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Potential Protective Role of Fiber Supplementation Against Depression: Insights from the National Health and Nutrition Examination Survey (NHANES) 2017–2018

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Abstract

Depression, which affects 280 million people worldwide, is a complex disorder. Research on the role of fiber supplementation in managing depression has yielded controversial results, possibly due to unaccounted covariates. This study used data from the National Health and Nutrition Examination Survey (NHANES) 2017-2018 to explore the relationship between fiber intake and depression, considering various influencing factors. Data from 9,254 adult subjects were analyzed, of which 3,979 fulfilled the inclusion and exclusion criteria. The variables were categorized for evaluation using a logistic regression model adjusted for covariates. Individuals were considered to be fiber supplemented if they reported consuming more than zero grams of fiber supplementation per day, and depression status was assessed using the Patient Health Questionnaire-9 (PHQ-9), with a score above 9 indicating moderate to severe depression, which served as the cut-off point for this study. The model showed that individuals taking fiber supplementation had a lower chance of depression [OR, 0.75; 95% CI, 0.59 – 0.96, p = 0.02] after adjusting for covariates such as vigorous recreational activities, living with a partner, old age, poverty, thyroid issues, comorbidities, obesity, and sex. In conclusion, supplementary fiber consumption may be a protective tool against moderate-to-severe depression.

Introduction

Depression is a highly prevalent mental disorder with a great burden on the global healthcare system. It is one of the leading causes of disability worldwide and impacts the economy, with productivity losses of one trillion dollars each year (Jezard, 2018). It is estimated that 280 million individuals worldwide suffer from depressive disorders, and 700,000 individuals die annually due to suicide (WHO, 2023). In the

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USA alone, depression affects more than nine million people, mainly women, and health costs are more than double the usual healthcare costs (Jezard, 2018). Although the diagnosis of depression has become more frequent, there is no consensus on the causal biological pathway.

The newest areas of research include the effect of the microbiota-gut-brain axis on the pathogenesis of depression. Dysbiosis has been linked to an increase in pro-inflammatory cytokines in the brain and alterations in glial cells. These changes are associated with depressive symptoms (Cui et al. 2024). With the inclusion of the microbiome as a potential factor in the development of depression, novel therapies are emerging. One of the novel treatments for depression is fiber ingestion. Dietary fiber has been described as a potential treatment for dysbiosis through the promotion of healthy flora growth and production of short-chain fatty acids (Sun et al., 2021). A recent meta-analysis concluded that dietary fiber intake is a protective factor, as it is associated with a 10% decrease in the odds of developing depression in the adult population (Saghafian et al., 2023). Nevertheless, the role of fiber supplementation remains inconsistent in the literature; negligible effects of fiber on mood and mental health have been reported (Aslam et al., 2023). These discrepancies may result from the large number of covariates not accounted for when investigating the relationship between depression and fiber intake (Mao et al., 2022; Saghafian et al., 2021).

Given these inconsistencies, this study sought to clarify the association between fiber supplementation and depression by addressing key limitations found in prior research, including the influence of important confounders such as age, sex, socioeconomic status, and comorbidities. Therefore, we hypothesized that the presence of fiber supplementation could have a negative association with moderate to severe depression in adults, with adjustments for potential confounders in a large, representative sample from NHANES 2017 to 2018. In addition, multivariable logistic regression was performed to evaluate the association between the quantity of fiber supplementation and moderate-to-severe depression as a secondary objective.

Materials and Methods

Study Population

We utilized the National Health and Nutrition Examination Survey from to 2017-2018, a cross-sectional, population-based study of the non-institutionalized civilian population in the United States that assesses adults' and children's health and nutritional status (NCHS, 2023). The initial eligible sample for this analysis included 9,254 participants. Our final sample comprised 4,773 adults aged 18 years or older who had data for both the PHQ-9 and dietary fiber supplementation, from whom 3,979 had complete data for the univariable analysis; the exclusion criteria are illustrated in Figure 1.

Exposure

Fiber intake was reported in the NHANES database as supplementary consumption. Therefore, this variable was transformed from continuous to dichotomous, considering individuals as supplemented if they reported more than zero grams/24 hrs of fiber supplementation in their diet.

Primary Outcome

Depression status was the primary outcome and was determined using the Patient Health Questionnaire-9 (PHQ-9), a screening tool for depression symptoms in the past two weeks. The PHQ-9 contains 9 items evaluated from "0" (not at all) to "3" (nearly every day), the maximum score is 27 and any score greater than 9 corresponds to moderate to severe depression, which was used as the cut-off point for this study (CDC & NCHS, 2020). This cutoff has been shown to have 88% sensitivity and specificity for major depression (Kroenke et al., 2001).

