The association between sexual activity frequency and depression: The moderating role of physical activity

DOI: 10.29063/ajrh2026/v30i5.10

Guoji Qin[1], Yan Gong[2]*

College of Physical Education, Guizhou Normal University, Guiyang, Guizhou, P. R. China[1]; School of Accounting, Guizhou University of Finance and Economics, Guiyang, Guizhou, P. R. China[2]

***For Correspondence:** Email: *2937665315@qq.com*; *3232929994@qq.com*; Phone: +86 199 8560 7236,+86 166 0857 5781

Abstract

This study utilizes data from 12,308 adults aged 20 to 59 in the NHANES from 2007 to 2016 to investigate the relationship between sexual activity frequency, physical activity, and depression. Additionally, it examines whether physical activity moderates the association between sexual activity frequency and depression, with a particular emphasis on gender differences. Logistic regression revealed that low sexual activity frequency significantly increased depression risk, while regular moderate-to-vigorous physical activity (MVPA) reduced it. Furthermore, physical activity moderated the relationship between sexual activity frequency and depression: at low MVPA levels, infrequent sexual activity predicted higher depressive symptoms, whereas this association disappeared at high MVPA levels. Subgroup analyses indicated that this moderating effect was evident among males but not females. These findings suggest that regular physical activity may buffer the adverse psychological effects of low sexual activity and highlight potential sex-specific mechanisms underlying the links between lifestyle behaviors and mental health. *(Afr J Reprod Health 2026; 30 [5]: 96-108).*

Keywords: Depressive symptoms, behaviors Mental health, Gender differences

Résumé

Cette étude utilise les données de 12 308 adultes âgés de 20 à 59 ans issues de l'enquête NHANES de 2007 à 2016 pour étudier la relation entre la fréquence de l'activité sexuelle, l'activité physique et la dépression. De plus, elle examine si l'activité physique modère l'association entre la fréquence de l'activité sexuelle et la dépression, en mettant particulièrement l'accent sur les différences de genre. Les régressions logistiques ont montré qu'une faible fréquence d'activité sexuelle augmentait significativement le risque de dépression, tandis qu'une activité physique régulière d'intensité modérée à vigoureuse (MVPA) le réduisait. De plus, l'activité physique modérait la relation entre la fréquence de l'activité sexuelle et la dépression : à de faibles niveaux de MVPA, une activité sexuelle peu fréquente était associée à davantage de symptômes dépressifs, alors que cette association disparaissait à des niveaux élevés de MVPA. Les analyses par sous-groupes ont révélé que cet effet modérateur était significatif chez les hommes mais non chez les femmes. Ces résultats suggèrent qu'une activité physique régulière pourrait atténuer les effets psychologiques négatifs d'une faible activité sexuelle et mettent en évidence des mécanismes potentiellement spécifiques au sexe dans les liens entre comportements de vie et santé mentale. *(Afr J Reprod Health 2026; 30 [5]: 96-108).*

Mots-clés: symptômes dépressifs, comportements de style de vie, santé mentale, différences entre les sexes

Introduction

Depression is a prevalent mental disorder, primarily characterized by persistent low mood and loss of interest.[1] Unlike ordinary mood fluctuations, it significantly affects patients' cognitive functions, behavioral patterns, and social interactions, often causing impairments in work, interpersonal relationships, and daily life.[1] In severe cases, depression can substantially increase the risk of self-harm and suicide, including suicidal thoughts, behaviors, and even death.[2-3] Epidemiological studies indicate that the global prevalence of depression is approximately 4%–7%, making it one of the most common psychological disorders in modern society.[4] Therefore, exploring its risk factors and enhancing prevention and early intervention are particularly important.

Sexual activity frequency is associated with various health and relationship outcomes and can serve as an important indicator of sexual and overall health.[5] Research by Chen found that maintaining a sexual frequency of 1–2 times per week is not only associated with the lowest incidence of depression

but can also serve as a reference standard for evaluating individual sexual and mental health.[6] Mollaioli's study indicated that sexually active individuals during the pandemic, despite facing the challenges of COVID-19, exhibited significantly lower rates of depression and anxiety.[7] Conversely, women with lower sexual frequency are at a higher risk of depression.[8] Additionally, sexual dysfunction and depression have a bidirectional relationship: sexual dysfunction increases the risk of depression, while patients with depression often exhibit sexual dysfunction.[9-10] Risky sexual behaviors (e.g., unprotected intercourse, sexual activity under the influence of alcohol, or multiple sexual partners) can also elevate the risk of depression.[11] Overall, existing studies have primarily focused on the associations between sexual function, risky sexual behaviors, and depression. However, research on the relationship between sexual activity frequency and depression remains limited.

Lifestyle factors play a key role in the prevention of depression.[1] A growing body of evidence has confirmed the association between physical activity and depression. According to the World Health Organization, physical activity and depression are closely interrelated, and regular exercise plays a crucial role in both the prevention and management of depression.[1] Moreover, the level of physical activity is significantly and inversely associated with depression risk, and a meta-analysis confirmed that higher activity levels can reduce the incidence of depression by 12%–21%, with an average effect size of 17%.[12]Although the relationship between physical activity and depression has been well established, and sexual activity frequency has also been shown to be associated with depression, the interaction between the two has been insufficiently investigated. Most existing studies have examined sexual behavior and depression or physical activity and depression in isolation, without addressing the mechanisms through which insufficient sexual activity frequency may increase depression risk under different lifestyle contexts. In fact, sexual activity is largely influenced by partner availability, social environment, and individual circumstances,**Error! Reference source not found.** whereas physical activity, as a controllable, universal, and low-cost lifestyle intervention, may serve as a compensatory psychological protective factor when intimate relationships are limited.[13]Moreover, the moderating role of physical activity may differ between men and women owing to sex-specific biological, psychological, and social factors, yet few studies have systematically examined these potential differences.[14-15] Examining such sex-based variations could yield more precise insights for the development of personalized intervention strategies.

If regular physical activity is confirmed to significantly buffer the adverse effects of low sexual contact frequency on depression risk, this would not only expand our understanding of the mechanisms underlying depression but also provide new perspectives for prevention and personalized intervention strategies, particularly for populations with restricted sexual activity due to illness, relationship status, or social circumstances.

