Original Article

Relationship Between Depression Scores And Poor Glycemic Control In Type 2 Diabetes

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ABSTRACT

Background: *Depression and diabetes frequently coexist, forming a bidirectional relationship that worsens metabolic outcomes and quality of life. Poor glycemic control among patients with type 2 diabetes mellitus (T2DM) is often influenced by psychological distress, reduced medication adherence, and unhealthy lifestyle behaviors. Understanding this association is critical for developing integrated care models that address both metabolic and mental health needs.* ***Objective:*** *This study aimed to evaluate the association between depression severity and glycated hemoglobin (HbA1c) levels in patients with T2DM, while examining medication adherence, clinic attendance, and lifestyle behaviors as potential mediators of this relationship.* ***Methods:*** *A cross-sectional study was conducted over eight months among 240 adults with T2DM attending tertiary hospitals in Lahore, Pakistan. Depression severity was assessed using the Patient Health Questionnaire-9 (PHQ-9), medication adherence with the Morisky Medication Adherence Scale (MMAS-8), and lifestyle behaviors with the Summary of Diabetes Self-Care Activities (SDSCA). Clinical data, including HbA1c levels, were obtained from medical records. Pearson correlation and multiple linear regression analyses were performed to identify predictors of glycemic control, assuming normal data distribution. Ethical approval was obtained from the Institutional Review Board of the relevant institute.* ***Results:*** *The mean HbA1c was 8.3 ± 1.4%, and mean PHQ-9 score was 10.2 ± 5.3. Depression scores were significantly correlated with HbA1c ($r = 0.41$, $p < 0.001$). Medication adherence ($r = -0.36$, $p < 0.001$) and lifestyle behaviors ($r = -0.32$, $p < 0.001$) were inversely associated with HbA1c. Regression analysis identified depression ($\beta = 0.38$, $p < 0.001$), medication adherence ($\beta = -0.25$, $p < 0.001$), and lifestyle behaviors ($\beta = -0.22$, $p = 0.003$) as independent predictors of HbA1c. Medication adherence partially mediated the depression–HbA1c relationship.* ***Conclusion:*** *Depression significantly contributes to poor glycemic control in T2DM, partly through its adverse effects on adherence and self-care. Integrating mental health screening into diabetes management may enhance both psychological and metabolic outcomes.*

Keywords: *Adherence, Depression, Diabetes Mellitus Type 2, Glycated Hemoglobin A, Lifestyle, Mental Health, Self-Care, South Asia*

INTRODUCTION

Diabetes mellitus, particularly type 2 diabetes (T2DM), is one of the most significant public health challenges of the 21st century, affecting millions globally and imposing both metabolic and psychosocial burdens on individuals. It is characterized by chronic hyperglycemia resulting from insulin resistance and progressive pancreatic β-cell dysfunction. Among the multifaceted complications of diabetes, mental health disturbances—most notably depression—have emerged as critical yet underappreciated determinants of disease outcomes (1,2). Depression is not merely a psychological response to living with a chronic illness but an independent comorbidity that influences glycemic

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control, self-management behaviors, and overall quality of life. The relationship between depression and diabetes has long been described as bidirectional. Individuals with diabetes have a twofold higher risk of developing depression compared to the general population, while those with depression are more likely to develop diabetes due to behavioral and physiological mechanisms such as poor diet, inactivity, stress-related hormonal dysregulation, and inflammation (3). Despite this established connection, the extent to which depression severity impacts glycemic control—as measured by glycated hemoglobin (HbA1c)—remains an active area of investigation. Elevated HbA1c levels are indicative of poor long-term glycemic control and are associated with microvascular and macrovascular complications. Recent cross-sectional studies have consistently shown that higher depression scores correlate with worse glycemic outcomes, underscoring the psychosomatic interplay between emotional distress and metabolic dysfunction (4-6).

