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The association of dietary inflammatory potential with depression and mental well-being among U.S. adults

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Abstract

Current treatment for depression is not considered effective among all cases and, thus far, nutritional protocols are minimal within depression treatment guidelines. Recently, there has been increasing interest in a possible protective and modifiable role of diet in common mental disorders, including depression, due to pro- and anti-inflammatory properties of nutrients. This study aims to investigate whether the Dietary Inflammatory Index (DII), designed to estimate the inflammatory potential of diet, is associated with depression and other measures of mental health. In a representative sample of U.S. adults (>20 years of age, N=11,592), the distribution of DII score is assessed. Multivariate logistic regression models determine the association between DII quintile and depression. Associations of DII quintile with frequent distress and frequent anxiety are also evaluated. In fully adjusted models, higher DII score is associated with over a twofold higher odds of depression (OR (95% CI) = 2.26 (1.60, 3.20) for highest vs. lowest quintile, Type III *p*-value = <0.0001). DII score is also associated with higher odds of frequent distress (OR (95% CI) = 1.81 (1.20, 2.71) for highest vs. lowest quintile, Type III *p*-value = 0.0167). This association was not significant for frequent anxiety (Type III *p*-value = 0.12). Results of this study indicate that dietary inflammatory potential is associated with depression. These results support existing hypotheses that inflammatory pathways play a role in the etiology of depression. Further research examining the underlying biological and cellular mechanisms of depression is warranted.

Introduction

Depression is a leading cause of disease burden worldwide.[1] Not only is depression an economically costly disease,[2] but it also has a high comorbidity with several chronic conditions.[3] Additional concern arises since current pharmaco- and psychotherapies do not provide complete remission among 20 to 50% of depression cases.[4] Thus, it is paramount that researchers continue to investigate the underlying neurobiology of depression and

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Conflict of Interest

The authors declare there is no conflict of interest.

identify treatment alternatives. Recently, there has been increasing interest in a possible protective and modifiable role of nutrition in common mental disorders, including depression, due to its influence on inflammatory pathways.[5] Even though the use of nutritional protocols in the treatment and prevention of most other chronic conditions is common,[6] further evidence is required to support inclusion in current depressive disorder and other mental health treatment guidelines.[7,8]

Major Depressive Disorder (MDD), also known as clinical depression, is among the most common psychiatric illnesses seen in a primary care setting, with a lifetime prevalence of 16.2%.[9] The DSM-5, a diagnostic manual, characterizes depression by symptoms of sleep disorder, suicidality, or appetite disorder; an energy, concentration, or interest deficit; agitation; or feelings of worthlessness, hopelessness, or regret.[10] In a recent study, only 28.7% that screened positive for depression in the United States reported receiving any treatment.[11] It is recommended that those with more severe or persistent cases of depression be treated with a combination of psychotherapy and antidepressants. However, when comparing whether the combination of pharmacological treatments and psychotherapy is more effective than pharmacotherapy alone, only a small benefit is observed.[12] Antidepressants are not considered an effective treatment option for milder forms of depression,[13] and the efficacy of alternative treatment options for mild depression is variable.[14–16] Given limitations in existing treatment options for depression patients, there is a need to further understand the underlying neurobiology of depression and identify alternative treatment strategies. While several theories abound, there is much evidence to support that chronic inflammation influences the development of depression and, more importantly, may provide an opportunity for intervention.