Therefore, this study aims to investigate: the association between different levels of physical activity (inactive, insufficiently active, weekend warrior, and regularly active) and depression; the association between sexual activity frequency (low vs. normal) and depression; the moderating effect of physical activity on the relationship between sexual activity frequency and depression; and potential sex differences in this moderating effect. The findings of this study are expected to enhance the understanding of the interrelationships among physical activity, sexual activity frequency, and depression. This may help identify research priorities and inform the development of intervention strategies tailored to individuals with different sexual activity frequencies, thereby maximizing the effectiveness of depression risk reduction.

Methods

Object

The National Health and Nutrition Examination Survey (NHANES) is a nationwide, population-based cross-sectional study designed to establish a representative health and nutrition database for assessing residents' nutritional status and related disease risks.[16] This study included adults aged 20–59 years, selected through stratified sampling from 2007 to 2016, totaling 12,308 participants.

NHANES' sampling framework covers approximately 15,000 households across the United States, and respondents are required to have resided continuously in the U.S. for at least 60 days to

participate. The study protocol and data usage were approved by the Ethics Review Board of the National Center for Health Statistics, and all participants provided informed consent after fully understanding the study objectives, potential risks, and benefits.[17] Detailed study design, sampling procedures, and exclusion criteria are shown in the figure below (see Figure 1). For the present study, data were accessed in August 2025 from the publicly available NHANES database (2007–2016 cycles). The dataset is fully de-identified, and the authors did not have access to identifiable participant information at any stage.

Assessment of physical activity

This study used the internationally recognized Global Physical Activity Questionnaire (GPAQ) to assess physical activity levels, requiring participants to recall and report the duration and frequency of moderate-to-vigorous exercise and recreational activities of at least 10 minutes per session during a typical week.[18] Following the U.S. Physical Activity Guidelines, a 2:1 intensity weighting (vigorous:moderate), calculating total leisure-time moderate-to-vigorous intensity physical activity (MVPA) by multiplying the weekly duration of vigorous activity by two and then adding the weekly duration of moderate activity.[19-20]

According to the recommended guidelines (150–300 minutes per week of moderate-intensity or 75–150 minutes per week of vigorous-intensity activity), participants were categorized into four groups: inactive (MVPA = 0 min/week); insufficiently active (<150 min/week); weekend warriors (≥150 min/week of MVPA performed 1–2 times/week); and regularly active (≥150 min/week of MVPA performed ≥3 times/week) .[20-21]

Assessment of sexual activity frequency

Sexual activity frequency data were extracted from the SXQ dataset, which provides information on both lifetime and current sexual behaviors among men and women. For adults aged 20–59 years, professionally trained interviewers administered in-home surveys using the computer-assisted personal interview (CAPI) system.In SXQ question 610, response codes were defined as follows: 0 = no sexual activity in the past 12 months; 1 = 1 time; 2 = 2–11 times; 3 = 13–51 times; 4 = 52–103 times; 5 = 104–364 times; and 6 = 365 times or more. Based on these responses, sexual activity of ≤11 times in the past 12 months was classified as low frequency sexual activity, whereas >11 times was classified as normal frequency sexual activity.[8]

Depression assessment

This study used the PHQ-9 (Patient Health Questionnaire-9) as the primary screening tool for depression, aimed at assessing the frequency of depressive symptoms experienced by participants over the past 14 days. The PHQ-9 is a simple and efficient self-report tool widely used in epidemiological research and clinical diagnosis, with good reliability and validity, and is effective in screening individuals with depression.[22] The PHQ-9 consists of 9 items, each rated on a four-point scale based on the frequency of symptoms, with the following options: 0 = not at all, 1 = several days, 2 = more than half the days, 3 = nearly every day. Each item score ranges from 0 to 3, with the total score ranging from 0 to 27, where higher scores indicate more severe depressive symptoms. For the diagnosis of clinical depression, this study used the DSM-IV (Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition) criteria, with a total PHQ-9 score of ≥10 as the threshold for clinical depression.[23] Specifically, a score of 10 or above on the PHQ-9 indicates that the participant may have moderate to severe depressive symptoms, and further clinical assessment and diagnosis may be required based on this.[24]

Covariates

Covariates included demographic, socioeconomic, and health-related factors: sex, age, race, education level, marital status, income-to-poverty ratio, body mass index (BMI), hypertension, diabetes, and sleep disorders.The 12,308 participants were categorized by race/ethnicity into Hispanic, non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, and other races. Education level was categorized as: less than 9th grade; 9–12th grade (without a diploma); high school graduate/GED or equivalent; some college or associate (AA) degree; and college graduate or higher. Marital status was classified as married/living with a partner or single.

The income-to-poverty ratio, a measure of poverty calculated by dividing household income by

the poverty threshold for the survey year, was dichotomized into low-income (<1.3) and middle-income (≥1.3) groups.[25] BMI was categorized into four groups: underweight (<19 kg/m²), normal weight (19–24.9 kg/m²), overweight (25–29.9 kg/m²), and obesity (≥30 kg/m²).[26] Hypertension (yes/no),[27] diabetes (yes/no/borderline),[27] and sleep disorders (yes/no)[28] were also included.

Data analysis

Raw data were organized and merged in Microsoft Excel 2010. Adults aged 20–59 years with complete information were included, and cases with missing or invalid responses were excluded.Group differences between participants with and without depression were assessed using the rank-sum test for continuous variables and the chi-square test for categorical variables.

Binary logistic regression was used to analyze associations between sexual activity frequency, physical activity patterns, and depression. Variables significant in univariate analyses ($p < 0.05$) entered stepwise logistic regression (entry = 0.05, removal = 0.10). Following the statistical methods of previous studies,[28-29] three stepwise-adjusted models were constructed: Model 1 (unadjusted), Model 2 (adjusted for demographics), and Model 3 (fully adjusted).Stratified regression further tested the moderating effect of leisure-time MVPA and explored sex-specific patterns. All analyses were conducted in SPSS 26.0 with two-tailed tests and $p < 0.05$.