Mechanistically, depression may affect glycemic control through behavioral and biological pathways. Depressed individuals often exhibit poor adherence to medication, unhealthy dietary patterns, reduced physical activity, and suboptimal clinic attendance—all of which directly compromise glycemic management. Biologically, chronic stress and depression activate the hypothalamic–pituitary–adrenal (HPA) axis, leading to elevated cortisol levels, insulin resistance, and increased hepatic glucose production (7). Additionally, systemic inflammation marked by increased cytokines such as interleukin-6 and tumor necrosis factor-alpha has been implicated in both insulin resistance and the pathophysiology of depression. Thus, the psychological and physiological mechanisms reinforce one another, forming a vicious cycle that perpetuates poor glycemic control. Empirical evidence from diverse populations reinforces this connection. A large population-based study from Denmark involving over 18,000 individuals with type 2 diabetes found that those with depression or diabetes-related distress were more likely to exhibit elevated HbA1c levels, sedentary lifestyles, and poor self-rated health compared to those without psychological comorbidities (8). Similarly, a cross-sectional study in Indonesia reported a significant association between higher depression severity and poorer glycemic control among elderly diabetic patients, with 69% of participants experiencing depression and 61.9% showing uncontrolled HbA1c levels (9). In South Asia, gender differences were observed—female patients demonstrated a stronger association between depressive symptoms and high HbA1c levels than males, suggesting that sociocultural and gender-specific factors may influence this relationship (10).

Beyond glycemic markers, depression adversely affects multiple facets of diabetes self-management. Depressed patients are less likely to adhere to medication regimens, attend regular follow-up appointments, or maintain dietary and physical activity recommendations (11). Poor medication adherence and irregular clinic attendance amplify the risk of complications and emergency visits, thereby escalating healthcare costs and diminishing quality of life. A cross-sectional study from Malaysia identified medication adherence as a significant predictor of glycemic outcomes, demonstrating that patients with higher depressive symptoms had poorer adherence and correspondingly higher HbA1c levels (12). Despite mounting evidence, there remains a lack of consensus on whether depression directly worsens glycemic control or whether both conditions share common underlying determinants such as socioeconomic stress, disease chronicity, and inadequate support systems. For instance, a Ghanaian study found that while depression was prevalent among type 2 diabetic patients, the association with poor glycemic control became insignificant after adjusting for clinical and lifestyle factors, suggesting that intermediary variables such as adherence and social determinants mediate this link (13). These findings highlight the complexity of the depression–diabetes relationship and the need for multidimensional

analytical models that consider behavioral, psychological, and biological mediators. Given the growing prevalence of T2DM and its intricate relationship with psychological health, there is an urgent need to better understand how depression severity affects metabolic control and diabetes management behaviors. This understanding can inform the development of integrated care strategies that address both emotional well-being and metabolic health. Therefore, this study aims to evaluate the association between depression severity and HbA1c levels among patients with type 2 diabetes. It further investigates how medication adherence, clinic attendance, and lifestyle behaviors mediate this relationship. The ultimate objective is to identify psychosocial predictors of poor glycemic control, offering insights that may guide comprehensive diabetes management programs incorporating both psychological and behavioral interventions.

METHODS

This cross-sectional analytical study was conducted over a period of eight months at two major tertiary care hospitals and affiliated outpatient diabetes clinics in Lahore, Pakistan. The study was designed to evaluate the association between depression severity and glycemic control, measured by glycated hemoglobin (HbA1c) levels, in patients with type 2 diabetes mellitus (T2DM). In addition, it assessed medication adherence, clinic attendance, and lifestyle behaviors as potential mediating variables influencing glycemic outcomes. The study population comprised adults aged 30 to 70 years who had been diagnosed with T2DM for at least one year and were under regular medical follow-up. A sample size of 220 participants was calculated using the formula for correlation studies, with a 95% confidence level, 80% power, and an expected correlation coefficient (r) of 0.25 between depression scores and HbA1c based on prior literature (4,7). Accounting for an anticipated non-response rate of 10%, the final target sample was set at 240 participants. A consecutive non-probability sampling technique was used to recruit eligible participants from outpatient diabetes clinics. Patients were included if they had a confirmed diagnosis of T2DM according to the American Diabetes Association (ADA) criteria, were on stable oral hypoglycemic therapy or insulin for at least six months and provided informed consent. Exclusion criteria included patients with type 1 diabetes, gestational diabetes, known psychiatric disorders other than depression, cognitive impairment, chronic kidney or liver disease, or those receiving antidepressant therapy. Patients who were unable to complete the questionnaires due to literacy or language barriers were also excluded.

