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Association Between Physical Activity and Depression among Women: An Analysis of NHANES 2017–2018 Data

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Abstract

Background: *Depression is a prevalent mental disorder that affects approximately 5% of adults globally as of 2023. Women are 50% more likely to experience depression than men, making it one of the leading causes of disability among women. Despite the effectiveness of antidepressants, their side effects underscore the need to explore other interventions, such as physical activity (PA). This study aimed to investigate the relationship between PA and depression among women using data from the National Health and Nutrition Examination Survey (NHANES) 2017-2018, addressing gaps in understanding the impact of PA intensity and specific lifestyle factors on women with depression.*

Methods: *This exploratory, observational, cross-sectional study included female participants aged 20 years and older from the NHANES 2017-2018 survey. Depressive symptoms were assessed using the 9-item Patient Health Questionnaire (PHQ-9), and PA was categorized into moderate- and vigorous activity. Logistic regression models were used to evaluate the association between PA and depression, controlling for potential confounders, including age, ethnicity, marital status, education, poverty ratio, lifestyle factors, and comorbidities.*

Results: *Overall, 10.45% of participants reported depressive symptoms. Moderate PA was associated with 35% lower odds of depression (OR=0.65, 95% CI: 0.47–0.91, p=0.009). Vigorous PA showed a non-significant trend toward reduced odds of depression (OR=0.76, 95% CI: 0.49–1.19, p=0.243), which became significant in sensitivity analyses. High sugar intake was linked to a higher risk of depression (OR=1.97, 95% CI: 1.24–3.13), while fiber intake was protective. Women with arthritis had 63% higher odds of depression (OR=1.63, 95% CI: 1.17–2.27, p=0.003), and those with chronic bronchitis had more than twice the odds (OR=2.08, 95% CI: 1.38–3.12, p<0.001).*

Conclusion: *This study addresses critical gaps in the literature by focusing on the specific effects of different PA intensities on depression among women. The findings support the inclusion of moderate exercise and a balanced diet in mental health interventions for women, offering valuable insights into non-pharmacological treatment options.*

Introduction

Depression is a common mental disorder that affects approximately 5% of adults globally in 2023 (World Health Organization, 2023). Women are 50% more likely to experience depression than men, and depression is one of the leading causes of disability in women (Sassarini, 2016; Kuehner, 2017). The Global Burden of Disease Study indicated that depression is the leading cause of disability related to mental health globally (GBD 2019 Mental Disorders Collaborators, 2022). Currently, the estimated prevalence of major depressive disorder is 4.7%, with an annual incidence rate of 3.0% (Gutiérrez-Rojas et al., 2020).

The World Health Organization (WHO) defines depression as a prolonged low mood and loss of interest that affects relationships and daily life. Antidepressants are effective for treating depression, but they often have unwanted side effects. From 2011 to 2014, 16.5% of women and 8.6% of men in the U.S. reported using these medications. This reliance on pharmacological treatments has led to a growing interest in exploring non-pharmacological options, such as exercise, for managing depressive symptoms (Pratt et al., 2017).

The World Health Organization (WHO) and National Institute for Health and Care Excellence (NICE) guidelines recommend adjunct PA as part of the treatment plan for depression (Heissel et al., 2023; Noetel et al., 2024). It has been suggested that PA may decrease the likelihood of developing depression and anxiety and enhance overall well-being (McDowell et al., 2018; Mahindru et al., 2023). A meta-analysis by Kvam et al. (2016) showed that PA has a moderate to large effect on reducing depressive symptoms across various populations, providing consistent evidence of its therapeutic potential (Kvam et al., 2016). Dishman et al. (2021) reported similar findings in their meta-analysis of 111 prospective studies, indicating that habitual and increasing PA levels are inversely associated with the incidence of depression among adults (Dishman et al., 2021). Furthermore, another meta-analysis by Schuch et al., which included 49 prospective cohort studies, found that individuals with high PA levels have a 17% lower chance of experiencing depression compared with those with low levels of PA (Schuch et al., 2018).

Although some studies have demonstrated an inverse relationship between physical activity (PA) and the severity of depressive symptoms, much of the existing research has not shown how different PA intensities and specific lifestyle factors (e.g., smoking, sugar intake, and fiber intake) impact depression in women. Moreover, previous studies have focused on general populations or predominantly male participants, leaving a gap in understanding how exercise specifically affects women (Dishman et al., 2021). This leads to an opportunity to develop personalized lifestyle recommendations for mental health issues.

This exploratory, observational, and cross-sectional study aims to address this gap by focusing on women and exploring the relationship between exercise and depression using the NHANES 2017-2018 dataset, which provides comprehensive information about participants.