Eligibility Criteria

Of the 9,254 participants in the NHANES 2017-2018 data set, we selected all adults (18 years old or older) with complete data on PHQ9 scores, fiber supplementation, and all the covariates listed in the following section.

Covariates

The covariates considered in this study were age, sex, poverty, physical activity, comorbidities, body mass index (BMI), thyroid problems, and marital status. Each covariate was categorized as follows: age was dichotomized into <60 and $\geq$ 60 years; sex was categorized as female or male; poverty was defined as a family income-to-poverty ratio $\leq$1; physical activity was classified as "yes" or "no" for engagement in vigorous activities; comorbidities were categorized as "yes" or "no" for at least one comorbidity; BMI was divided with cut-off values of < 30 kg/m2 and $\geq$30 kg/m2; thyroid problems were classified as "yes" or "no"; and marital status was categorized as "yes" for individuals who were married or living with a partner, or "no" otherwise.

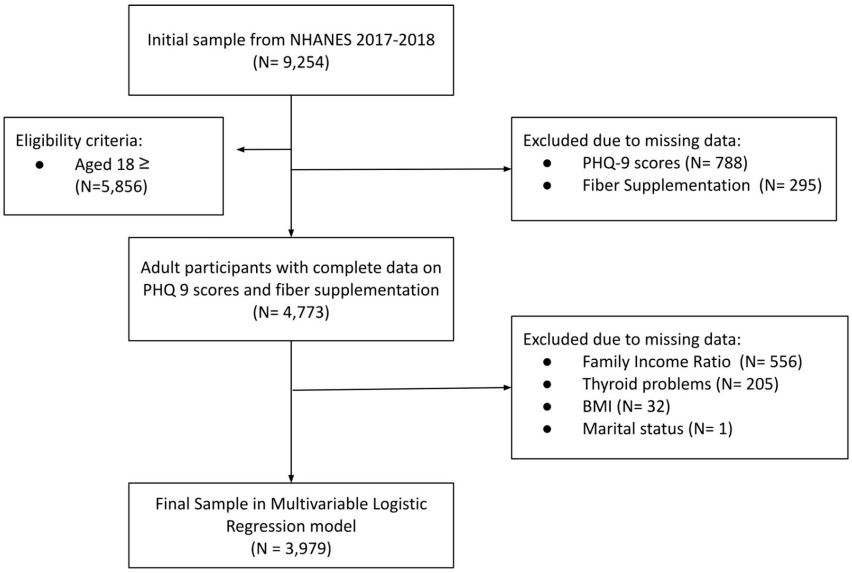

Figure 1: *Subjects Flow Diagram*

Statistical Analysis

All analyses were conducted using Stata statistical software, version 18.5 (StataCorp, College Station, Texas, USA). A univariate logistic regression model was built to determine the relationship between fiber supplementation and depressive symptoms. Additionally, a multivariable logistic regression model was built to adjust for covariates. A secondary multivariable logistic model was built to assess the impact of dietary fiber as a continuous variable on depressive symptoms after adjusting for the same covariates as in the primary model. Each variable was added using a stepwise approach, considering the odds ratio in the univariate analysis. Pearson's goodness-of-fit test and the area under the ROC curve were used to determine the adequacy of the multivariable regression models. To assess collinearity, the variance inflation factor (VIF) was calculated for the final models, with values below 10 indicating acceptable collinearity levels. All STATA outputs are provided in the Supplementary Material.

Results

Population Description

Of the 9,254 initial participants, 3,979 were included in the final model; the elimination process is shown in Figure 1. The demographic characteristics of all the participants are described in detail in Table 1.

Explanatory Analysis

Univariable Analysis

Univariable analysis showed that fiber supplementation was negatively associated with depression symptoms (OR, 0.80; 95% CI, 0.65 – 0.99, p = 0.039). This indicates that individuals who reported any fiber supplementation had a 20% reduction in the odds of experiencing moderate-to-severe depression symptoms.

Mutivariable Analysis

In multivariable logistic regression analyses, the negative association remained significant (OR, 0.75; 95% CI, 0.59 – 0.96, p = 0.02). Therefore, fiber supplementation was associated with a 25% decrease in the odds of presenting with moderate to severe depression when adjusting for important covariates. Factors such as poverty and comorbidities were positively associated with depression, whereas vigorous recreational activity, marital status, and old age were negatively associated with depression. The results of the final model from the multivariate logistic regression analysis are shown in Table 2 and Figure 2.