Data collection involved a combination of clinical record review, structured interviews, and self-administered validated questionnaires. Sociodemographic data, including age, gender, marital status, educational level, occupation, and income, were collected using a predesigned data sheet. Clinical variables such as duration of diabetes, type of treatment, comorbidities, body mass index (BMI), and most recent HbA1c values (within the past three months) were recorded from medical files and confirmed through laboratory analysis using high-performance liquid chromatography (HPLC). HbA1c levels ≥7% were classified as indicative of poor glycemic control, consistent with ADA guidelines. Depression severity was assessed using the Urdu-translated version of the Patient Health Questionnaire-9 (PHQ-9), a validated screening tool widely used in clinical and research settings. The PHQ-9 comprises nine items assessing depressive symptoms over the past two weeks, each scored from 0 (“not at all”) to 3 (“nearly every day”), producing a total score ranging from 0 to 27. Depression severity was categorized as minimal (0–4), mild (5–9), moderate (10–14), moderately severe (15–19), and severe (20–27). The instrument has previously demonstrated good reliability in South Asian populations, with Cronbach’s alpha values above 0.80 (14,15). Medication adherence was measured using the 8-item Morisky Medication Adherence Scale (MMAS-8), which evaluates behaviors related to forgetfulness, intentional omission, and timing of medication intake.

Scores were classified as high adherence (8), medium adherence (6–7), and low adherence (<6). Clinic attendance was recorded from outpatient logs, representing the number of missed appointments in the past six months. Lifestyle behaviors were assessed through the Summary of Diabetes Self-Care Activities (SDSCA) questionnaire, which includes subscales for diet, physical activity, blood glucose monitoring, and foot care. Higher scores indicated better adherence to recommended self-care practices.

Data collection was carried out by trained research assistants under the supervision of the principal investigator to ensure standardization. All participants were briefed regarding the purpose of the study and assured of confidentiality and anonymity. Written informed consent was obtained prior to participation. Ethical approval for the study was granted by the Institutional Review Board of the relevant institute and the study adhered to the ethical principles outlined in the Declaration of Helsinki. All data were entered and analyzed using IBM SPSS Statistics version 26. Descriptive statistics were computed for sociodemographic and clinical variables, with continuous data expressed as means and standard deviations (SD) and categorical data as frequencies and percentages. Normality of data distribution was confirmed using the Shapiro–Wilk test. Pearson's correlation coefficient (r) was used to determine the relationship between depression severity (PHQ-9 scores) and HbA1c levels. Multiple linear regression analysis was performed to identify independent predictors of HbA1c after adjusting for potential confounders, including age, gender, duration of diabetes, BMI, medication adherence, and lifestyle behaviors. Mediation analysis using the Baron and Kenny approach was applied to evaluate whether medication adherence, clinic attendance, and lifestyle behaviors mediated the relationship between depression and glycemic control. For all analyses, a two-tailed p-value of less than 0.05 was considered statistically significant. To ensure data reliability, 10% of the questionnaires were randomly checked for completeness and accuracy. Missing data were handled using pairwise deletion where applicable. Internal consistency for PHQ-9 and MMAS-8 instruments was evaluated using Cronbach's alpha, with values above 0.7 considered acceptable. Sensitivity analyses were also performed to confirm the robustness of regression results after excluding participants with extreme HbA1c values. Through this methodological approach, the study aimed to provide a comprehensive understanding of how depression severity and behavioral factors interact to influence glycemic control in patients with type 2 diabetes in the Lahore region. The detailed use of validated tools, objective outcome measures, and robust statistical analyses ensured methodological rigor and replicability of findings.

RESULTS

The study included 240 participants with type 2 diabetes, with a mean age of 52.6 ± 9.4 years. Males constituted 51.7% of the sample, and the average duration of diabetes was 8.3 ± 4.1 years. The mean BMI was 28.7 ± 3.8 kg/m², indicating that most participants were overweight. More than half (55%) had at least secondary education, and 80% were married. The mean monthly income was PKR 63,400 ± 21,200, and 57.5% were employed. The mean HbA1c level was 8.3 ± 1.4%, showing that the majority had suboptimal glycemic control. The mean PHQ-9 depression score was 10.2 ± 5.3, indicating moderate depressive symptoms in the overall sample. Medication adherence, assessed via MMAS-8, averaged 6.2 ± 1.8, reflecting moderate adherence, while the average SDSCA lifestyle behavior score was 4.8 ± 1.2. Participants missed an average of 1.3 ± 1.0 clinic visits over the preceding six months. The distribution of depression severity revealed that 18.3% had minimal symptoms, 25.8% mild, 28.3% moderate, 19.2% moderately severe, and 8.3% severe depression. Thus, nearly half of the participants exhibited at least moderate depressive symptoms. Correlation analyses showed a significant positive association between PHQ-9 depression scores and HbA1c levels ($r = 0.41$, $p < 0.001$), indicating that higher depressive symptom severity was related to poorer