Ethics approval and consent to participate

All procedures performed in the study were in accordance with the Declaration of Helsinki. The study protocols for NHANES were approved by the National Center for Health Statistics (NCHS) Research Ethics Review Board (Protocol#2017–1). All adult participants in NHANES had provide informed consent to the purpose, risks and benefits of the study and signed an informed consent form.

Results

Demographic characteristics

This study included 12,308 adults aged 20–59 years from the 2007–2016 cycles of the U.S. National Health and Nutrition Examination Survey, who provided complete data on physical activity, sexual activity frequency, diabetes, sleep disorders, hypertension, BMI, and other demographic variables.Significant differences were found between participants with and without depression in terms of sex, age, race, education level, marital status, income-to-poverty ratio, BMI, hypertension, diabetes, sleep disorders, sexual activity frequency, and physical activity patterns (see Table 1).

The relationship between sexual activity frequency and depression

In the logistic regression analysis, using normal sexual activity frequency as the reference, Model 1 (without adjusting for any covariates) showed an odds ratio (OR) of 1.67, 95% CI 1.47–1.90, for the association between low sexual activity frequency and depression. Model 2, adjusted for demographic variables such as sex, race, education level, marital status, and income-to-poverty ratio, showed OR 1.30, 95% CI 1.13–1.49. Model 3, further adjusted for all remaining covariates based on Model 2, showed OR 1.27, 95% CI 1.10–1.46 (see Table 2).

The relationship between physical activity and depression

In the logistic regression analysis, using inactive participants as the reference, Model 1 (without adjusting for any covariates) showed the following associations with depression: insufficiently active, OR 0.51, 95% CI 0.42–0.62; weekend warriors, OR 0.28, 95% CI 0.19–0.42; and regularly active, OR 0.33, 95% CI 0.28–0.39.Model 2, adjusted for demographic variables (sex, race, education level, marital status, and income-to-poverty ratio), showed OR 0.64, 95% CI 0.52–0.78 for insufficiently active; OR 0.40, 95% CI 0.27–0.59 for weekend warriors; and OR 0.47, 95% CI 0.40–0.55 for regularly active.

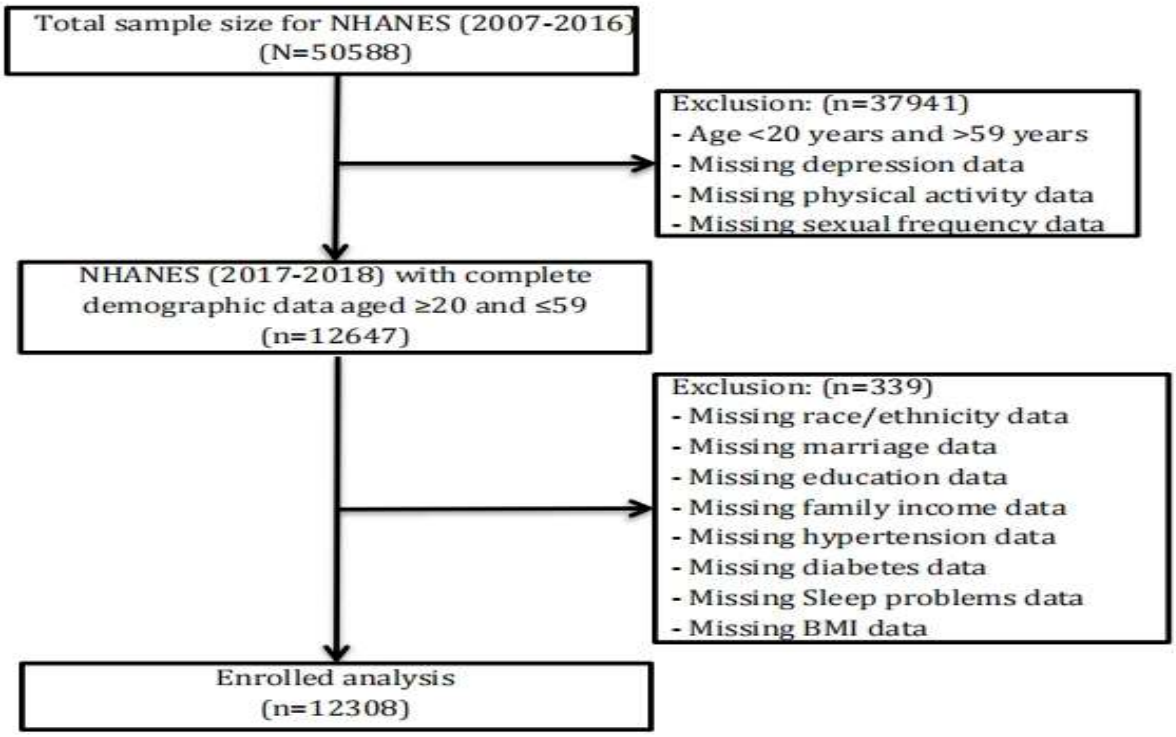

Figure 1: Data Selection Flowchart

Table 1: Demographic characteristics of adults aged 20–59 years by depression status

Variables	Total (n = 12308)	No Depression (n = 11197)	Depression (n = 1111)	Statistic	*p*
Sex, n (%)				124.44[a]	<.001*
Male	6152 (49.98)	5774 (51.57)	378 (34.02)		
Female	6156 (50.02)	5423 (48.43)	733 (65.98)		
Age, Median (Q_1, Q_3)	38.00 (29.00, 48.00)	38.00 (29.00, 47.00)	39.00 (31.00, 49.00)	-3.45[b]	<.001*
Race, n (%)				43.41[a]	<.001*
Hispanic	1879 (15.27)	1745 (15.58)	134 (12.06)		
Non-Hispanic White	1239 (10.07)	1093 (9.76)	146 (13.14)		
Non-Hispanic Black	5230 (42.49)	4733 (42.27)	497 (44.73)		
Non-Hispanic Asian	2611 (21.21)	2352 (21.01)	259 (23.31)		
Other	1349 (10.96)	1274 (11.38)	75 (6.75)		
Education, n (%)				204.20[a]	<.001*
Less than 9th Grade	608 (4.94)	525 (4.69)	83 (7.47)		
9th–12th Grade	1718 (13.96)	1465 (13.08)	253 (22.77)		
High School Graduate / GED or Equivalent	2755 (22.38)	2462 (21.99)	293 (26.37)		
Some college or an AA Degree	3988 (32.40)	3626 (32.38)	362 (32.58)		
College Graduate or Higher	3239 (26.32)	3119 (27.86)	120 (10.80)		
Marital Status, n (%)				127.92[a]	<.001*
Single	4234 (34.40)	3681 (32.87)	553 (49.77)		