Secondary Analysis

As a secondary analysis, fiber supplementation was tested as a continuous variable in the multivariate logistic regression model. The new independent variable corresponded to the total fiber ingested in the last 24 h. The results were very similar; after including the same covariates as in the primary model, a 1-gram increase in fiber supplementation was associated with a decrease of 12% in the odds of

	Fiber Supplementation		
	No**	Yes**	Total
N	2,968 (62.2%)	1,805 (37.8%)	4,773 (100.0%)
Age in years at screening	50.304 (17.578)	48.129 (19.511)	49.481 (18.361)
Gender			
Male	1,436 (48.4%)	903 (50.0%)	2,339 (49.0%)
Female	1,532 (51.6%)	902 (50.0%)	2,434 (51.0%)
Depression Status*			
Not Depressed	2,684 (90.4%)	1,664 (92.2%)	4,348 (91.1%)
Depressed	284 (9.6%)	141 (7.8%)	425 (8.9%)
Marital status			
Married	1,486 (51.9%)	789 (47.0%)	2,275 (50.1%)
Widowed	190 (6.6%)	141 (8.4%)	331 (7.3%)
Divorced	329 (11.5%)	193 (11.5%)	522 (11.5%)
Separated	110 (3.8%)	59 (3.5%)	169 (3.7%)
Never Married	470 (16.4%)	345 (20.6%)	815 (18.0%)
Living with a partner	276 (9.6%)	151 (9.0%)	427 (9.4%)
Poverty Status			
Family income above federal poverty threshold	2,152 (81.0%)	1,244 (79.7%)	3,396 (80.5%)
Family income equal or less than federal poverty threshold	504 (19.0%)	317 (20.3%)	821 (19.5%)
Obesity			
Not Obese	1,674 (56.9%)	1,065 (59.6%)	2,739 (57.9%)
Obese	1,269 (43.1%)	723 (40.4%)	1,992 (42.1%)
Ever told you had thyroid problem			
No	2,486 (87.0%)	1,501 (89.6%)	3,987 (88.0%)
Yes	371 (13.0%)	174 (10.4%)	545 (12.0%)
Vigorous recreational activities			
No	2,246 (75.7%)	1,317 (73.0%)	3,563 (74.6%)
Yes	722 (24.3%)	488 (27.0%)	1,210 (25.4%)

*In this study, depression status was dichotomized using a PHQ-9 score ≥ 10 points, corresponding to moderate to severe depressive symptoms (major depression disorder).

**Mean (SD) ; N(%)

Table 1: *Sample demographics.*

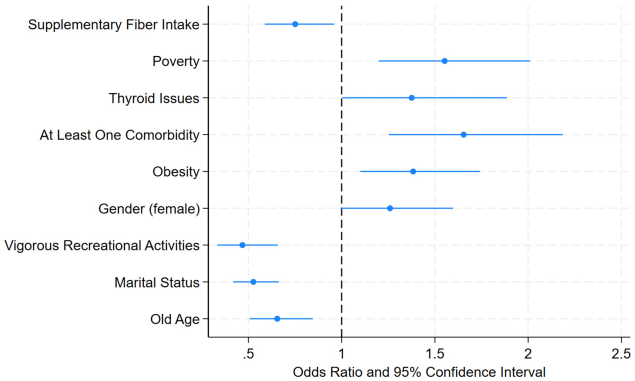

Figure 2: *Odds ratios and 95% confidence intervals from multivariable logistic regression analysis.*

Variable	OR (95 CI %)	p-value
Fiber supplementation		
No	1	
Yes	0.751 (0.587 - 0.959)	0.022
Poverty situation		
No	1	
Yes	1.552 (1.198 – 2.010)	0.001
Ever told you had a thyroid problem?		
No	1	
Yes	1.375 (1.003 – 1.886)	0.048
At least one comorbidity		
No	1	
Yes	1.654 (1.252 - 2.185)	0
Obesity		
No	1	
Yes	1.384 (1.100 - 1.741)	0.006
Sex		
Male	1	
Female	1.259 (0.993 – 1.597)	0.057
Vigorous recreational activities		
No	1	
Yes	0.470 (0.333 – 0.658)	0
Marital status – Married and/or living with someone		
No	1	
Yes	0.526 (0.418 – 0.663)	0
Old age		
Under 60 years old	1	
60 years and older	0.655 (0.507 - 0.845)	0.001

