.15)	13.47 (11.28,16.74)	
	p<0.001	p=0.047	
Total polyunsaturated fatty acids (gm)[3]			p<0.001
Male	7.62 (6.09,9.49)	6.92 (5.46,8.76)	
Female	8.01 (6.39,10.06)	7.56 (5.80,9.64)	
	p<0.001	p=0.029	
Total monounsaturated fatty acids (gm)[3]			p=0.307
Male	13.05 (10.91,15.36)	13.21 (10.69,15.16)	
Female	12.77 (10.67,14.91)	12.93 (10.63,14.74)	
	p=0.003	p=0.473	
Vitamin B12 (mcg)[2]			p=0.861
Male	0.22 (0.15,0.31)	0.21 (0.14,0.30)	
Female	0.22 (0.15,0.31)	0.23 (0.14,0.33)	
	p=0.184	p=0.500	

[1]Total Folate includes dietary intake of folic acid, food folate, and supplemental folate and is represented as Dietary Folate Equivalent (DFE) (National Institute of Health)
[2]Represented per 1,000 calories
[3]Represented as percent from calories
[4]Values reported as median (IQR: 25th, 75th percentiles)
*Depression score based on the results of the Patient Health Questionnaire (PHQ-9), which included 9 questions about depressive symptoms over the past 2 weeks. The total score ranged from 0-27, with a score of ≥ 10 previously validated to be defined as depression.
Based on Mann Whitney U Test. **See Appendix D for output data.

Nutrient Intake Compared to EAR

The average nutrient intakes (not corrected for caloric intake) between those participants not depressed and depressed compared to the EAR is described below in **Table 4**. Participants who reported being depressed consumed less total folate, zinc, magnesium, total polyunsaturated and monounsaturated fatty acids, and vitamin B12 than those who reported not being depressed. When comparing nutrient intake to the EAR, those who were depressed consumed lower than the EAR for total folate 310.8 (237.3,446.1) and magnesium (240.8 (179.3,311.6). All other nutrient intake met or exceeded the EAR for both depressed and not depressed participants.

Table 4. Comparison of Nutrient Intake Vs Estimated Average Requirements (EAR)

Nutrient	EAR per day for >19 years	Not Depressed* *(n=4,392)*	Depressed* *(n=446)*
Total Folate (mcg DFE)[1]	320 (mcg DFE)	366.5 (264.0,500.5)[3]	310.8 (237.3,446.1)
Zinc (mg)	Men: 9.4 mg Women: 6.8 mg	10.3 (7.5,14.1)	9.3 (6.8,12.6)
Magnesium (mg)	Men: 330-350 mg Women: 255-265 mg	275.0 (210.5,357.0)	240.8 (179.3,311.6)
Total polyunsaturated fatty acids (gm)[2]	Up to 10% of total calories**	8.15 (6.22,9.74)	7.71 (5.69,9.30)
Total monounsaturated fatty acids (gm)[2]	Up to 20% of total calories**	13.07 (10.79,15.18)	12.77 (10.67,14.79)
Vitamin B12 (mcg)	2.0 mcg	4.3 (2.7,6.4)	4.0 (2.5,6.0)

[1]Total Folate includes dietary intake of folic acid, food folate, and supplemental folate and is represented as Dietary Folate Equivalent (DFE) (National Institute of Health)
[2]Represented as percent from calories
[3]Values reported as median (IQR: 25th, 75th percentiles)
*Depression score based on the results of the Patient Health Questionnaire (PHQ-9), which included 9 questions about depressive symptoms over the past 2 weeks. The total score ranged from 0-27, with a score of ≥ 10 previously validated to be defined as depression.
**Based on the recommendations by Therapeutic Lifestyle Changes (TLC) (National Center for Chronic Disease Prevention and Health Promotion)
See **Appendix D** for output data.