Materials and Methods

Study Population and Design

NHANES is an ongoing program conducted at the National Center for Health Statistics, which is part of the Centers for Disease Control and Prevention. This study is designed to investigate general health-related behaviors of the population, socioeconomic and nutritional status, and physical examination results. This survey focuses on civilian, non-institutionalized individuals living in the United States. The method employs a continuous, multistage probability sampling method to assess health and nutritional status across the country. The National Center for Health Statistics Research Ethics Review Board approved all potential study protocols for NHANES, and written informed consent was obtained from all participants. Therefore, no additional external ethical approval or informed consent was required for this analysis. Participants from the 2017–2018 cycle were included. This study only included female participants aged 20 years and older, with a complete 9-item Patient Health Questionnaire (PHQ-9), who reported whether they engaged in moderate or vigorous PAs. The flowchart shows the screening process [Figure 1].

Exposure Description

For this model, exercise was coded as a binary variable and divided into 'Moderate Physical Activity' and 'Vigorous Physical Activity', adapted from the NHANES items of each corresponding level of PA, for which the participants were asked "In a typical week do you/does SP do any moderate / vigorous-intensity sports, fitness, or recreational activities that cause small/large increases in breathing or heart rate... at least 10 minutes continuously?"

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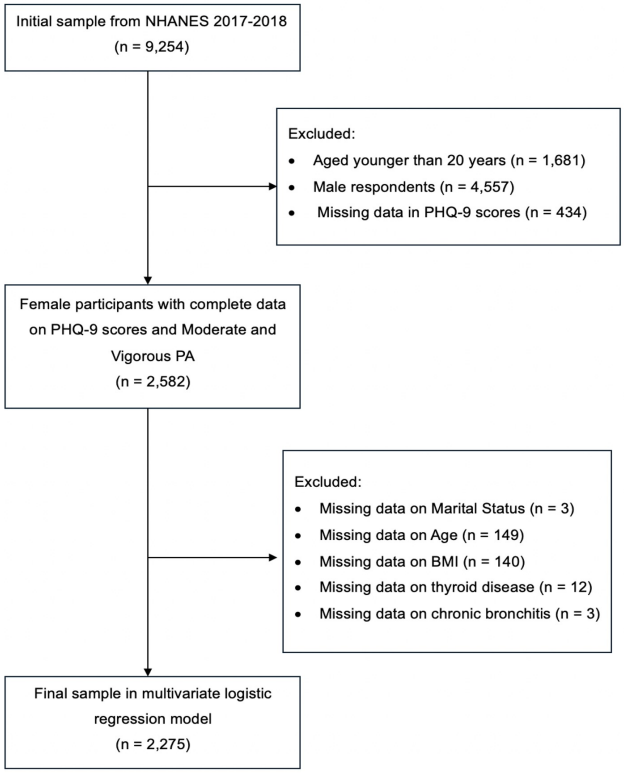

Figure 1: *Determination of sample size.*

Outcome Description

Symptoms of depression were assessed using the PHQ-9, a well-established depression screening tool known for its strong factor structure, reliability, and validity. This tool is widely used in primary care and research settings and produces scores ranging from 0 to 27, indicating the severity of depressive symptoms. A cutoff score of 10 was used to identify probable cases of depressive symptoms, with a sensitivity of 88% and specificity of 88% (Kroenke et al., 2001).

Potential Covariates

All analyses were controlled for age, gender, ethnicity, marital status, education, poverty ratio, lifestyle characteristics, and comorbidities, as these factors were found to be associated with depression or both depression and PA. According to age distribution, the subjects were divided into four groups: young adults (20–34 years), adults (34–49 years), older adults (50–64 years), and senior adults (65 years and above). Marital status was defined as married, widowed, divorced, separated, never married, or living with a partner. The income variable was based on the poverty income ratio (PIR), which was calculated by dividing family income by the poverty level threshold specific to family size and survey year. A ratio below 1.00 indicates that family income is below the official poverty threshold, whereas a ratio of 1.00 or higher suggests that family income is at or above the poverty level (Keppel et al., 2004). Income was categorized into four Poverty Income Ratio (PIR) groups and defined as follows: high income (PIR $\geq$ 3.00), middle income (PIR $\geq$ 2.00 to < 3.00), low income (PIR $\geq$ 1.00 to < 2.00), and very low income (PIR < 1.00). Lifestyle factors included smoking, dietary sugar and fiber intake, and minutes of sedentary activity. The total amount of sedentary activity was assessed by determining the amount of time spent sitting during the day. Patients provided their total time in minutes per day, which was then converted into hours per day for easier interpretation. Finally, thyroid problems, arthritis, chronic bronchitis, and Body Mass Index (BMI) were included in the model. Thyroid problems, arthritis, and chronic bronchitis were defined as having been told by a doctor or health professional that the individual has the disease and were coded as binary variables.