OR, odds ratios; CI, confidence interval

Table 2: *Relationship between covariates and depression from multivariate logistic regression analysis.*

Variable	VIF	1/VIF
Fiber supplementation	1.43	0.697
Poverty situation	1.19	0.839
Ever told you had thyroid problem?	1.28	0.778
At least one comorbidity	2.95	0.338
Obesity	1.66	0.602
Gender	1.82	0.55
Vigorous recreational activities	1.22	0.82
Marital status	1.85	0.54
Old age	1.85	0.539
Mean VIF	1.7	

VIF, variance inflation factor

Table 3: *Multicollinearity test from multivariate logistic regression analysis.*

presenting moderate to severe depression (OR, 0.88; 95% CI, 0.813 – 0.945; p = 0.001). This confirmed that higher fiber supplementation further reduced the odds of depression.

Sensitivity Analysis

The goodness-of-fit of the model was tested using Pearson's goodness-of-fit test and the area under the ROC curve (AUC). The resulting AUC was 0.6933, indicating acceptable model fit. Pearson's goodness-of-fit test concluded that the number of covariate patterns was less than 10% of the number of observations, and the Prob > chi2 was 0.3105, indicating that our final model is acceptable. Table 3 shows the results of the multicollinearity tests between the variables and the dependent variable. It can be seen that all variance inflation factor (VIF) values are less than 10, indicating no collinearity between that predictor and other predictors.

Discussion

We found that fiber supplementation has a negative association with depressive symptoms, specifically a 25% lower risk of developing depression than those subjects that did not use it (p= 0.022, 95% CI 0.58-0.95). A recent meta-analysis by Saghafian et al. (2023) compared 18 publications related to the effect of fiber intake on depression and observed similar findings, with dietary fiber intake corresponding to a 10% decrease in the odds of developing depression symptoms in adults (OR = 0.90; 95% confidence interval [CI]: 0.86, 0.95) with a dose-dependent association (every 5 g increase in total daily fiber intake was associated with a 5% reduction in the risk of depression). The mechanism of action may involve the ability of the fiber to enhance gut microbiota diversity, which has been linked to improved mood regulation and emotional resilience (Sun et al., 2021).

Factors such as poverty, thyroid disease, comorbidities, obesity, and female sex were identified as significant risk factors for depression, which is potentially influenced by stress, healthcare access, and social isolation. Interestingly, we identified physical activity, being married or living together, and advanced age as being negatively related to depression. When considering the presence of other health conditions, we found a 65% increase in the odds of developing depression among participants with at least one comorbidity. Despite this high value, the variable was broad, and further studies are needed to assess specific comorbidities related to the outcome. For instance, a subgroup analysis by Mao et al. (2022) showed a slight difference in the association between fiber intake and depression among participants with or without type-2 diabetes. Additionally, cross-sectional studies have shown a relationship between hyperthyroidism and depressive symptoms, whereas hypothyroidism seems to be less related. However, longitudinal studies do not necessarily establish such a link. (Roa Dueñas et al., 2024).

Poverty is a deeper term than simply not being able to access good services. It is a multidimensional condition related to low educational levels, reduced physical health, and unemployment. Although different types of programs have been established to support low-income families and have shown an improvement in the risk of mental health disorders, their long-term impact is still unknown (Ridley et al., 2020).

The main strengths of this study are the use of a representative sample of the US population, its comprehensive approach that provides a multifactorial understanding of depression, and the use of standardized measures for both fiber intake and depression assessment. Important limitations include the lack of ICD-10 codes in the dataset used, which could jeopardize the interpretation of depression, along with the lack of information on other potential confounders such as diseases, medication, and family history; the amount of fiber reported, which corresponded to supplementation and not to fiber obtained directly from daily meals; the cross-sectional design, which does not allow determination of causality between variables; and self-reported data, which may lead to recall bias.

In conclusion, our findings support the evidence that fiber plays a role in improving mental health and suggest that dietary fiber intake, along with physical and social factors, may help reduce the risk of depression. Future research should investigate the differential effects of various fiber sources and explore dose-response relationships to deepen our understanding of the protective role of fiber in mental health.

Supplementary Materials

Stata codes
Primary, secondary, sensitivity analyses

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Conflicts of Interest

The authors declare no conflict of interest.

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