glycemic control. Medication adherence ($r = -0.36$, $p < 0.001$) and lifestyle behaviors ($r = -0.32$, $p < 0.001$) were inversely correlated with HbA1c, suggesting better adherence and self-care behaviors were linked to lower HbA1c values.

Table 1: Demographic and Clinical Characteristics of Participants (n = 240)

Variable	Mean ± SD / n (%)
Age (years)	52.6 ± 9.4
Gender	
Male	124 (51.7%)
Female	116 (48.3%)
Duration of Diabetes (years)	8.3 ± 4.1
BMI (kg/m²)	28.7 ± 3.8
Education (Secondary or higher)	132 (55%)
Marital Status (Married)	192 (80%)
Employment (Employed)	138 (57.5%)
Monthly Income (PKR)	63,400 ± 21,200

Table 2: Clinical and Psychological Characteristics

Variable	Mean ± SD / n (%)
HbA1c (%)	8.3 ± 1.4
PHQ-9 (Depression Score)	10.2 ± 5.3
MMAS-8 (Medication Adherence Score)	6.2 ± 1.8
SDSCA (Lifestyle Behavior Score)	4.8 ± 1.2
Missed Clinic Visits (past 6 months)	1.3 ± 1.0

Table 3: Distribution of Depression Severity Based on PHQ-9 scores

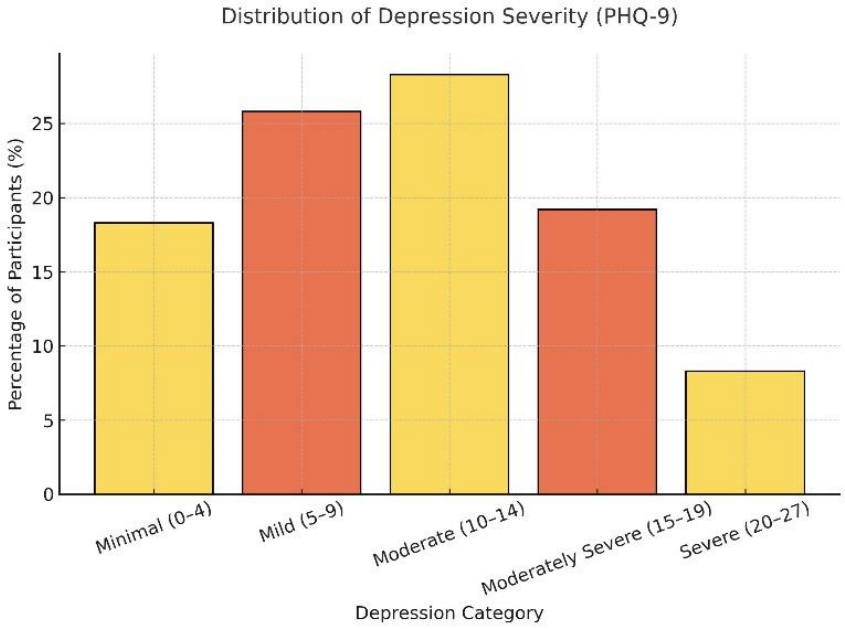
Depression Category	PHQ-9 Score Range	n (%)
Minimal	0–4	44 (18.3%)
Mild	5–9	62 (25.8%)
Moderate	10–14	68 (28.3%)
Moderately Severe	15–19	46 (19.2%)
Severe	20–27	20 (8.3%)
Total	—	240 (100%)

