Proceedings of the 6th International Conference on Biological Engineering and Medical Science
DOI: 10.54254/2753-8818/2026.37060

Diabetes and Depressive Symptoms Before and in 2021-2023 among U.S. Adults

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Abstract. Diabetes is a major chronic disease in the United States, and the psychological burden of long-term disease management may increase vulnerability to depressive symptoms. Changes in social and healthcare environments may also have affected mental health in recent years. Using data from U.S. adults, we evaluated whether self-reported diabetes was related to clinically relevant depressive symptoms and whether the magnitude of this relationship varied between the 2015–2018 and 2021–2023 survey periods. We analyzed National Health and Nutrition Examination Survey data for 12,653 participants aged ≥20 years who had nonmissing information on self-reported diabetes, all nine PHQ-9 items, prespecified covariates, and the variables required for survey-design adjustment. Participants with a total PHQ-9 score ≥10 were classified as having clinically relevant depressive symptoms. Descriptive estimates and logistic regression analyses incorporated the NHANES sampling weights, strata, and primary sampling units. The adjusted models accounted for demographic and socioeconomic factors, BMI, and smoking status. Adults with self-reported diabetes had a higher burden of clinically relevant depressive symptoms. Depressive symptom prevalence was also higher in 2021-2023 than in 2015-2018 in both diabetes groups. However, the diabetes-by-period interaction was not statistically significant, indicating insufficient evidence that the diabetes–depression association changed between the two periods. Sensitivity analyses using continuous PHQ-9 scores and nonlinear covariate specifications produced consistent findings. These results support continued depression screening and integrated mental-health care in diabetes management.

Keywords: Diabetes, Depressive Symptoms, PHQ-9, NHANES, Survey-Weighted Logistic Regression

1. Introduction

Diabetes is a major chronic disease and a continuing public health challenge in the United States, affecting millions of adults and generating substantial personal, clinical, and economic burdens [1]. Although diabetes research frequently emphasizes glycemic control and physical complications, its association with mental health is also important. Adults living with diabetes must manage medications, dietary restrictions, healthcare expenses, and concerns about long-term complications. These demands may contribute to emotional distress and depressive symptoms. Messina et al.

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DOI: 10.54254/2753-8818/2026.37060

identified depression as an important complication among adults with type 2 diabetes, emphasizing its relevance to comprehensive diabetes care [2].

Diabetes and depression may be connected through behavioral, psychosocial, and biological pathways. Depressive symptoms may impair medication adherence, self-care, and quality of life [3]. A meta-analysis also found that depression was associated with poorer adherence to diabetes treatment recommendations [4]. Chronic inflammation and disease burden may represent shared biological pathways, although the mechanisms remain incompletely understood [5]. Moreover, the observed association may be influenced by age, sex, race and ethnicity, socioeconomic status, body mass index (BMI), and smoking.

Previous research has often focused on depression prediction among people with diabetes, biomarker analyses, or studies limited to a single survey period. It remains unclear whether the diabetes–depression association differed between the pre-pandemic period and 2021-2023. Therefore, this study used nationally representative data and consistent variable definitions to address three questions: whether depressive symptom prevalence differed by diabetes status and period, whether diabetes remained associated with depressive symptoms after adjustment, and whether the association differed between periods. By addressing these questions, this study aims to provide population-based evidence to improve the identification of co-occurring depressive symptoms and inform intervention strategies for adults with diabetes in the context of a changing public health environment.

2. Data and methods

2.1. Data source and study population

This repeated cross-sectional analysis used publicly accessible National Health and Nutrition Examination Survey (NHANES) data. Through a complex multistage probability sampling strategy, NHANES collects information representing the noninstitutionalized civilian population of the United States [6]. Data from 2015-2016 and 2017-2018 were combined to represent the 2015-2018 period and compared with the 2021-2023 period. The incomplete 2019-2020 cycle was excluded because NHANES field operations were interrupted by the COVID-19 pandemic. Adults aged 20 years or older with complete data on diabetes, PHQ-9 items, covariates, and survey-design variables were included. Participants with probable type 1 diabetes—defined as having been diagnosed before age 30, current insulin use, and no use of diabetes pills—were excluded; therefore, the exposure is described as self-reported diabetes rather than confirmed type 2 diabetes.