The pathogenic host defense theory[17] supports the link between inflammation and depression. It states that initial evolutionary pressures led to a genomic bias for inflammation. The inflammatory response includes a series of immunological and behavioral responses, which have an important role in promoting healing following human contact with pathogens, predators, or conspecific rivals. This is in line with the theory of sickness behavior.[18,19] While this host defense is necessary for survival, long term inflammation can lead to chronic inflammation and has potential to alter neurobiology leading to depression. Chronic inflammation has a number of unique features.[20] It is a longer-term phenomenon that can develop over the lifespan. Chronic inflammation is also systemic, and the magnitude of the inflammatory response is lower than other types of inflammation (e.g. sepsis). Chronic inflammation is already recognized as an important factor in the development of several chronic diseases, including cancer,[21] cardiovascular disease,[22] and type II diabetes.[23] Compelling evidence suggests that persistent inflammation can also result in neurodegenerative and neuropsychiatric diseases, including depression.[21,24,25] Inflammatory cytokines are observed to cross the blood-brain barrier and interact with a number of pathophysiologic mechanisms associated with depression, including neural plasticity, neurotransmitter metabolism, and regulation of the hypothalamic-pituitary-adrenal (HPA) axis.[26] Furthermore, studies have demonstrated that exogenous infusion of cytokines can lead to depressive-like symptoms and behaviors.[27,28]

Diet and nutrition is one proposed strategy for preventing depression and ameliorating depressive symptoms, in part due to the ability of specific food parameters to influence inflammatory pathways.[5] For example, consumption of *n*-3 fatty acids decreases production of arachidonic acid-derived eicosanoids, which regulate immunological functions associated with inflammation. *n*-3 fatty acid consumption also decreases production of pro-inflammatory cytokines TNF, IL-1, and IL-6.[29] Furthermore, diet is a behavioral and environmental exposure that individuals are exposed to daily, indicating the potential to influence chronic inflammatory pathways.

Thus far, few population-based epidemiologic studies have examined the association between mental health outcomes and the degree to which diet induces or suppresses inflammatory pathways, or more simply, dietary inflammatory potential. This approach differs from other nutritional epidemiology studies that assess single nutrients in isolation, which fail to recognize the complex interactions between foods that may impact inflammation differently.[30] Dietary inflammatory potential also differs from general dietary patterns (e.g. Mediterranean diet, Western diet), which group individuals based on their consumption of certain foods in combination but are not characterized by their potential to influence underlying biological mechanisms.[31] To date, only three previous studies have investigated the association between inflammatory potential of diet and depression.[32–34] These studies observed a positive association between dietary inflammatory potential and depression, and the use of longitudinal cohorts in their analyses is an advantage. However, a weakness of existing studies is that they have limited generalizability since their study populations are restricted to university graduates, middle-aged women, or female nurses. Therefore, the aim of this study is to evaluate whether the Dietary Inflammatory Index (DII), designed to estimate the inflammatory potential of diet,[35] is associated with depression and other measures of mental well-being in a representative sample of adults in the US.

Methods

Data for this cross-sectional study came from the continuous National Health and Nutrition Examination Survey (NHANES 2007–2012). NHANES includes a complex, multistage probability sampling design to select a sample representative of the U.S. population. Non-Hispanic Black and Hispanic persons, those at or below 130% of the federal poverty level, and persons aged 80 or older were oversampled.[36,37] Approval for the NHANES survey and data collection was provided by the National Center for Health Statistics (NCHS) Research Ethics Review Board (ERB). NHANES' participation included two components: an in-home interview and a health examination. Signed consent for both was obtained from all participants during the in-home interview.[38] Additionally, statistically defined or random subsamples of the NHANES interviewed or examined sample were asked to participate in supplemental survey components (including nutrition and dietary and mental health components).[36,37] This study was determined to be exempt from institutional review board (IRB) by the University of Madison Health Sciences IRB. Analyses were limited to adults > 20 years of age as defined by NHANES.[36] Due to truncation in the NHANES data, persons aged 80 years or older were classified as a single age group. Statistical analyses were limited to those with non-missing information for variables of interest. No other sample restrictions were made.

DII calculation

Details regarding the DII development and scoring are provided elsewhere.[35] Briefly, the DII is based on a literature review of 1,943 peer-reviewed articles that assessed the role of food parameters on inflammatory markers: IL-1β, IL-4, IL-6, IL-10, TNF-α, and C reactive protein (CRP). The DII assigns food parameters an inflammatory effect score based on the weighted number of publications determined by study characteristics, and whether the association between a food parameter and biological markers is pro- or anti-inflammatory. A world database of food parameter consumption is used to standardize specific inflammatory effect scores. DII scores across food parameters are then summed to create an 'overall DII score'.