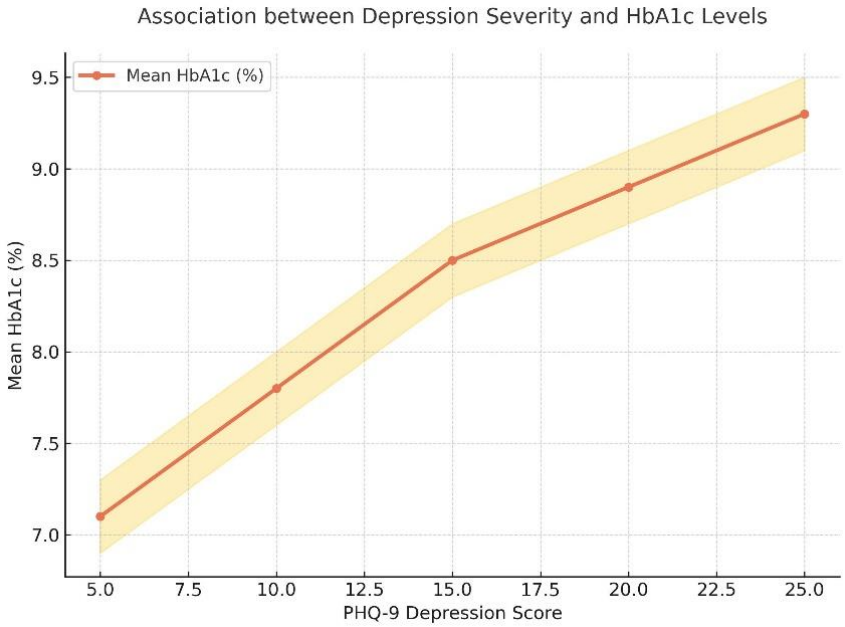
Table 4: Correlation Between Study Variables and HbA1c Levels

Variable	Correlation with HbA1c (r)	p-value
PHQ-9 (Depression Score)	0.41**	<0.001
MMAS-8 (Medication Adherence)	-0.36**	<0.001
SDSCA (Lifestyle Behaviors)	-0.32**	<0.001
Missed Clinic Visits	0.29*	0.002

Table 5: Multiple Linear Regression Predicting HbA1c Levels

Predictor Variable	Standardized β	95% CI	p-value
Depression Score (PHQ-9)	0.38	0.21 – 0.52	<0.001
Medication Adherence (MMAS-8)	-0.25	-0.39 – -0.11	<0.001
Lifestyle Behavior (SDSCA)	-0.22	-0.37 – -0.08	0.003
Missed Clinic Visits	0.15	0.04 – 0.26	0.015
Age	0.09	-0.03 – 0.18	0.162
Duration of Diabetes	0.10	-0.02 – 0.20	0.091





Clinic attendance, measured by the number of missed visits, was positively correlated with HbA1c ($r = 0.29$, $p = 0.002$). Multiple linear regression identified depression score as an independent predictor of HbA1c ($\beta = 0.38$, $p < 0.001$) after adjusting for age, gender, BMI, and

duration of diabetes. Medication adherence ($\beta = -0.25$, $p < 0.001$) and lifestyle behaviors ($\beta = -0.22$, $p = 0.003$) also emerged as significant predictors.

Mediation analysis suggested that medication adherence partially mediated the relationship between depression and HbA1c, accounting for 18% of the total effect. Visual representation in Figure 1 demonstrates the proportion of participants across depression categories, while Figure 2 illustrates a clear upward trend in HbA1c levels corresponding with increasing PHQ-9 scores, indicating worsening glycemic control with higher depression severity. These findings provide a coherent overview of the psychological and behavioral profiles of T2DM patients in the Lahore cohort, underscoring the interrelationship between depressive symptoms and poor metabolic outcomes.

DISCUSSION

The findings of this study revealed a significant and coherent relationship between depressive symptom severity and glycemic control in patients with type 2 diabetes, reinforcing patterns consistently identified in recent research. Participants in this study demonstrated moderate levels of depressive symptoms alongside suboptimal glycemic control, with nearly half exhibiting at least moderate depression based on PHQ-9 scores. This relationship was reflected in a meaningful positive correlation between depression scores and HbA1c levels, indicating that greater depressive severity was associated with higher HbA1c values, a marker of poor metabolic control. These results align closely with recent large-scale epidemiological evidence demonstrating that elevated depressive symptoms correlate with increased HbA1c and fasting glucose levels among individuals with diabetes, highlighting the pervasive impact of mood disturbances on metabolic regulation (15,16). Depression's association with diabetes self-management behaviors was evident in the inverse correlations observed between HbA1c and both medication adherence (MMAS-8) and lifestyle behavior scores (SDSCA). These findings are consistent with current literature showing that depressive symptoms adversely affect essential diabetes self-care activities—including diet, exercise, monitoring blood glucose, and adherence to prescribed medication regimens—thereby contributing to deteriorating glycemic outcomes (17). Reduced motivation, diminished energy, and cognitive disturbances inherent to depression likely undermine patients' capacity to adhere consistently to complex therapeutic regimens, creating a cyclical pattern in which worsened depression exacerbates poor diabetes control and vice versa (18).