The final complete-case analytic sample included 12,653 adults. Of these, 8,286 participated in 2015-2018 and 4,367 participated in 2021-2023. Participant selection is presented in Figure 1, while Table 1 reports the weighted characteristics of the included population.

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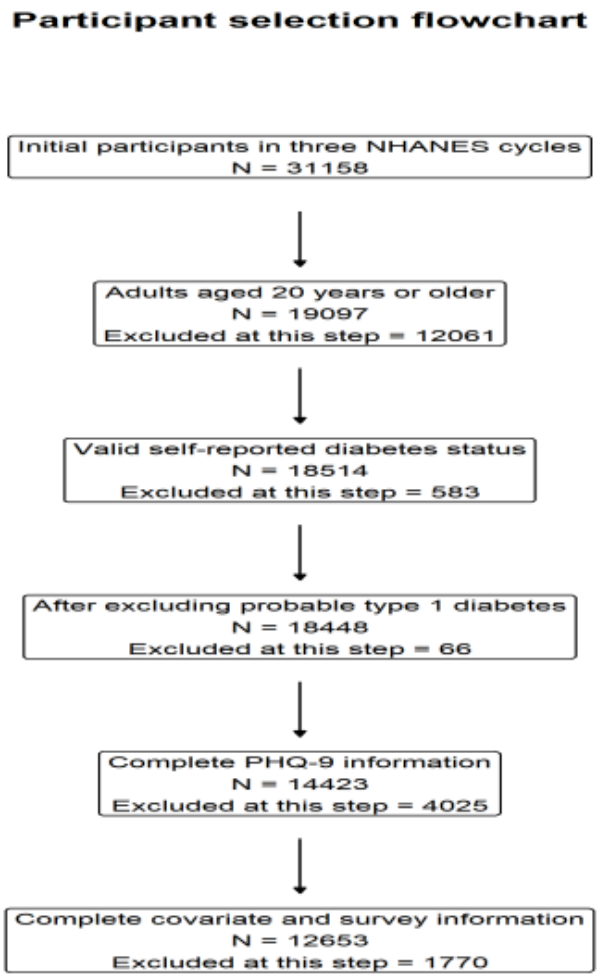

Figure 1. Participant selection for the NHANES 2015–2018 and 2021–2023 analytic sample

2.2. Measures and variable definitions

Depressive symptom severity was assessed with the validated nine-item Patient Health Questionnaire, which produces a total score from 0 to 27 [7]. For the primary analysis, participants scoring ≥10 on the PHQ-9 were classified as having clinically relevant depressive symptoms. This threshold identifies a screening outcome and should not be interpreted as a clinical diagnosis of major depressive disorder.

Self-reported diabetes was defined as an affirmative response to having been told by a doctor or health professional that the participant had diabetes, excluding cases of gestational diabetes. Survey period was coded as 2015-2018 or 2021-2023 and was used both as a main exposure and in the diabetes-by-period interaction.

Covariates selected a priori included age, sex, race and ethnicity, educational attainment, family poverty-income ratio (PIR), measured body mass index (BMI), and smoking status. Age, PIR, and BMI were analyzed as continuous variables. Education and smoking were analyzed categorically using the classifications reported in Table 1.

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2.3. Statistical analysis and survey weights

All analyses were performed in R and incorporated examination weights, sampling strata, and primary sampling units to reflect the NHANES design. Weighted means described continuous characteristics, and weighted proportions described categorical characteristics. Prevalence estimates and their 95% confidence intervals (CIs) were calculated for each combination of diabetes status and survey period.