Married or Living with a Partner	8074 (65.60)	7516 (67.13)	558 (50.23)		
Income-to-Poverty Ratio, n (%)				295.98[a]	<.001*
Impoverished	3849 (31.27)	3248 (29.01)	601 (54.10)		
Moderate Income	8459 (68.73)	7949 (70.99)	510 (45.90)		
BMI, n (%)				69.70[a]	<.001*
Normal	4105 (33.35)	3808 (34.01)	297 (26.73)		
Obesity	3933 (31.95)	3459 (30.89)	474 (42.66)		
Overweight	3899 (31.68)	3599 (32.14)	300 (27.00)		
Underweight	371 (3.01)	331 (2.96)	40 (3.60)		
Hypertension, n (%)				147.20[a]	<.001*
Yes	2796 (22.72)	2382 (21.27)	414 (37.26)		
No	9512 (77.28)	8815 (78.73)	697 (62.74)		
Diabetes, n (%)				59.11[a]	<.001*
Yes	796 (6.47)	671 (5.99)	125 (11.25)		
No	11333 (92.08)	10376 (92.67)	957 (86.14)		
Borderline	179 (1.45)	150 (1.34)	29 (2.61)		
Sleep Disorders, n (%)				496.87[a]	<.001*
Yes	1379 (11.20)	1031 (9.21)	348 (31.32)		
No	10929 (88.80)	10166 (90.79)	763 (68.68)		
Sexual Activity Frequency, n (%)				64.86[a]	<.001*
Normal	8511 (69.15)	7861 (70.21)	650 (58.51)		
Low	3797 (30.85)	3336 (29.79)	461 (41.49)		
Physical Activity, n (%)				239.08[a]	<.001*
Inactive	5529 (44.92)	4791 (42.79)	738 (66.43)		
Insufficiently Active	1903 (15.46)	1764 (15.75)	139 (12.51)		
Regularly Active	4228 (34.35)	4021 (35.91)	207 (18.63)		
Weekend Warriors	648 (5.26)	621 (5.55)	27 (2.43)		

Notes: Values are presented as median (Q_1, Q_3) for continuous variables and n (%) for categorical variables.

*$p < 0.001$. [a] Chi-square test. [b] Rank-sum test**.**

Table 2: Results of logistic regression analysis of sexual activity frequency and physical activity in relation to depression

Variables	**Model 1**		**Model 2**		**Model 3**	
	p	**OR (95%CI)**	***p***	**OR (95%CI)**	***p***	**OR (95%CI)**
Sexual Activity Frequency						
Normal	1.00 (Reference)					
Low	<.001*	1.67 (1.47–1.90)	<.001*	1.30(1.13–1.49)	<.001*	1.27(1.10–1.46)
Physical Activity						
Inactive	1.00 (Reference)					
Insufficiently Active	<.001*	0.51 (0.42–0.62)	<.001*	0.64 (0.52–0.78)	<.001*	0.65 (0.53–0.79)
Weekend Warriors	<.001*	0.28 (0.19–0.42)	<.001*	0.40 (0.27–0.59)	<.001*	0.43 (0.29–0.65)
Regularly Active	<.001*	0.33 (0.28–0.39)	<.001*	0.47 (0.40–0.55)	<.001*	0.49 (0.4–0.58)

Notes： * $p < 0.001$.

Model 1: Unadjusted for any confounding variables.

Model 2: Adjusted for sex, race, education level, marital status, and income-to-poverty ratio.

Model 3: Further adjusted for remaining covariates based on Model 2.

Table 3: Simple slope analysis of the moderating effect of physical activity on the relationship between sexual activity frequency and depression in the overall sample and males

	MVPA Level	***β***	***p***	**95% CI**
Overall Sample				
Sexual Activity Frequency (Normal)	1.00 (Reference)			
Sexual Activity Frequency (Low)	Average Value	0.380	< 0.001*	0.220–0.540
	High (+1SD)	0.060	0.605	−0.167–0.286
	Low (−1SD）	0.700	< 0.001*	0.480–0.921
Males				
Sexual Activity Frequency (Normal)	1.00 (Reference)			
Sexual Activity Frequency (Low)	Average Value	0.419	< 0.001*	0.217–0.622
	High（+1SD）	−0.035	0.812	−0.326–0.255
	Low（−1SD）	0.874	< 0.001*	0.594–1.154

Table 4: Moderating effect of physical activity on the relationship between sexual activity frequency and depression in the overall sample, males, and females

	Model 1		**Model 2**		**Model 3**	
	β	***p***	***β***	***p***	***β***	***p***
Overall Sample						
Normal	1.00 (Reference)					
Low	0.043	<0.001**	0.042	<0.001**	0.041	< 0.001**
MVPA			−0.056	<0.001**	−0.035	<0.001**
Low × MVPA					−0.040	<0.001**
Males						
Normal	1.00 (Reference)					
Low	0.055	<0.001**	0.053	<0.001**	0.051	< 0.001**
MVPA			−0.051	<0.001**	−0.019	0.197
Low × MVPA					−0.063	<0.001**
Females						
Normal	1.00 (Reference)					
Low	0.033	0.007*	0.033	0.008*	0.032	0.009*
MVPA			-0.068	<0.001**	-0.06	<0.001**
Low × MVPA					-0.015	0.287

Notes: * $p < 0.01$, ** $p < 0.001$.
Model 1: included the independent variable (sexual activity frequency) along with 10 control variables: sleep disorders, BMI, diabetes, hypertension, income-to-poverty ratio, marital status, education level, race, sex, and age.
Model 2: introduced the moderating variable, physical activity (MVPA), based on Model 1.
Model 3: further included the interaction term "low frequency sexual activity × MVPA" based on Model2.