Nutrient Intake Compared to EAR by Gender

Table 5 displays the average nutrient intakes (not corrected for caloric intake) between those participants not depressed and depressed compared to the EAR by gender. Participants who reported being depressed consumed less total folate, zinc, magnesium, total polyunsaturated fatty acids, and vitamin B12 than those who reported not being depressed. For magnesium, both depressed and not depressed groups regardless of gender did not meet the EAR (310.5 (233.8,397.3) for those not depressed and 285.8 (213.1,375.5) for those depressed compared to 330-350 mg recommended intake for males; 244 (192.5,313.5) for those not depressed and 220.8 (170.0,279.9) for those not depressed compared to 255-265 mg recommended intake for females). Total folate EAR were not met for females who reported being depressed (298.3 (222.6,397.9 compared to 320 mcg DFE recommended intake for females). All other nutrient intake met or exceeded the EAR for both depressed and not depressed participants in both male and female groups.

Table 5. Comparison of Nutrient Intake Vs Estimated Average Requirements (EAR) by Gender			
Nutrient	**EAR per day for >19 years**	**Not Depressed*** *(n=4,392)*	**Depressed*** *(n=446)*
Total Folate (mcg DFE)[1]			
Male	320 (mcg DFE)	423 (301.5,570.5)[3]	346.5 (255.3,514.0)
Female	320 (mcg DFE)	325.5 (238.0,429.5)	298.3 (222.6,397.9)
Zinc (mg)			
Male	9.4 mg	12.3 (9.0,16.5)	11.3 (7.9,14.1)
Female	6.8 mg	8.7 (6.7,11.6)	8.5 (6.3,11.3)
Magnesium (mg)			
Male	330-350 mg	310.5 (233.8,397.3)	285.8 (213.1,375.5)
Female	255-265 mg	244 (192.5,313.5)	220.8 (170.0, 279.9)
Total polyunsaturated fatty acids (gm)[2]			
Male	Up to 10% of total calories	7.6 (6.1,9.5)	6.9 (5.5,8.8)
Female	Up to 10% of total calories	8.0 (6.4,10.1)	7.6 (5.8,9.6)
Total monounsaturated fatty acids (gm)[2]			
Male	Up to 20% of total calories**	13.1 (10.9,15.4)	13.2 (10.7,15.2)
Female	Up to 20% of total calories**	12.8 (10.7,14.9)	12.9 (10.6,14.7)
Vitamin B12 (mcg)			
Male	2.0 mcg	5.0 (3.3,7.4)	4.5 (3.0,6.7)
Female	2.0 mcg	3.6 (2.4,5.4)	3.5 (2.4,5.5)

[1]Total Folate includes dietary intake of folic acid, food folate, and supplemental folate and is represented as Dietary Folate Equivalent (DFE) (National Institute of Health)
[2]Represented as percent from calories
[3]Values reported as median (IQR: 25th, 75th percentiles)
*Depression score based on the results of the Patient Health Questionnaire (PHQ-9), which included 9 questions about depressive symptoms over the past 2 weeks. The total score ranged from 0-27, with a score of ≥ 10 previously validated to be defined as depression.
**Based on the recommendations by Therapeutic Lifestyle Changes (TLC) (National Center for Chronic Disease Prevention and Health Promotion)
See **Appendix D** for output data.

Discussion

In this cross-sectional study, lower intakes of total folate, magnesium, zinc, and polyunsaturated fatty acids were found in those who were depressed compared to those who were not depressed. Furthermore, women had a significantly higher intake of total folate, magnesium, and polyunsaturated fatty acids when compared to men in both depressed and not depressed groups.

In a cross sectional study by Maserejian et al. (2012) examining the relationship between zinc intake and depression symptoms, the researchers found that zinc intake was associated with depressive symptoms only among women and not men (Maserejian et al, 2012). In the current study, a difference was found in zinc intake between those with and without depression. Women were found to have a significantly lower intake of zinc compared to men in those without depression and women were found to consume more zinc than men in those with depression (although not significant). This latter result contrasts with the study by Maserjein et al. (2012) that found women with a lower zinc intake were more likely to exhibit depressive symptoms. The researchers did however find similar demographic characteristics results to this study where depression was more common in those who were of Hispanic race and of lower socioeconomic status. The authors of the study suggested zinc supplementation may be beneficial in conjunction with other depression treatments (Maserejian et al, 2012).