The primary outcome was examined with survey-weighted logistic regression. Model 0 contained diabetes status, period, and a diabetes-by-period product term. Model 1 added age, sex, race and ethnicity, education, and PIR, while Model 2 additionally incorporated BMI and smoking status. Estimates are presented as odds ratios (ORs) with 95% CIs and P values. Evidence of a change in the diabetes–depressive symptom relationship across periods was assessed from the interaction term.

For sensitivity analyses, PHQ-9 was treated as a continuous measure, and age, PIR, and BMI were represented using natural splines with three degrees of freedom. The complete-case sample was retained throughout. All tests were two-sided, with $P < 0.05$ used as the criterion for statistical significance.

3. Results

3.1. Sample characteristics

The analytic sample included 12,653 adults: 8,286 from 2015-2018 and 4,367 from 2021-2023. Weighted participant characteristics are presented in Table 1. Most characteristics were similar across periods, although smoking status differed significantly (P = 0.025). The weighted prevalence of clinically relevant depressive symptoms was 7.8% in 2015–2018 and 12.2% in 2021-2023.

Table 1. Weighted characteristics of U.S. adults by survey period

Characteristic	Overall[1]	Pre-pandemic N = 128,194,771[1]	2021-2023 N = 58,940,691[1]	p-value[2]
Age, years	48.07 (17.09)	47.79 (17.00)	48.66 (17.26)	0.2
Gender				0.5
Male	48.7%	48.5%	49.2%	
Female	51.3%	51.5%	50.8%	
Race/ethnicity				0.3
Non-Hispanic White	65.4%	65.8%	64.4%	
Mexican American	7.7%	8.4%	6.4%	
Other Hispanic	6.7%	6.0%	8.2%	
Non-Hispanic Black	10.2%	10.5%	9.6%	
Other Race/Multiracial	9.9%	9.3%	11.4%	
Education				0.12
College graduate or above	33.4%	31.9%	36.9%	
Some college/AA degree	31.6%	32.0%	30.5%	
High school/GED	24.5%	24.5%	24.6%	
9th-11th grade	7.0%	7.6%	5.7%	
Less than 9th grade	3.4%	4.0%	2.3%	
Family poverty-income ratio	3.07 (1.64)	3.05 (1.64)	3.12 (1.63)	0.5
Body mass index, kg/m²	29.65 (7.15)	29.65 (7.14)	29.64 (7.17)	0.9
Smoking status				0.025

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Table 1. (continued)

Never	57.9%	56.1%	61.6%	
Former	25.1%	25.8%	23.6%	
Current	17.0%	18.0%	14.8%	
Diabetes status				>0.9
No diabetes	88.9%	88.9%	89.0%	
Self-reported diabetes	11.1%	11.1%	11.0%	
Depressive symptoms				<0.001
PHQ-9 < 10	90.8%	92.2%	87.8%	
Clinically relevant depressive symptoms	9.2%	7.8%	12.2%	

[1]Mean (SD); %
[2]Design-based Kruskal-Wallis test; Pearson's X^2: Rao & Scott adjustment

3.2. Prevalence of depressive symptoms by diabetes status

As shown in Table 2 and Figure 2, adjusted depressive-symptom prevalence was higher among adults with diabetes in both periods. In 2015-2018, prevalence was approximately 7% among adults without diabetes and 12% among those with diabetes. In 2021–2023, the corresponding estimates were approximately 12% and 17%. Within-period differences between diabetes status groups were statistically significant in 2015-2018 ($P < 0.001$) and 2021–2023 ($P = 0.009$).

Table 2. Model-adjusted prevalence of clinically relevant depressive symptoms by diabetes status and survey period

Survey period	Diabetes status	Adjusted prevalence, % (95% CI)	Within-period P value
2015–2018	No diabetes	Approximately 7.0 (6.4-7.8)	
2015–2018	Diabetes	Approximately 12.0 (10.2-14.4)	<0.001
2021–2023	No diabetes	Approximately 12.0 (10.6-13.8)	
2021–2023	Diabetes	Approximately 17.0 (13.5-21.0)	0.009