Model 3, further adjusted for all remaining covariates based on Model 2, showed OR 0.65, 95% CI 0.53–0.79 for insufficiently active; OR 0.43, 95% CI 0.29–0.65 for weekend warriors;

Moderating role of physical activity

The study used stratified regression analysis to systematically examine the interaction between sexual activity frequency (independent variable) and MVPA (moderator) on depressive symptoms (PHQ-9 score), with higher PHQ-9 scores indicating more severe depressive symptoms. In addition, subgroup analyses were conducted to explore potential sex differences in the moderating effect of physical activity.Model 1, which included sexual activity frequency and 10 control variables, revealed that low sexual activity frequency was significantly associated with more severe depressive symptoms compared with normal frequency ($\beta = 0.401$, $p < 0.01$). In Model 2, after introducing the moderating variable (MVPA) based on Model 1, the effect of sexual activity frequency remained significant ($\beta = 0.389$, $p < 0.01$), while the main effect of MVPA was

not significant.In Model 3, after further including the interaction term (low sexual activity frequency × MVPA) based on Model 2, the interaction was significant ($p < 0.01$). These results indicate that MVPA moderates the relationship between sexual activity frequency and depression: as MVPA levels increase, the negative effect of low sexual activity on depression weakens (see Table 4).To further examine the moderating role of MVPA (moderator) on the effect of sexual activity frequency on depression severity (PHQ-9 score), a simple slopes analysis was conducted. The results showed that when sexual activity frequency was low, the effect on depression severity depended on MVPA levels. At MVPA levels 1 SD below the mean (−1 SD), low sexual activity significantly increased the risk of depression ($\beta = 0.700$, $p < 0.001$), whereas at MVPA levels 1 SD above the mean (+1 SD), the effect was not significant ($\beta = 0.060$, $p = 0.605$) (see Table 3).

Sex-stratified subgroup analysis

Among male participants, Model 1, which included sexual activity frequency and 10 control variables, revealed that low sexual activity frequency was significantly associated with more severe depressive symptoms compared with normal frequency ($\beta = 0.055$, $p < 0.001$).In Model 2, after introducing the moderating variable (MVPA) based on Model 1, the association between sexual activity frequency and depressive symptoms remained significant ($\beta = 0.053$, $p < 0.001$), while the main effect of MVPA was also significant ($\beta = -0.051$, $p < 0.001$).In Model 3, after further including the interaction term (low sexual activity frequency × MVPA) based on Model 2, the interaction was significant ($\beta = -0.063$, $p < 0.001$). These results indicate that MVPA moderates the association between sexual activity frequency and depression in men: as MVPA levels increase, the negative effect of low sexual activity frequency on depression is attenuated (see Table 4).To further examine the moderating role of MVPA on the association between sexual activity frequency and depression severity (PHQ-9 score) in male participants, a simple slopes analysis was conducted. The results showed that when sexual activity frequency was low, the effect on depression severity depended on MVPA levels. At MVPA levels 1 SD below the mean (−1 SD), low sexual activity significantly increased the risk of depression ($\beta = 0.874$, $p < 0.001$), whereas at MVPA levels 1 SD above the mean (+1 SD), the effect was not significant ($\beta = -0.035$, $p = 0.812$) (see Table 3). In contrast, in females, MVPA did not significantly moderate the relationship between sexual activity frequency and depression; therefore, a simple slopes analysis was not conducted.Among female participants, Model 1, which included sexual activity frequency and 10 control variables, revealed that low sexual activity frequency was significantly associated with more severe depressive symptoms compared with normal frequency ($\beta = 0.033$, $p = 0.007$).In Model 2, after introducing the moderating variable (MVPA) based on Model 1, the association between sexual activity frequency and depressive symptoms remained significant ($\beta = 0.033$, $p = 0.008$), while the main effect of MVPA was also significant ($\beta = -0.068$, $p < 0.001$).In Model 3, after further including the interaction term (low sexual activity frequency × MVPA) based on Model 2, the interaction was not significant ($\beta = -0.015$, $p = 0.287$). These results indicate that MVPA does not significantly moderate the association between sexual activity frequency and depression in women (see Table 4)..

Discussion

Sexual activity frequency and depression

Wu's study found that women with low sexual activity frequency (≤11 times per year) had an increased risk of depression.[8] Another cross-sectional study of 186 college students over 21 days also indicated that depressive symptoms were negatively associated with the number of sexual contacts and the pleasure and connectedness experienced during sexual intimacy.[30] Consistent with these studies, the present study found a significant association between sexual activity frequency and depression risk, with low sexual activity frequency being an important potential risk factor for depressive symptoms; compared with normal sexual activity frequency, it was associated with a 26% to 67% increased risk of depression.This association appears to differ by sex. In men, reduced sexual activity may lower testosterone levels, which have been linked to mood disorders, thereby increasing the risk of depressive symptoms.[7,31] In women, satisfying sexual experiences may enhance self-esteem and self-efficacy, positively impacting mental health.[32]In addition, the frequency and

quality of sexual activity may influence depression risk through multiple psychological and social mechanisms. Sexual activity is not only a fulfillment of physiological needs but also an important way to maintain emotional bonds.[33] Regular sexual contact helps promote intimacy between partners and enhances social support, which has been widely recognized as a protective factor against depression.[4] Conversely, long-term low-frequency sexual contact may lead to emotional distancing and decreased life satisfaction, thereby increasing depression risk.[34]

Physical activity and depression

This study further supports the protective role of physical activity against depression, consistent with previous findings. A meta-analysis confirmed that physical activity reduces depression risk across age groups and regions,[12] and exercise can alleviate depressive symptoms comparably to psychotherapy or medication.[35]Even participants engaging in less than 150 min/week of MVPA showed a 36–49% lower risk than inactive individuals, indicating benefits below the WHO guideline.[36-37]Interestingly, the "weekend warrior" pattern (>150 min/week in 1–2 sessions) was linked to a 57–72% lower risk, consistent with findings that this pattern also reduces anxiety.[20] These results suggest flexible activity schedules can protect mental health, though excessive exercise may produce a U-shaped effect.[38]