In a similarly designed study conducted by Beyoun et al. (2010), researchers used 2005-2006 NHANES data to examine the relationship between depressive symptoms and serum vitamin B-12, folate, and homocysteine levels (Beydoun et al, 2013). The authors found similar results to the present study in that more women reported being depressed

than men. Also, those who reported being depressed were more likely to be unmarried, less educated, and of lower socioeconomic status. The authors also found that an inverse relationship existed between depressive symptoms and serum folate levels, particularly in women, but did not find a relationship between vitamin B-12 and depression (Beydoun et al, 2013). A significant relationship between folate intake and depression was also found in the present study; however, women had significantly higher folate intakes compared to men. The present study also found no association between depression and vitamin B-12.

There has been a lot of research on omega-3 polyunsaturated fatty acids recently that has shown a positive interaction with depression (Hoffmire et al, 2013). Previous research has found that low levels of omega-3 polyunsaturated fatty acids are present in depressed patients and omega-3 polyunsaturated fatty acid supplementation may reduce depressive symptoms. Hoffmire et al. (2013) conducted a study examining the relationship between fish consumption and the severity of depressive symptoms. Researchers found that consuming any omega-3 polyunsaturated fatty acids was linked to a smaller amount of depressive symptoms (Hoffmire et al, 2013). Similar results were found in the present study where those who reported being not depressed consumed significantly more total polyunsaturated fatty acids compared to those who were depressed.

Davidson et al. (2012) looked at the relationship between various nutrients from food sources in participants with diagnosed mood disorders. These researchers found a strong correlation between psychological function and dietary magnesium and zinc in that those with higher scores had higher intakes of magnesium and zinc (Davidson et al, 2012). The current study found similar results in that those without depression had a

higher intake of magnesium compared to those without depression. Potential explanations of why higher nutrient intakes may affect depression include that foods high in these nutrients may exhibit more anti-inflammatory effects, contain greater antioxidant values that are protective, and/or contribute to neurotransmitters like serotonin (specifically for folate and vitamin B-12) (Davidson et al, 2012).

Based on the results of the current study, those who are depressed are more likely to consume a diet that is lower in total folate, magnesium, zinc, and polyunsaturated fatty acids. Also, those who reported being depressed were more likely to be female, middle aged, not married, received lower education, and make a lower income. There are many possible explanations for these results including limited availability, lack of adorability, or knowledge to consume foods that are abundant in the studied micro and macronutrients. The exact mechanism of how specific macro and micronutrients affect depression or the extent of its influence is still unknown. The current study and other research has shown a need for future nutrition interventions that may be beneficial in those that are showing depressive symptoms, particularly in those groups that are more likely to become depressed. More research needs to be conducted that examines dietary influence on mental health status so specific interventions to the ever-growing problem can be created.

Limitations of this study include that the cross sectional nature of the study does not provide results that signify causal relationships, therefore only associations between the various studied micronutrient intakes and depression can be made. Also, other confounding variables not controlled for could have affected the results. Sample weights were not used; therefore sampling errors were not accounted for. Another limitation is the

use of 24 hour recalls, even though two averaged recalls were used to better represent normal intake. The 24 hour recalls may not provide an accurate representation of a person's actual diet due to high reporter bias and may represent short-term dietary intake and may not be reflective of long term intake, of which may more directly contribute to depression.

Strengths of this study include the use of a nationally representative and racially diverse data set, and large sample size. Additional research needs to be conducted to determine whether a causal relationship exists between micronutrient intake and depression prevalence. Future research should take into consideration various dietary and demographic characteristics differences that may impact nutrient intake. Understanding the relationship between diet and mental health status would be useful and may help generate alternate forms of treatment such as diet modification or nutrient supplementations.

Conclusion

In conclusion, the results of this study suggest that there may be a link between nutrient intake, specifically folate, magnesium, zinc, and polyunsaturated fatty acids, and mental health status. Depression is a common psychological disorder and can lead to the development of chronic diseases. Nutrition intervention, in conjunction with other therapies, may be beneficial to mental health status and reduce other comorbidities from developing. Additional research needs to be conducted in a larger, more diverse population that examines whether as causal relationship exists between micro and macronutrient intake and depression prevalence.