Statistical Analysis

All analyses were performed using STATA software version 18.5. A logistic regression model was used to study the impact of moderate and vigorous

exercise in the presence of depression in women. Percentages, odds ratios (ORs), and standard errors (SEs) were estimated to assess the odds of developing depression according to the presence of moderate or vigorous PA. The models described the association between depressive symptoms measured by the PHQ-9 questionnaire and moderate and vigorous PA, sociodemographic factors, health behaviors, and characteristics such as comorbidities.

The Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) were used to evaluate the quality of the stepwise models in terms of their fit and complexity. AIC measures the amount of information lost when using a specific model to approximate reality, thereby helping to identify a better model based on the available data. The preferred model was the one with the lowest AIC value. In addition, the variation inflation factors were used to check for multicollinearity among the independent variables in the model. The Hosmer-Lemeshow test was used to determine whether the model's predicted probabilities aligned well with the observed outcomes, indicating good predictive performance. The associations were presented as odds ratios (ORs) with 95% confidence intervals (CIs) and p-values. Statistical significance was defined as a two-sided p-value of < 0.05.

Results

The study sample consisted of 2,288 women aged 20 years and older in the United States. The selected baseline sociodemographic characteristics are presented in Table 1. There was an even distribution of each age group; middle-aged adults (35–64 years) showed the highest rates of depression. White women were the largest group, followed by Black and Mexican American women. Hispanic women (both Mexican and Non-Mexican) represented over 20% of the dataset. Nonetheless, non-Mexican Hispanic women exhibited the highest prevalence of depression, while Black women had the lowest rates. Nearly half of the women were married (46%); however, a significant proportion (12–15%) were divorced or widowed, highlighting the presence of women who may face social or emotional challenges that could be linked to depression (Xie et al., 2024). Most women in the dataset belonged to the high-income group (43.88%), followed by women in the near-poor category (24.95%).

Multivariate logistic regression analyses showed that women engaging in moderate PA had 35% lower odds (OR = 0.65, p = 0.009, 95% CI: 0.47–0.91) of depression compared to those who did not, suggesting that moderate activity is protective against depression. In contrast, women who engage in vigorous PA had 24% lower odds (OR = 0.76, p = 0.243, CI: 0.49–1.19) of being depressed compared to those who did not, although this result was not statistically significant. According to age group, senior adults showed 51% lower odds of depression (OR = 0.49, p = 0.001, 95% CI: 0.30–0.79) compared with young adults, suggesting that depression may be less prevalent in older women.

Furthermore, women who were widows (OR = 1.82, p = 0.017), divorced (OR = 2.21, $p < 0.001$), separated (OR = 2.28, p = 0.007), or living with a partner (OR = 1.73, p = 0.031) showed higher odds of depression compared to married women, indicating that marital disruption and living arrangements may influence mental health. Regarding socioeconomic status, although not statistically significant, women showed a trend toward increased odds of depression at lower income levels.

Women with a diagnosis of arthritis and bronchitis had 63% (OR = 1.63, p = 0.003) and 108% (OR = 2.08, $p < 0.001$) higher odds of depression, respectively, highlighting the burden of chronic illness on mental health. On the other hand, women who consumed more sugar than recommended had significantly higher odds of depression (OR = 1.97, p = 0.004, 95% CI: 1.24–3.13) compared to those who consumed sugar within the recommended range.

Sensitivity Analysis

To explore the robustness of the results, additional models under alternative associative assumptions were fitted, including an unadjusted model containing only the main predictors, PA, and a model excluding the variables for sugar intake, BMI, and sedentarism due to plausibly being consequences of our outcome, depression. Both models were consistent, confirming a negative relationship between depressive symptoms and PA.

After examining the main model results, which showed a non-statistically significant effect of vigorous PA on depression odds, despite a significant effect of moderate PA, two additional post hoc models were fitted. Each model included only one level of PA, while all original covariates were retained. When fitted alone, vigorous PA showed a significant reduction in the odds of depression of 40% (OR = 0.60, p = 0.018, 95% CI: 0.39–0.91), whereas the significant effect of moderate PA was confirmed in consistency with the main model.