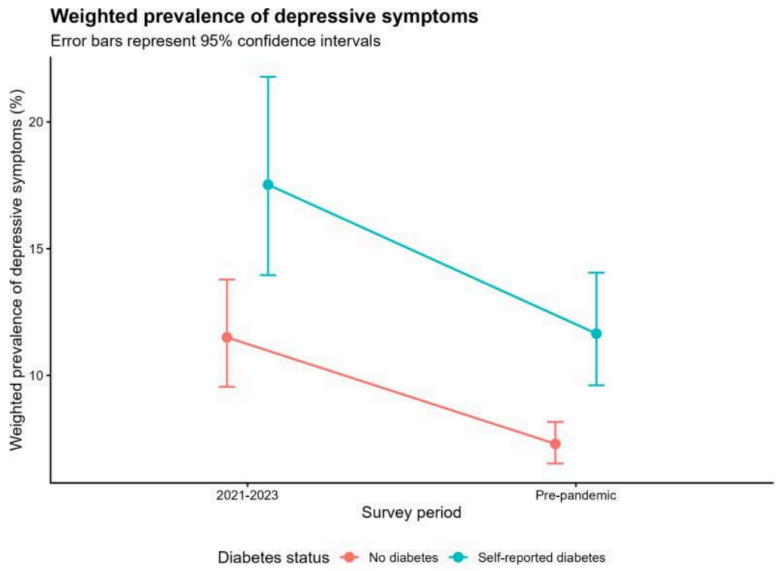

Figure 2. Model-adjusted prevalence of clinically relevant depressive symptoms by diabetes status and survey period

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3.3. Association between diabetes and depressive symptoms

Survey-weighted logistic regression showed that self-reported diabetes and the 2021-2023 period were each associated with higher odds of clinically relevant depressive symptoms (Table 3). These associations remained after adjustment for demographic characteristics, socioeconomic factors, BMI, and smoking status. However, the diabetes-by-period interaction was not statistically significant in any model. Therefore, there was insufficient evidence that the association between diabetes and depressive symptoms differed between 2015-2018 and 2021-2023. Fully adjusted period-specific estimates are presented in Figure 3.

Table 3. Survey-weighted regression findings for self-reported diabetes and clinically relevant depressive symptoms

Finding	Model 0	Model 1	Model 2
Diabetes association	Higher odds of depressive symptoms	Association remained after demographic and socioeconomic adjustment	Association remained after additional BMI and smoking adjustment
Period association	Higher odds in 2021–2023	Association remained after adjustment	Association remained after full adjustment
Diabetes × period interaction	Not statistically significant	Not statistically significant	Not statistically significant