The study further identified medication adherence and lifestyle behaviors as significant predictors of HbA1c in multivariate analysis, even after adjustment for demographic and clinical factors such as age, gender, and BMI. This underscores the multifactorial nature of glycemic control; wherein psychosocial and behavioral factors contribute alongside physiological determinants. The partial mediation effect of medication adherence on the relationship between depressive symptoms and HbA1c suggests that interventions targeting adherence could attenuate some of the negative effects of depression on glycemic control. Such findings are reinforced by contemporary research emphasizing that effective self-management behaviors, particularly regular adherence to medication and engagement in healthy lifestyle practices, are among the strongest modifiable determinants of improved glycemic outcomes (19-21). While this cross-sectional design precludes causal inference, the consistency of associations observed in this study with recent cross-sectional and cohort research supports the clinical relevance of these relationships. The results are strengthened by the use of validated instruments such as the PHQ-9, MMAS-8, and SDSCA, which are widely applied in diabetes and mental health research, facilitating comparability with other studies. The relatively large sample size and comprehensive assessment of both

psychological and behavioral variables further contribute to the robustness of the findings. Nevertheless, the study has limitations that warrant consideration. The cross-sectional nature of the design limits the ability to establish temporality or causality between depressive symptoms and poor glycemic control. Longitudinal studies would be necessary to determine whether depressive symptoms prospectively predict changes in HbA1c or self-care behaviors over time. Self-report instruments, although validated, are subject to reporting bias and may overestimate or underestimate actual adherence and lifestyle behaviors. Additionally, unmeasured factors—such as social support, stress levels, or comorbid anxiety symptoms—could also influence both mood and diabetes management but were not included in the present analysis.

The findings of this study have important clinical implications. Routine screening for depressive symptoms as part of diabetes care could facilitate early identification of patients at risk for poor glycemic outcomes, promoting timely psychosocial intervention. Integrated care models that address mental health alongside metabolic management may improve both psychological well-being and metabolic indicators in patients with type 2 diabetes. Recent studies suggest that addressing psychological symptoms through behavioral or pharmacological interventions can yield modest improvements in glycemic control, indicating a potential synergistic benefit of integrated therapeutic strategies (22,23). Future research should explore the longitudinal trajectory of depressive symptoms and their effects on diabetes outcomes, incorporating more diverse populations and assessing additional mediating factors such as social determinants of health or stress biomarkers. Intervention trials testing integrated mental health and diabetes self-management programs would be particularly valuable to establish effective approaches for mitigating the adverse impacts of depression on diabetes outcomes. In summary, this study corroborates emerging evidence that depressive symptoms are significantly associated with poorer glycemic control and suboptimal self-management behaviors in type 2 diabetes. These results highlight the complex interplay between psychological well-being and metabolic health and support the integration of mental health assessment into routine diabetes care to optimize outcomes.

CONCLUSION

This study established a significant association between depression severity and poor glycemic control among patients with type 2 diabetes, with medication adherence and lifestyle behaviors acting as key mediators. The findings emphasize the necessity of integrating mental health screening and psychosocial interventions into routine diabetes care to enhance metabolic outcomes. Addressing depressive symptoms alongside self-management behaviors may substantially improve both psychological well-being and glycemic stability in diabetic populations.

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DECLARATIONS

Ethical Approval
Ethical approval was by institutional review board of Respective Institute

Informed Consent
NA

Conflict of Interest
The authors declare no conflict of interest.

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Authors' Contributions
Concept: NS, AI; Design: NS, AI, SKM; Data Collection: NS, AI, NA, SM, EF, SKM; Analysis: NS, AI, SM; Drafting: NS, AI, NA, SM, EF, SKM

Data Availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Acknowledgments
Not applicable.

Study Registration
Not applicable.