Quintiles of DII score were calculated using the entire NHANES adult (>20 years) cohort with non-missing data for each of the food parameters in both 24 h dietary recalls. NHANES dietary intake data was measured using two 24 h dietary recalls collected first in-person during the medical examination and then via telephone 3 to 10 days later. Average consumption was estimated as the mean of these two values for each food parameter. Food parameters used to estimate the DII for this study were total calories; carbohydrates; fat; protein; alcohol; caffeine; fiber; cholesterol; saturated, monounsaturated, and polyunsaturated fatty acids; *n*-3 and *n*-6 polyunsaturated fatty acids; niacin; riboflavin; thiamin; vitamins A, B6, B12, C, D, E; β-carotene; iron; magnesium; selenium; zinc; and folate.

Depression and Mental Well-being

Depression was measured using the Patient Health Questionnaire (PHQ-9), a nine-item screener that assesses the frequency of depressive symptoms over the previous two weeks.[39] Responses to each item were gathered via Computer Assisted Personal Interviews (CAPI) and scored 0–3 for a total possible score of 27. A score of 10 or above was used to define cases of depression, as recommended by Kroenke & Spitzer (2002), with a sensitivity and specificity of 88% to detect cases of major depression.

Measures of frequent distress and anxiety were derived from the Health-Related Quality of Life (HRQOL) survey.[40,41] Frequent distress was defined as reporting poor mental health, including stress, depression, and problems with emotions, >14 days out of the past 30. Frequent anxiety was defined as reporting feeling worried, tense, or anxious > 14 days out of the past 30.

Covariates

Covariates included sociodemographics, lifestyle and health behaviors, as well as co-morbid health conditions. Sociodemographic factors include age group, sex, the ratio of family income to federal poverty level, employment status, health insurance status, education, and marital status. Lifestyle covariates included body mass index, smoking status, self-report of vitamin supplement use, total daily energy intake (kcal, averaged from dietary recall 1 and 2), self-report menopause status (among women), self-report physical activity metabolic equivalent (MET) minutes per week score, and self-report sedentary behavior. Physical activity was measured using a questionnaire based on the Global Physical Activity

Questionnaire (GPAQ)[42] that asks about average weekly minutes of moderate and vigorous recreational and work activity, as well as walking or biking to work. Each minute of walking or bicycling for transportation or moderate work-related or leisure-time physical activity received a MET score of 4.0. Each minute of vigorous work-related or leisure-time physical activity received a MET score of 8.0. The total MET score across all domains was summed to create a MET-min/week score. Sedentary behavior was measured using NHANES survey cycle weighted population distribution tertiles of minutes per day spent sitting based on self-report estimates. Finally, statistical analyses also accounted for self-report history (yes, no) of comorbidity diagnosis including cardiovascular disease, diabetes, hypertension, and dyslipidemia, respiratory illness, or any type of cancer.

Statistical Analyses

All analyses were conducted using SAS® (version 9.4, Cary, NC) survey design procedures to account for the effects of sampling design stratification and clustering procedures. Six-year sampling weights were calculated by multiplying the sample weights provided by NHANES for two-year cycles by one-third. Applying sample weights accounts for (a) unequal probabilities of selection across NHANES participants, (b) non-response specific to dietary recalls 1 and 2, and (c) the proportion of weekend-weekday combinations of dietary recalls 1 and 2.[36,43]

Chi-Square (χ^2) or Type III *F*-tests were used to compare population characteristics by DII quintile. Logistic regression was used to compute odds ratios (ORs) and 95% confidence intervals (95% CI) for depression across DII quintiles. To assess effect modification, interactions of DII quintile with sex and poverty-income ratio category regarding depression were tested separately.