Moderating role of physical activity

Based on the above discussion, we have thoroughly confirmed the relationships of sexual activity frequency and physical activity with depression, respectively, and further conducted stratified regression and simple slope analyses. The results showed that the interaction between sexual activity frequency and physical activity was significant. When sexual activity frequency was low, MVPA significantly buffered the "low frequency sexual activity → depression" pathway—higher MVPA weakened the negative impact of low-frequency sexual activity on depressive symptoms. Conversely, at low MVPA levels (−1 SD), this adverse effect was significantly amplified. This evidence of a dual-domain "behavior–social intimacy" interaction supplements prior studies that primarily examined either the main effect of exercise or the one-way association between sexual health and depression, revealing that MVPA can serve as a modifiable protective factor, specifically counteracting the psychological vulnerability caused by limited intimate behavior, representing a key innovation over existing literature.[8,12,13]

The buffering effect of physical activity on the adverse impact of low sexual activity frequency on depression may involve multiple mechanisms. First, from a neurobiological perspective, exercise can upregulate brain-derived neurotrophic factor (BDNF), promoting hippocampal plasticity and neurogenesis, thereby improving emotion regulation.[39-40] Exercise can also downregulate overactivation of the hypothalamic–pituitary–adrenal (HPA) axis, reducing stress responses, a common physiological pathway in depression.[41] Second, from a psychological perspective, physical activity enhances self-efficacy and a sense of control; these positive psychological resources can buffer the loneliness and helplessness caused by limited intimate relationships.[42-43] Finally, from a sociological and interpersonal perspective, exercise often involves social interactions (exercising with partners or in groups); when sexual activity frequency is low, such alternative social connections can partially satisfy human needs for intimacy and belonging, thereby alleviating loneliness and depression.[44]

The synergistic action of these mechanisms provides an explanation for our findings: physical activity not only improves mood through neurobiological and physiological pathways but also, via compensatory psychological and social resources, specifically offsets the psychological vulnerability caused by low sexual activity frequency. Based on this, we offer the following practical recommendations for real-life application. First, for individuals with low sexual activity frequency due to objective conditions (e.g., separation, childcare stress, health issues), physical activity should be prioritized as a "first-line buffer" against depression; even small amounts may be beneficial.[36] Additionally, sexual activity frequency is sometimes constrained by external factors (e.g., partner willingness, physical condition, environment), whereas physical activity is largely under personal control. Focusing on controllable factors, such as physical activity, is a more proactive and effective strategy for mitigating depression risk.

Overall, this study suggests that when the quantity or frequency of intimate relationships is temporarily uncontrollable, physical activity provides a low-cost, low-risk, and mechanistically clear alternative pathway that can effectively alleviate depressive symptoms and reduce the risk associated with low sexual activity, providing actionable strategies for public health interventions and individual self-management.

Sex differences in the moderating role of physical activity

Importantly, our sex-stratified analyses indicate that the protective moderating effect of MVPA was significant in men but not in women. This sex-specific pattern indicates that men may gain greater compensatory benefits from physical activity when sexual activity frequency is low. Several mechanisms may account for this difference. From a hormonal perspective, men generally have higher baseline testosterone levels, which are associated with both sexual desire and mood regulation. Physical activity can increase testosterone and other neuroendocrine factors, potentially enhancing resilience against depressive symptoms when sexual activity is low.[45-47] In addition, men and women differ in stress reactivity, with men showing more pronounced physiological responses to acute stressors via the hypothalamic–pituitary–adrenal (HPA) axis, which may be more effectively modulated by exercise-induced reductions in cortisol and sympathetic activity.[48]From a psychological perspective, sexual activity may hold different significance for men and women. Men often derive a larger portion of emotional satisfaction and self-esteem from sexual activity, whereas women may benefit more from relational and emotional intimacy within broader social contexts.[49] Consequently, physical activity may serve as a direct compensatory mechanism for men, whereas women may rely more on broader social or relational resources to buffer depressive symptoms. Socially, while exercise can facilitate interaction and a sense of belonging for both sexes, the types of social engagement and the perceived emotional benefits may differ. Women may gain more affective support from family and peer networks than from physical activity per se.[50]These findings underscore the need for sex-sensitive approaches in mental health promotion. Interventions aimed at reducing depressive symptoms in men could prioritize physical activity as a targeted strategy, particularly when sexual activity frequency is limited. For women, interventions may need to integrate broader relational or social support components in addition to promoting physical activity. Future research should further explore sex-specific mechanisms, including hormonal, psychological, and social pathways, to clarify the complex interplay among sexual behavior, physical activity, and depression across sexes. These investigations could guide the development of personalized and effective prevention and intervention strategies, considering the nuanced interactions of biological and psychosocial factors in shaping mental health outcomes.

Limitations

This study is subject to several limitations. First, the cross-sectional design of the study restricts the ability to draw causal inferences. While associations between sexual activity frequency, physical activity, and depression have been observed, the cross-sectional nature of the data limits our ability to determine the directionality or causality of these relationships. Future longitudinal studies would be necessary to confirm whether physical activity can directly alleviate depressive symptoms associated with low sexual activity frequency. Additionally, the data used in this study span from 2007 to 2016, which may be considered relatively outdated. Given the rapid changes in lifestyle factors and public health trends, the relevance of these findings to current populations may be limited. This temporal gap should be acknowledged when interpreting the results, and future research should consider incorporating more recent data to better reflect current trends in physical activity, sexual behavior, and mental health.

Conclusion

This study demonstrated that low sexual activity frequency is significantly associated with increased risk of depression, while higher physical activity levels are protective. Importantly, physical activity buffered the adverse effect of low sexual activity frequency on depression, but this moderating role

was only evident in men, not in women. These findings suggest that physical activity may serve as a practical compensatory strategy to mitigate depressive symptoms when sexual activity is limited, with sex-specific differences underscoring the need for tailored interventions. Promoting physical activity, even at sub-guideline levels, could provide an accessible and effective approach for depression prevention, particularly in populations with restricted sexual opportunities.