	Not depressed	Depressed	Total
N	2038 (89.58%)	237 (10.42%)	2275 (100.0%)
Physical Activity			
Only moderate			
Yes	507 (24.87%)	42 (17.72%)	549 (24.13%)
No	1531 (75.12%)	195 (82.27%)	1726 (75.86%)
Vigorous			
Yes	436 (21.39%)	31 (13.08%)	237 (10.41%)
No	1602 (78.61%)	206 (86.92%)	2038 (89.58%)
Age			
Young adults	486 (23.84%)	48 (20.25%)	534 (23.47%)
Adults	473 (21.44%)	64 (27.00%)	537 (23.60%)
Older adults	592 (29.04%)	76 (32.07%)	668 (29.36%)
Senior adults	487 (23.89%)	49 (20.68%)	536 (23.56%)
Race/Ethnicity			
Mexican American	273 (13.39%)	35 (14.77%)	308 (13.53%)
Other Hispanic	192 (9.42%)	25 (10.55%)	217 (9.53%)
White	716 (35.13%)	89 (37.55%)	805 (35.38%)
Black	482 (23.65%)	57 (24.05%)	539 (23.69%)
Other	375 (18.40%)	31 (13.08%)	406 (17.84%)
Marital Status			
Married	976 (47.89%)	76 (32.07%)	1052 (46.24%)
Widowed	206 (10.10%)	31 (13.08%)	237 (10.41%)
Divorced	242 (11.87%)	42 (17.72%)	284 (12.48%)
Separated	81 (3.97%)	18 (7.59%)	99 (4.35%)
Never married	349 (17.12%)	42 (17.72%)	391 (17.18%)
Living with a partner	184 (9.02%)	28 (11.81%)	212 (9.31%)
Income			
High income	922 (45.24%)	79 (33.33%)	1001 (44.00%)
Middle income	296 (14.52%)	28 (11.81%)	324 (14.24%)
Low	499 (24.48%)	69 (29.11%)	568 (24.97%)
Very low	321 (15.75%)	61 (25.74%)	382 (16.79%)
BMI			
Underweight	30 (1.47%)	5 (2.11%)	35 (1.54%)
Normal weight	533 (26.15%)	39 (16.46%)	572 (25.14%)
Pre-Obesity	571 (28.01%)	56 (23.63%)	627 (27.56%)
Obesity class I	408 (20.01%)	68 (28.69%)	476 (20.92%)
Obesity class II	247 (12.11%)	32 (13.50%)	279 (12.26%)
Obesity class III	249 (12.21%)	37 (15.61%)	286 (12.57%)
Diagnosis of Arthritis			
Yes	660 (32.38%)	109 (45.99%)	769 (33.80%)
No	1378 (67.61%)	128 (54.01%)	1506 (66.20%)
Diagnosis of Chronic Bronchitis			
Yes	136 (6.67%)	40 (16.88%)	176 (7.74%)
No	1902 (93.32%)	197 (83.12%)	2099 (92.26%)
Diagnosis of Thyroid disease			
Yes	338 (16.58%)	55 (23.21%)	393 (17.27%)
No	1700 (83.41%)	182 (76.79%)	1882 (82.73%)
Smoked at least 100 cigarettes in life			
No	1419(69.62%)	120 (50.63%)	1536 (67.52%)
Yes	619 (30.37%)	117 (49.37%)	739 (32.48%)
Current smoker	264 (12.95%)	69 (%)	333 (14.64%)
Past smoker	355 (17.41%)	51 (%)	406 (17.85%)
Sugar intake			
Below recommended	1918 (94.11%)	209 (88.19%)	2127 (93.49%)
Average or above recommended	209 (10.26%)	28 (11.81%)	148 (6.55%)
Fiber intake			
Below average	2009 (98.58%)	234 (98.73%)	2038 (89.58%)
Average or above average	29 (1.42%)	3 (1.27%)	237 (10.42%)
Sedentary level			
Low	1469 (72.08%)	173 (73.00%)	1642 (72.18%)
High	569 (27.92%)	64 (27.00%)	633 (27.82%)