Finally, we also addressed concerns of missing data. Among the 14,029 adult participants in the 2007 to 2012 NHANES interviews, examinations, and two 24 h dietary recalls, 11,592 (83% of the eligible sample) had non-missing information for variables of interest. As a sensitivity analysis, we dropped poverty-income ratio from analyses since it was responsible for the largest proportion of missing cases.[44] This increased our sample size to 12,584 (90% of the eligible sample).

Results

The range of DII score in NHANES was −5.29 to 4.71. Median scores of DII quintiles were −2.78, −1.45, −0.33, 0.82, and 2.43, where values >0 indicate a pro-inflammatory score and those <0 indicate an anti-inflammatory score. Dietary inflammatory potential varies significantly by population demographics (Table 1). Individuals that reported consumption of more pro-inflammatory diets tended to fare worse socioeconomically. Among those in the highest DII quintile (Q5, most pro-inflammatory) 25.1% fell below the federal poverty line compared to those that fell in the lowest DII quintile where only 9.8% fell below the federal poverty line. Those in the highest DII quintile also fared worse compared to the lowest DII quintile regarding education (27.9% have <high school education vs. 9.0%), employment (49.3% employed vs. 68.7% employed), smoking status (36.0% current smokers vs. 13.3%), and health insurance status (51.9% privately insured vs. 72.7%). Distribution of DII also

varied by race and ethnicity. A greater percentage of individuals that identified as Non-Hispanic black fell into the highest compared to lowest quintile of DII (17.0% vs. 6.8%). The differences among other racial/ethnic groups were not as large. Similarly, females, current smokers, and individuals with BMI >30.0 kg/m^2 had a larger proportion of individuals in the highest compared to lowest quintile. Alternatively, those in the higher DII quintiles had lower supplement use and total energy intake than those in lower quintiles. The proportion of respondents with a health history of co-morbid conditions including hyperlipidemia, diabetes, cardiovascular disease, or respiratory disease also increased by DII quintile. For measures of mental health, as DII quintile increased, so did the proportion of those reporting depression, frequent mental distress, and frequent anxiety.

Odds ratios (OR) and 95% confidence intervals (CI) of depression by DII quintile are provided in Table 2. A higher DII score was associated with over a two-fold higher odds of depression in fully adjusted models (OR (95% CI) = 2.26 (1.60, 3.20) for highest vs. lowest quintile, Type III *p*-value < 0.0001). When testing for interactions, the association between DII quintile and odds of depression was not significantly modified by sex (Type III *p*-value =0.71) or poverty-income ratio category (Type III *p*-value =0.43).

Table 3 shows results from the secondary analysis evaluating the odds of frequent distress and frequent anxiety days by DII quintile. In fully adjusted models, a higher DII score was associated with higher odds of frequent distress (OR (95% CI) = 1.81 (1.20, 2.71) for highest vs. lowest quintile, Type III *p*-value = 0.0167). This association was not significant for frequent anxiety (Type III *p*-value = 0.12).

When we dropped poverty income ratio from our analyses as a sensitivity analysis to addressing missing observations, this significance of our results did not change and the change in ORs for the association of DII quintile with mental health measures was <10% (data not shown).

Discussion

Using a large, population-based sample from NHANES, results of this study indicate that dietary inflammatory potential, measured by DII score, is associated with higher odds of depression even after accounting for a number of sociodemographic and lifestyle factors and comorbidities. In addition, these results support the hypothesis that chronic stimulation of inflammatory pathways plays a role in the development of depression,[45] and diet has the potential to influence these mechanisms.