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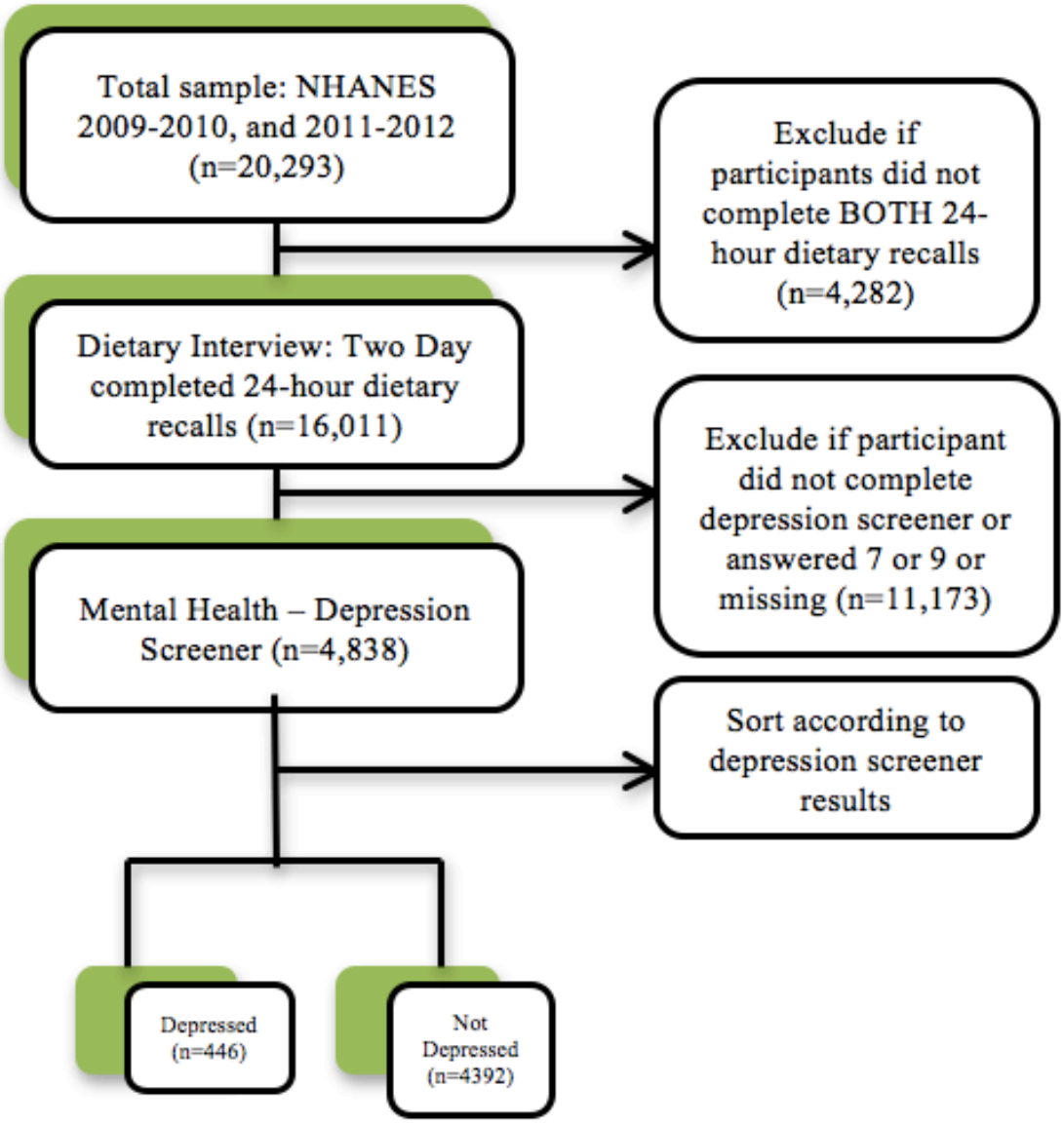
Appendix A: Population Schematic



Appendix B: Variable Definitions and Calculations

Gender
1 =Male
2 = Female

Age
1 = 20-30 years
2 = 31-50 years
3 = 51-70 years
4 = > 70 years

Education
1 = High school graduate/GED equivalent or below
2 = Some college or AA degree and above

Race
1 = Mexican American
2 = Other Hispanic
3 = Non-Hispanic White
4 = Non-Hispanic Black
5 = Other, including multiracial persons

Marital Status
1 = Married (Married/Living with Partner)
2 = Not Married (Widowed/Divorced/Separated/Never Married)