Table 1: *Sociodemographic characteristics of the study sample.*

Variable	OR (95 CI%)	p-value
Moderate PA	0.61 (0.42-0.89)	0.01
Vigorous PA	0.55 (0.36-0.85)	0.008
Age		
Young adults	0.93 (0.60-1.44)	0.755
Older adults	0.72 (0.48-1.07)	0.11
Senior adults	0.46 (0.28-0.74)	0.002
Race/Ethnicity		
Mexican American	1.02 (0.65-1.60)	0.919
Other Hispanic	1.02 (0.61-1.68)	0.934
Black	0.83 (0.56-1.21)	0.342
Other	0.84 (0.53-1.32)	0.464
Marital Status		
Widowed	1.86(1.13-3.05)	0.014
Divorced	2.28(1.48-3.52)	0
Separated	2.32(1.27-4.21)	0.006
Never married	1.48(0.95-2.33)	0.082
Living with a partner	1.69(1.02-2.79)	0.039
Income		
Middle	0.92(0.57-1.48)	0.751
Low	1.12(0.78-1.62)	0.51
Very low	1.37(0.92-2.03)	0.116
BMI		
Normal weight	0.56(0.19-1.61)	0.287
Pre-Obesity	0.69(0.24-1.96)	0.492
Obesity class I	1.07(0.37-3.01)	0.898
Obesity class II	0.79(0.27-2.31)	0.672
Obesity class III	0.84(0.29-2.44)	0.755
Diagnosis of Arthritis	1.67(1.20-2.33)	0.002
Diagnosis of Chronic Bronchitis	2.23(1.47-3.37)	0
Diagnosis of Thyroid disease	1.47(1.03-2.10)	0.032
Sugar Intake (above recommended)	2.07 (1.29-3.31)	0.004
Fiber Intake	0.58 (0.16-2.12)	0.415
Sedentarism	0.89 (0.64-1.23)	0.498

Table 2: *Relationship between covariates and depression in logistic regression analysis*

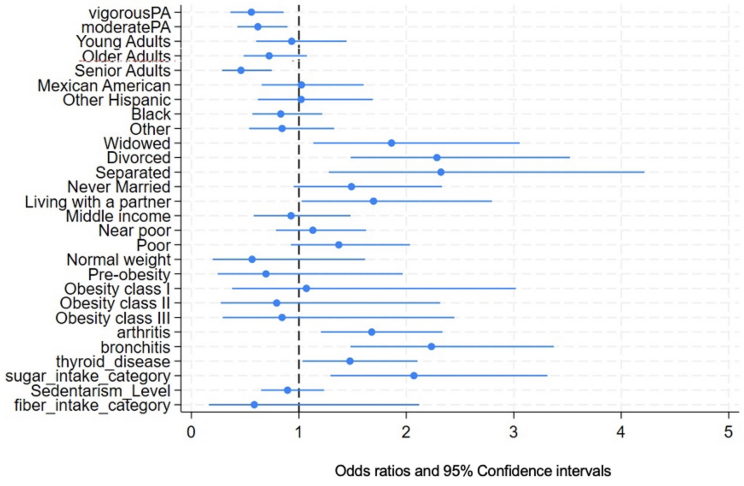

Figure 2: *Forest plot of the relationship between covariates and depression from logistic regression analysis.*

Discussion

The aim of this study was to investigate the association between exercise and the prevalence of depressive symptoms in a sample of 2,288 adult women in the NHANES survey, 10.45% of whom reported depressive symptoms. Our results indicate that moderate PA is associated with significantly lower odds of depression. Vigorous exercise showed a trend toward lower odds, although not statistically significant. Previous research has shown that PA can play a significant role in reducing symptoms of depression across various demographic and age groups (Pérez-López et al., 2017). Given the strong association between moderate and vigorous activity in our model, the lack of a statistically significant effect of vigorous exercise on depression may be attributable to its strong correlation with moderate activity.

Although exercise was our primary focus, significant lifestyle factors emerged as notable predictors of depression severity. Similar to findings from another cross-sectional study using NHANES data, the present analysis indicates that higher sugar intake is associated with an increased likelihood of experiencing depressive symptoms (Zhang et al., 2024).

Dietary fiber intake was associated with lower odds of depression, exhibiting a statistically significant protective effect. This result aligns with emerging evidence on the benefits of dietary fiber for gut health, which may influence mood regulation via the gut-brain axis (Fatahi et al., 2020; Xu et al., 2018). Our findings support the hypothesis that a balanced diet, low in added sugars and high in fiber, could be beneficial for mental health, possibly due to reduced inflammation and improved microbiome health.

It is important to acknowledge the limitations of this study. Its cross-sectional design prevented causal relationships, leaving it unclear whether exercise, lifestyle factors, or depression occurred first. Additionally, reliance on self-reported data for both physical activity and depression may introduce inaccuracies due to recall or reporting biases. The relatively small number of participants who engaged in higher-than-recommended exercise levels also limits the generalizability of this particular finding. Future longitudinal research will be valuable in clarifying these relationships and examining the mechanisms through which exercise intensity, diet, and other lifestyle factors influence mental health.

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