Our findings are consistent with previous studies that evaluated the association between inflammatory potential of diet and depression. Sánchez-Villegas *et al.* investigated the relationship between dietary inflammatory potential and risk of depression in a prospective cohort of Spanish university graduates.[32] Results indicated that those within the highest DII quintile have a 1.47 (1.17, 1.85) times higher risk of depression compared to the lowest DII quintile. Similarly, Shivappa and colleagues observed a lower risk of developing depression among women with lower DII scores using data from the Australian Longitudinal Study on Women's Health.[33] Previously, Lucas *et al.* used reduced-rank regression to identify an

inflammatory dietary pattern associated with inflammatory markers in the Nurses' Health Study.[34] Women with the most pro-inflammatory dietary pattern had a 1.41 (1.22, 1.63) times higher risk of depression than those with the least pro-inflammatory dietary pattern.

The median DII quintile values observed in NHANES differ from those in the Seguimiento University of Navarra (SUN) cohort of Sánchez-Villegas *et al.* (2015). For example, the median DII score for the most pro-inflammatory quintile in NHANES is 2.39 compared to 0.66 for the same quintile in the SUN cohort, suggesting a greater inflammatory potential among Western diets compared to Mediterranean diets. The range of DII scores observed in NHANES (−5.29 to 4.71) is comparable to other American and European population-based studies, including White and Hispanic adults in the Seasonal Variation in Blood Lipids Study (5.3 to 4.3),[46] a cohort of British adults in Whitehall II (−3.35 to 4.23),[47] and adults in the Observation of Cardiovascular Risk Factors in Luxembourg study (4.02 to 4.00).[48] The range of possible DII score values do not exceed −8.87 to 7.98.[35]

It is also interesting to note that as DII score and dietary inflammatory potential increase, mean daily energy intake tends to decrease. Previous studies indicate that this is likely due to the phenomenon that decreasing levels of energy intake is associated with a lower variety of foods consumed.[33] Thus, the lower intake of total kilocalories in higher DII quintiles translates to a lower consumption of anti-inflammatory nutrients.

Regarding other measures of mental well-being as assessed by the HRQOL, results indicate that the odds of frequent distress due to dietary inflammatory potential is lower than the odds of depression due to dietary inflammatory potential. Dietary inflammatory potential was also not associated with the odds of frequent anxiety. Previous studies have only looked at depression or depressive symptoms as an outcome and not considered other measures of mental health. Unlike, the PHQ-9, the HRQOL instrument is not designed to identify clinical cases of depression as defined by DSM-5 criteria,[10] but instead is meant to track population trends in the burden of chronic disease and disability.[40] Results using the PHQ-9 cut-points corresponding to major depression are consistent with previous studies that indicate the association between circulating levels of inflammatory markers are less strongly associated with milder forms of depression,[49,50] likely being included in measures of frequent distress and anxiety and may explain observed weaker and null findings.

Additionally, while the association between inflammation and depression is well established, there is less evidence and inconsistent results regarding the association between inflammation and anxiety-based disorders.[51] Anxiety and depressive disorders have a high comorbidity,[52] and evidence indicates that these disorders share genetic determinants as well as underlying neurobiological mechanisms.[51,53–55] However, manifestations of these disorders differ. Anxiety disorders are characterized by motor tension, fatigue, and excessive and senseless worries. On the other hand, symptoms of depression include lack of concentration, low self-esteem, and negative thinking. It is hypothesized that environmental factors may determine variation in the development of mental health disorders.[56] Underlying pathophysiologic mechanisms for anxiety and depressive disorders must be further elucidated in order to determine whether inflammatory processes and nutritional factors affect the development of these disorders differently.

Limitations of this study include measurement of dietary inflammatory potential using data from dietary recalls. While the results of two 24 h dietary recalls taken at different time points were averaged when calculating individual DII score to minimize within-individual variance, it is acknowledged that this approach is less precise than using daily diary records.[57] It is well established that 24 h dietary recalls are an imperfect measure when assessing diet as they are prone to differential underreporting across population subgroups.[58] Another limitation of this study was the use of self-reported estimates of physical activity and sendentary behavior, which are considered less reliable and less accurate compared to direct measurement (e.g. accelerometry).[59] Furthermore, there is also the possibility that an inability to adjust for unmeasured factors may explain the observed association between dietary inflammatory potential and depression.