Contribution of authors

Guoji Qin conceived and designed the study, organized the database, performed the statistical analysis, drafted the initial manuscript, and served as the corresponding author. Yan Gong contributed to the discussion section and provided data support. All authors participated in the editing and revision of the manuscript and approved the final version.

Funding

No funding was received for this study.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available in the [NHANES] repository, [NHANES Questionnaires, Datasets, and Related Documentation (cdc.gov)]. Raw data supporting the obtained results are available at the corresponding author

Competing interests

The authors declare no competing interests.

Acknowledgments

We sincerely thank the participants of the NHANES 2007–2016 surveys for their valuable contributions. We also acknowledge the National Center for Health Statistics (NCHS) for providing access to these comprehensive datasets, which made this study possible. Finally, we are grateful to our colleagues and mentors for their guidance and support throughout the research process. No funding was received for this study

References

1. World Health Organization. *Depression* [Internet]. 2020 [cited 2021 Apr 30]. Available from: https://www.who.int/news-room/fact-sheets/detail/depression.
2. Sokero TP, Melartin TK, Rytsälä H J, Leskelä U S, Lestelä-Mielonen P S , Isometsä E T. Suicidal ideation and attempts among psychiatric patients with major depressive disorder. J Clin Psychiatry 2003 Sep; 64(9): 1094–1100.
3. Gramaglia C, Feggi A, Bergamasco P, Bert F, Gattoni E ,Marangon D. Clinical characteristics associated with suicide attempts in clinical settings: a comparison of suicidal and non-suicidal depressed inpatients. **Front** Psychiatry 2016; 7: 109.
4. World Health Organization**.** Depression and other common mental disorders: global health estimates [Internet]. Geneva: World Health Organization; 2017. Report No. WHO/MSD/MER/2017.2. [cited 2021 Apr 30]. Available from: https://apps.who.int/iris/handle/10665/254610
5. Muise A, Schimmack U , Impett E A. Sexual frequency predicts greater well-being, but more is not always better. Soc Psychol Pers Sci 2016; 7(4): 295–302.
6. Chen M, Yi R and Zhang Z. Optimal sexual frequency may exist and help mitigate depression odds in young and middle-aged US citizens: a cross-sectional stud***y***. J Affect Disord *2025; 375: **1***65–173.
7. Mollaioli D, Sansone A, Ciocca G, Limoncin E, Colonnello E, Di Lorenzo G, Jannini E A. Benefits of sexual activity on psychological, relational, and sexual health during the COVID-19 breakout. J Sex Med 2021; 18(1): 35–49.
8. Wu X, Gao H, Zhang Y , Zhang X. Associations between sexual activity frequency and depression in women: insights from the NHANES data. J Sex Med 2025; 22(2): 334–343.
9. Baldwin D S. Depression and sexual dysfunction. Br Med Bull 2001 Mar; 57(1): 81–99.
10. Adler R A. The anterior pituitary-grafted rat: a valid model of chronic hyperprolactinaemia. Endocr Rev 1986; 7(3): 302–313.
11. Seth P, Patel S N, Sales J M, DiClemente R J, Wingood G M , Rose E S. The impact of depressive symptomatology on risky sexual behavior and sexual communication among African American female adolescents. Psychol Health Med 2011; 16(3): 346–356.
12. Schuch F B, Vancampfort D, Firth J, Rosenbaum S, Ward P B, Silva E S, Hallgren M, Ponce De Leon A, Dunn A L, Deslandes A C, Fleck M P, Carvalho A F, Stubbs B. Physical activity and incident depression: a meta-analysis of prospective cohort studies. Am J Psychiatry 2018; 175(7): 631–648.
13. Craike M J, Coleman D , MacMahon C. Direct and buffering effects of physical activity on stress-related depression in mothers of infants. J Sport Exerc Psychol 2010; 32(1): 23–38.
14. Halliday AJ, Kern ML, Turnbull DA. Can physical activity help explain the gender gap in adolescent mental