Annual Household Income
1 = under $34,999
2 = $35,000 and over

Calculations:

Nutrient x total calories/1000 = per 1,000 calories

Nutrient x total calories/100 = % from calories

Appendix C: Demographic Table with Expanded Variables

Table 6: Demographic Characteristics of NHANES 2009-2010 and 2011-2012 Participants above Age 18				
Demographic Variable	**Total**	**Not Depressed***	**Depressed***	**P value****
Gender, n (%)	*(n=4,838)*	*(n=4,392)*	*(n=446)*	p<0.001
Female	2487 (51.4%)	2199 (50.1%)	288 (64.6%)	
Male	2351 (48.6%)	2193 (49.9%)	158 (35.4%)	
Age (yrs)	*(n=4,838)*	*(n=4,392)*	*(n=446)*	
Total, mean±SD	48.3±18.5	48.5±18.7	47.0±16.1	p=0.007
Race, n (%)	*(n=4,838)*	*(n=4,392)*	*(n=446)*	p=0.03
Mexican American	874 (18.1%)	781 (17.8%)	93 (20.9%)	
Other Hispanic	485 (10.0%)	429 (9.8%)	56 (12.6%)	
Non-Hispanic White	2420 (50.0%)	2228 (50.7%)	192 (43.0%)	
Non-Hispanic Black	837 (17.3%)	755 (17.2%)	82 (18.4%)	
Other, including multiracial persons	222 (4.6%)	199 (4.5%)	23 (5.2%)	
Marital Status, n (%)	*(n=4,608)*	*(n=4,176)*	*(n=432)*	p<0.001
Married	2461 (53.4%)	2300 (55.1%)	161 (37.3%)	
Widowed	377 (8.2%)	328 (7.9%)	49 (11.3%)	
Divorced	494 (10.7%)	434 (10.4%)	60 (13.9%)	
Separated	137 (3.0%)	107 (2.6%)	30 (6.9%)	
Never Married	771 (16.7%)	681 (16.3%)	90 (20.8%)	
Living with Partner	368 (8.0%)	326 (7.8%)	42 (9.7%)	
Education (grade or level of school completed), n (%)	*(n=4,602)*	*(n=4,170)*	*(n=432)*	p<0.001
Less than 9th grade	496 (10.8%)	432 (10.4%)	64 (14.8%)	
9-11th grade (Includes 12th grade with no diploma)	700 (15.2%)	599 (14.4%)	101 (23.4%)	
High school graduate/GED or equivalent	1060 (23.0%)	968 (23.2%)	92 (21.3%)	
Same college or AA degree	1339 (29.1%)	1205 (28.9%)	134 (31.0%)	
College graduate or above	1007 (21.9%)	966 (23.2%)	41 (9.5%)	
Annual household income, n (%)	*(n=4,389)*	*(n=3,988)*	*(n=401)*	p<0.001
Under $19,999	927 (21.1%)	768 (19.3%)	159 (39.7%)	
$20,000 to $34,999	984 (22.4%)	878 (22.0%)	106 (26.4%)	
$35,000 to $54,999	825 (18.8%)	766 (19.2%)	59 (14.7%)	
$55,000 to $74,999	502 (11.4%)	482 (12.1%)	20 (5.0%)	
$75,000 to $99,999	475 (10.8%)	447 (11.2%)	28 (7.0%)	
$100,000 and over	676 (15.4%)	647 (16.2%)	29 (7.2%)	

*Depression score based on the results of the Patient Health Questionnaire (PHQ-9), which included 9 questions about depressive symptoms over the past 2 weeks. The total score ranged from 0-27, with a score of ≥ 10 previously validated to be defined as depression.
Based on chi-square analysis. See **Appendix D for output data.

Appendix D: Output Files

Normality Data: Distribution Data Output.spv

Table 1: Table 1 ChiSquareAnalysis.spv & Table 1 ChiSquareAnalysis#2.spv

Table 2: Table 2 Output.spv

Table 3: Table 3 and Table 5 Output.spv

Table 4: Table 4 Output.spv

Table 5: Table 3 and Table 5 Output.spv

Table 6: Table 6 Output.spv & Table 6 Output #2.spv