Finally, due to the cross-sectional nature of NHANES it is not possible to determine a causal relationship between dietary inflammatory potential and depression, and necessitates caution when interpreting results. Studies indicate that emotionally distressed and depressed individuals may self-medicate by increasing their consumption of sweet carbohydrates and fat rich foods.[60] Increased consumption of carbohydrates and saturated fats would result in a higher DII score. This suggests that observed associations in our analyses could partially be due to reverse causation. However, previous prospective studies establishing temporal associations between dietary inflammatory potential and depression with repeated measures supports the conclusion that a causal relationship may exist.[32–34]

Given how little is known regarding the underlying neurobiology of depression, additional studies that investigate the temporal biological processes that mediate the association between dietary inflammatory potential and depression as well as other indicators of mental well-being should be prioritized. For example, recent studies demonstrate that gut microbiota, which are influenced by diet, can trigger neural pathways and the central nervous system.[61] Further research examining the biological and cellular mechanisms underlying these associations is warranted.

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Highlights

- Current treatment for depression is not considered effective among a large proportion of cases.
- Diet may be a modifiable behavior that influences mental health via chronic inflammation.
- Results indicate that dietary inflammatory potential (DIP) is associated with depression.
- Evidence also indicates that DIP is associated with frequent mental distress.
- Investigation of biological processes that mediate DIP and depression should be prioritized.

Table 1

Demographic characteristics by Dietary Inflammatory Index Score (DII), NHANES 2007–2012[1]

	Total sample	Quintile of DII score[1]					
	N=11,592	Q1 (N=2,511)	Q2 (N=2,460)	Q3 (N=2,296)	Q4 (N=2,144)	Q5 (N=2,181)	*P* trend[†]
Age (%)							0.0033
20 to <40	36.5	35.8	33.5	36.9	35.9	36.5	
40 to <65	46.7	48.9	48.8	47.2	45.9	46.7	
65 and older	16.8	15.3	17.7	15.9	18.2	16.8	
Male (%)	48.0	65.4	51.6	44.1	37.9	31.9	<.0001
Race/ethnicity (%)							<.0001
Non-Hispanic White	70.9	75.4	73.9	69.0	68.6	64.6	
Non-Hispanic Black	10.7	6.8	8.6	10.9	12.9	17.0	
Hispanic	12.7	11.0	12.4	14.4	12.7	13.6	
Other or Multi-race/ethnicity	5.7	6.8	5.1	5.7	5.8	4.8	
Poverty-Income Ratio (%)							<.0001
<1.00	14.6	9.8	11.4	13.9	16.4	25.1	
1.00 to <4.00	47.5	39.6	45.1	49.4	55.8	52.0	
4.00 and above	37.9	50.6	43.5	36.7	27.8	22.9	
Education (%)							<.0001
<High school	16.5	9.0	13.8	17.0	19.2	27.9	
High school or equivalent	22.7	17.1	20.7	22.2	27.9	28.8	
Associates degree or some college	30.9	29.0	31.9	31.1	32.8	30.1	
College grad and above	30.0	44.8	33.5	29.7	20.1	13.3	
Marital status (%)							<.0001
Married or living with partner	63.1	67.4	67.6	63.9	57.9	55.0	
Never married	19.0	18.3	16.3	19.4	20.2	22.2	
Widowed, divorced, or separated	17.8	14.3	16.1	16.7	21.9	22.8	
Employment status (%)							<.0001
Employed	61.6	68.7	63.2	65.1	56.8	49.3	
Not working	35.0	27.7	33.9	31.4	39.9	46.9	
Not working and looking for work	3.4	3.7	2.9	3.5	3.3	3.7	