health? A cross-sectional exploration. *Ment Health Phys Act*. 2019; 16: 8-18.
15. Ni RJ, Yu Y. Relationship between physical activity and risk of depression in a married group. *BMC Public Health*. 2024; 24: 10.
16. Cao C, Liu Q, Yang L, Zheng X, Lan P, Koyanagi A, Smith L, Jackson S E , Jacob L. Handgrip strength is associated with suicidal thoughts in men: cross-sectional analyses from NHANES. Scand J Med Sci Sports 2020; 30(1): 92–99.
17. Yang L, Cao C, Kantor E D, Nguyen L H, Zheng X, Park Y, Giovannucci E, Willett W C ,Hu F B. Trends in sedentary behavior among the US population, 2001–2016. JAMA 2019; 321(16): 1587–1597.
17. Almohamad M, Kaye E K, Mofleh D , Spartano N L. The association of sedentary behaviour and physical activity with periodontal disease in NHANES 2011–2012. J Clin Periodontol 2022; 49(8): 758–767.
18. Piercy K L, Troiano R P, Ballard R M, Carlson S A, Fulton J E, Galuska D A, George S M, Olson R D. The physical activity guidelines for Americans. JAMA 2018; 320(19): 2020–2028.
19. Chen Z, Jian J, Jia J, Tu J , Li X. The association between weekend warrior physical activity pattern and anxiety: evidence from a US population-based study. BMC Psychiatry 2025; 25(1): 168.
20. Chen R, Wang K, Chen Q, Zhang M, Yang H, Zhang M, Qi K, Zheng M, Wang Y , He Q. Weekend warrior physical activity pattern is associated with lower depression risk: findings from NHANES 2007–2018. Gen Hosp Psychiatry 2023; 84: 165–171.
21. Sun Y, Kong Z, Song Y, Liu J, Wang X. The validity and reliability of the PHQ-9 on screening of depression in neurology: a cross-sectional study. *BMC Psychiatry*. 2022; 22(1): 98.
22. Park L T and Zarate C A Jr. Depression in the primary care setting. N Engl J Med 2019; 380(6): 559–568.
23. Kroenke K, Spitzer RL, Williams JB**.** The PHQ-9: validity of a brief depression severity measure. *J Gen Intern Med*. 2001; 16(9): 606-613.
24. Zhang J, Cao Y, Mo H, Feng R. The association between different types of physical activity and smoking behavior. BMC Psychiatry. 2023 Dec 11;23(1):927.
25. Mo H, Zhang J, Huo C, Zhang M, Xiao J, Peng J, Wang G, Wang C , Li Y. The association of vitamin D deficiency, age and depression in US adults: a cross-sectional analysis. BMC Psychiatry 2023; 23(1): 534.
26. **Error! Reference source not found.**
27. Zhang J, Mo H, Feng J, Jiao Z, Yang W, Xue Z ,Feng R. Association between physical activity across diverse domains and sedentary behavior with sleep disorders. Sci Rep 2025; 15(1): 15911.
28. You Y, Chen Y, Liu R, Zhang Y, Wang M, Yang Z, Liu J , Ma X. Inverted U-shaped relationship between sleep duration and phenotypic age in US adults: a population-based study. Sci Rep 2024; 14(1): 6247.
29. Kashdan T B, Adams L, Savostyanova A, Ferssizidis P, McKnight P E ,Nezlek J B. Effects of social anxiety and depressive symptoms on the frequency and quality of sexual activity: a daily process approach. Behav Res Ther 2011; 49(5): 352–360.
30. Ciocca G, Limoncin E, Carosa E, Mollaioli D, Gravina G L, Lenzi A , Jannini E A. Is testosterone a food for the brain? Sex Med Rev 2016; 4(1): 15–25.
31. Jackson S E, Firth J, Veronese N, Stubbs B, Smith L, Koyanagi A, Yang L and Vancampfort D. Decline in sexuality and wellbeing in older adults: a population-based study. J Affect Disord 2019; 245: 912–917.
32. Laumann E O, Paik A and Rosen R C. Sexual dysfunction in the United States: prevalence and predictors. JAMA 1999; 281(6): 537–544.
33. Stephenson K R , Meston C M. The conditional importance of sex: exploring the association between sexual well-being and life satisfaction. J Sex Marital Ther 2015; 41(1): 25–38.
34. Kvam S, Kleppe C L, Nordhus I H , Hovland A. Exercise as a treatment for depression: a meta-analysis. J Affect Disord 2016; 202: 67–86.
35. Pearce M, Garcia L, Abbas A, Strain T, Schuch F B, Golubic R, Kelly P, Khan S, Utukuri M, Laird Y, Mok A, Smith A, Tainio M, Brage S, Woodcock J. Association between physical activity and risk of depression: a systematic review and meta-analysis. JAMA Psychiatry 2022; 79(6): 550–559.
36. Bull F C, Al-Ansari S S, Biddle S, Borodulin K, Buman M P, Cardon G, Carty C, Chaput J P, Chastin S, Chou R, Dempsey P C, DiPietro L, Ekelund U, Firth J, Friedenreich C M, Garcia L, Gichu M, Jago R, Katzmarzyk P T, Lambert E, Leitzmann M, Milton K, Ortega F B, Ranasinghe C, Stamatakis E, Tiedemann A, Troiano R P, van der Ploeg H P, Wari V, Willumsen J F. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. Br J Sports Med 2020; 54(24): 1451–1462.
37. Chekroud S R, Gueorguieva R, Zheutlin A B, Paulus M, Krumholz H M, Krystal J H, Chekroud A M. Association between physical exercise and mental health in 1.2 million individuals in the USA between 2011 and 2015: a cross-sectional study. Lancet Psychiatry 2018; 5(9): 739–746.
38. Szuhany K L, Bugatti M , Otto M W. A meta-analytic review of the effects of exercise on brain-derived neurotrophic factor. J Psychiatr Res 2015; 60: 56–64.
39. Dinoff A, Herrmann N, Swardfager W , Lanctôt K L. The effect of exercise on resting concentrations of peripheral brain-derived neurotrophic factor (BDNF): a meta-analysis. PLoS One 2016; 11(9): e0163037.
40. Zschucke E, Gaudlitz K , Ströhle A. Exercise and physical activity in mental disorders: clinical and experimental evidence. J Prev Med Public Health 2013; 46 Suppl 1: S12–S21.
41. McAuley E, Jerome G J, Marquez D X, Elavsky S , Blissmer B. Exercise self-efficacy in older adults: social, affective, and behavioral influences. Ann Behav Med 2003; 25(1): 1–7.
42. Reed J , Buck S. The effect of regular aerobic exercise on positive-activated affect: a meta-analysis. Psychol Sport Exerc 2009; 10(6): 581–594.
43. Doré I, O'Loughlin J L, Beauchamp G, Martineau M , Fournier L. Volume and social context of physical activity in association with mental health, anxiety and depression among youth. Prev Med 2016; 91: 344–350.

44. Rajhans P, Goin-Kochel R P, Strathearn L , Kim S. It takes two! Exploring sex differences in parenting neurobiology and behaviour. J Neuroendocrinol 2019; 31(9): e12721.
45. Ghadiri N, Esfarjani F, Marandi S M, Banitalebi E , Saghaee E. Combined ursolic acid and resistance/endurance training improve type 3 diabetes biomarkers-related memory deficits in hippocampus of aged male Wistar rats. Int J Prev Med 2023; 14: 65.
46. Hackett G I. Long term cardiovascular safety of testosterone therapy: a review of the TRAVERSE study. World J Mens Health 2025; 43(2): 282–290.
47. Wang Y, Jiao Y, Nie J, O'Neil A, Huang W, Zhang L, Han J, Liu H, Zhu Y, Yu C , Woodward M. Sex differences in the association between marital status and the risk of cardiovascular, cancer, and all-cause mortality: a systematic review and meta-analysis of 7,881,040 individuals. Glob Health Res Policy 2020; 5: 4.
48. Umberson D, Thomeer M B, Kroeger R A, Lodge A C ,Xu M. Challenges and opportunities for research on same-sex relationships. J Marriage Fam 2015; 77(1): 96–111.
49. Cowley E S, Watson P M, Paterson C, Wagenmakers A J M, Thompson A, Belton S, Thijssen D , Foweather L. Remote physical activity intervention to promote physical activity and health in adolescent girls (the HERizon project): a multi-arm, pilot randomised trial. BMC Public Health 2024; 24: 2098.