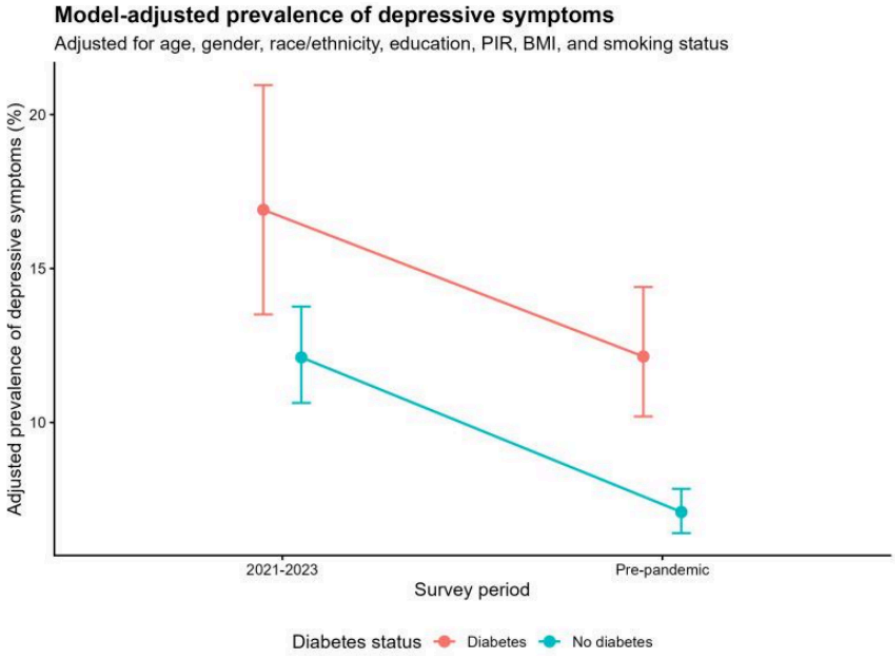

Figure 3. Model-adjusted prevalence of depressive symptoms

Table 4. Sensitivity analyses of the diabetes-by-period interaction

Sensitivity analysis	Diabetes effect (95% CI)	Period effect (95% CI)	Diabetes × period interaction (95% CI)	Interaction P value
Continuous PHQ-9 score	1.06 (0.67–1.46)	1.02 (0.74–1.29)	−0.31 (−0.96 to 0.34)	0.341
Nonlinear covariate specification	OR 1.85 (1.42–2.41)	OR 1.89 (1.55–2.30)	OR 0.79 (0.52–1.21)	0.265

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3.4. Sensitivity analyses

Sensitivity analyses were consistent with the primary findings (Table 4). In the continuous-outcome model, diabetes was associated with a 1.06-point-higher PHQ-9 score in 2015–2018 (95% CI: 0.67–1.46; $P < 0.001$). The diabetes-by-period interaction was not significant ($\beta = -0.31$, 95% CI: −0.96 to 0.34; $P = 0.341$).

In the nonlinear logistic model, diabetes was associated with higher odds of depressive symptoms in the reference period (OR = 1.85, 95% CI: 1.42–2.41; $P < 0.001$). The period effect was also significant (OR = 1.89, 95% CI: 1.55–2.30; $P < 0.001$), whereas the interaction remained nonsignificant (OR = 0.79, 95% CI: 0.52–1.21; $P = 0.265$).

3.5. Public health implications

Adults with self-reported diabetes had a consistently higher burden of clinically relevant depressive symptoms. The higher prevalence in 2021-2023 was observed in both diabetes groups, and the nonsignificant interaction did not support a diabetes-specific change between periods. These findings support routine depression screening and access to mental-health assessment within diabetes care. Coordinating behavioral-health services with diabetes self-management support may help address both psychological symptoms and chronic-disease management needs.

4. Conclusion

This study used nationally representative NHANES data from 2015-2018 and 2021-2023 to examine the association between self-reported diabetes and clinically relevant depressive symptoms among U.S. adults. The final complete-case sample included 12,653 participants aged 20 years or older. Survey-weighted descriptive analyses and sequential regression models accounted for the complex sampling design and were adjusted for demographic characteristics, socioeconomic status, BMI, and smoking.

Adults with self-reported diabetes had a higher burden of clinically relevant depressive symptoms during both periods. Model-adjusted prevalence was approximately 12% among adults with diabetes and 7% among adults without diabetes in 2015-2018. In 2021-2023, the corresponding estimates were approximately 17% and 12%. Thus, depressive symptoms were more common in the later period among adults both with and without diabetes.

Despite these prevalence differences, there was no statistically significant evidence that survey period modified the diabetes–depression association. Sensitivity analyses treating PHQ-9 score as a continuous outcome and modeling age, PIR, and BMI nonlinearly produced the same interaction conclusion. The results therefore suggest a persistent diabetes-associated mental-health burden rather than a clearly period-specific change in the relative association. Routine depression screening and the integration of mental health services into diabetes care may help alleviate this burden.

Several limitations should be considered. The repeated cross-sectional design cannot establish temporal order, causality, or within-person change. Diabetes status was based on self-report and may have been misclassified; the PHQ-9 is a screening tool, not a clinical diagnostic assessment. Complete-case analysis may have introduced selection bias, and residual confounding may remain. In addition, two survey periods cannot represent the entire course of pandemic-related change. Future studies could use longitudinal data, clinically verified diabetes diagnoses, more detailed diabetes-type classifications, and repeated mental-health assessments.

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