	Total sample	Quintile of DII score[1]					
	N=11,592	Q1 (N=2,511)	Q2 (N=2,460)	Q3 (N=2,296)	Q4 (N=2,144)	Q5 (N=2,181)	*P* trend[†]
Smoking status (%)							<.0001
Never	54.8	57.6	55.5	58.3	54.1	46.2	
Former	24.8	29.2	28.1	22.5	23.6	17.9	
Current	20.3	13.3	16.4	19.2	22.3	36.0	
Health insurance status (%)							<.0001
Private	64.3	72.7	67.7	65.5	58.3	51.9	
Subsidized	17.1	11.9	16.3	16.4	19.9	24.3	
Uninsured	18.5	15.4	16.1	18.0	21.8	23.8	
Menopause[‡] (%)	46.2	45.2	48.2	47.2	46.3	44.0	0.6699
Supplement use (%)	52.7	62.5	57.6	49.6	48.1	39.6	<.0001
Body Mass Index (%)							<.0001
<18.5 (kg/m2)	1.4	1.4	1.1	1.2	1.6	1.8	
18.5 to <25.0 (kg/m2)	29.0	32.5	29.1	28.0	27.4	26.7	
25.0 to <30.0 (kg/m2)	33.5	36.3	35.5	33.1	30.6	30.3	
30.0 and above (kg/m2)	36.0	29.8	34.4	37.8	40.4	41.2	
Physical Activity, mean (±95% CI), MET-min/week	3543 (±180)	3897 (±611)	3688 (±572)	3530 (±548)	3302 (±540)	3072 (±462)	0.033
Sedentary time[§] (%)							0.0034
Low	31.9	30.6	30.6	33.3	33.3	32.5	
Medium	34.9	31.8	35.7	37.0	34.1	36.6	
High	33.2	37.5	33.6	29.7	32.6	30.9	
Total energy intake, mean (±95% CI), kcal/day	2105 (±27)	2719 (±70)	2281 (±54)	2018 (±57)	1743 (±56)	1409 (±43)	<.0001
Comorbidities							
Any comorbidity	59.3	59.4	59.8	58.2	58.2	61.2	0.7173
Hypertension[¶] (%)	30.8	28.5	31.0	30.3	33.5	31.4	0.1661
Hyperlipidemia[¶] (%)	32.9	34.1	34.4	33.7	33.0	27.7	0.0251
Diabetes[¶] (%)	8.6	7.3	7.8	9.9	8.7	10.2	0.0128
Cardiovascular disease[¶] (%)	8.0	6.0	7.7	8.5	9.4	9.5	0.0006
Respiratory disease[¶] (%)	18.3	15.2	16.6	18.2	17.6	26.2	<.0001

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	Total sample	Quintile of DII score[1]					
	N=11,592	Q1 (N=2,511)	Q2 (N=2,460)	Q3 (N=2,296)	Q4 (N=2,144)	Q5 (N=2,181)	*P* trend[†]
Cancer[¶] (%)	9.6	10.7	8.8	8.8	10.1	9.4	0.3914
Poor mental health							
Depression	8.1	3.7	6.4	7.6	10.7	14.9	<.0001
Frequent mental distress	12.4	8.6	9.6	12.0	14.5	20.5	<.0001
Frequent anxiety	17.7	13.4	17.1	16.8	19.3	24.4	<.0001

[1] Quintiles determined using entire NHANES 2007 to 2012 cohorts before dropping cases with missing observation for study variables

[†] Rao-Scott chi-square and F test

[‡] Out of a total of 5,940 women

[§] Defined using NHANES survey cycle weighted population distribution tertiles of self-report minutes of sedentary time per day

[¶] If an individual reported any of these health conditions they were classified as having at least one comorbidity, regardless of whether they had missing data for other health conditions. Thus in this table, while distributions for specific comorbidities by DII quintile is provided, the total N varies.

Table 2

Odds ratios and 95% confidence intervals for prevalence of depression by quintile of dietary inflammatory index (DII), NHANES 2007–2012

	Quintile of DII score										
	Q1 (N=2,511)		Q2 (N=2,460)		Q3 (N=2,296)		Q4 (N=2,144)		Q5 (N=2,181)		
Median DII	−2.78		−1.45		−0.33		0.82		2.43		
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	*P* trend[†]
Crude association	1.00	Ref.	1.78	1.27, 2.49	2.14	1.67, 2.74	3.11	2.40, 4.03	4.56	3.37, 6.16	<.0001
Model 1	1.00	Ref.	1.73	1.24, 2.42	2.03	1.60, 2.59	2.92	2.25, 3.78	4.19	3.07, 5.72	<.0001
Model 2	1.00	Ref.	1.47	1.03, 2.09	1.65	1.29, 2.12	1.95	1.47, 2.60	2.34	1.69, 3.24	<.0001
Model 3	1.00	Ref.	1.52	1.05, 2.21	1.68	1.27, 2.21	2.03	1.50, 2.75	2.26	1.60, 3.20	<.0001

[†]Type III *F*-test

Model 1: adjusted for age and gender

Model 2: includes all variables from model 1, plus race/ethnicity, poverty income ratio category, employment status, health insurance status, educational status, and marital status

Model 3: includes all variables from model 2, plus BMI, smoking, physical activity, sedentary time, use of vitamin supplements, total energy intake, menopause (among women), and any comorbidity (history of hypertension, dyslipidemia, diabetes, CVD, respiratory illness, or cancer)

Table 3

Odds ratios and 95% confidence intervals for measures of poor mental health by quintile of dietary inflammatory index (DII), NHANES 2007–2012

	Quintile of DII score										
	Q1 (N=2,511)		Q2 (N=2,460)		Q3 (N=2,296)		Q4 (N=2,144)		Q5 (N=2,181)		
	−2.78		−1.45		−0.33		0.82		2.43		
Median DII	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	***P* trend**[†]
Frequent distress[‡]											
Crude association	1.00	Ref.	1.16	0.83, 1.64	1.48	1.07, 2.03	2.04	1.43, 2.89	2.64	1.92, 3.64	<.0001
Model 1	1.00	Ref.	1.09	0.79, 1.49	1.36	1.00, 1.84	1.66	1.21, 2.28	2.44	1.80, 3.32	<.0001
Model 2	1.00	Ref.	0.99	0.72, 1.37	1.21	0.89, 1.63	1.32	0.95, 1.81	1.76	1.28, 2.41	0.0011
Model 3	1.00	Ref.	1.02	0.72, 1.46	1.27	0.90, 1.80	1.42	0.95, 2.11	1.81	1.20, 2.71	0.0167
Frequent anxiety[‡]											
Crude association	1.00	Ref.	1.34	1.07, 1.66	1.31	1.06, 1.61	1.55	1.23, 1.95	2.08	1.66, 2.62	<.0001
Model 1	1.00	Ref.	1.30	1.04, 1.64	1.24	1.00, 1.53	1.44	1.13, 1.84	1.89	1.48, 2.42	<.0001
Model 2	1.00	Ref.	1.22	0.97, 1.54	1.14	0.92, 1.41	1.23	0.96, 1.57	1.48	1.15, 1.92	0.0578
Model 3	1.00	Ref.	1.29	0.99, 1.68	1.24	0.95, 1.62	1.38	1.02, 1.88	1.64	1.14, 2.35	0.1166

[†]Type III *F*-test

[‡]Measured derived from the health-related quality of life (HRQOL) survey

Model 1: adjusted for age and gender

Model 2: includes all variables from model 1, plus race/ethnicity, poverty income ratio category, employment status, health insurance status, educational status, and marital status

Model 3: includes all variables from model 2, plus BMI, smoking, physical activity, sedentary time, use of vitamin supplements, total energy intake, menopause (among women), and any comorbidity (history of hypertension, dyslipidemia, diabetes, CVD, respiratory illness, or cancer)