

Prevalence of Depression in the Diabetic Population and its Influence on Glycaemic Profile: A Prospective Interventional Study

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ABSTRACT

Objectives: The study aims to determine the prevalence of depression in the diabetic population and its influence on glycaemic profile. **Materials and Methods:** A prospective interventional study was conducted at Narayana Medical College and Hospital, Nellore, Andhra Pradesh, India. This study included 300 patients diagnosed with Type 2 Diabetes (T2D) and exhibiting depression with a PHQ-9 score >5. Depression levels were assessed before and after the intervention using validated measures. A chi-square test was used to analyze the changes in depression status, while a *t*-test was employed to evaluate the effect of the intervention on glycaemic control. The reduction in depression levels following the intervention was also reported. **Results:** After a 4-month psychotherapeutic intervention, significant improvements were observed in both depression severity and glycaemic control. The percentage of patients without depression increased from 65.10% to 74.84%, while those with mild, moderate, and severe depression decreased to 34.40%, 29.30%, and 8.40%, respectively, indicating a substantial reduction in depression levels. Glycaemic control also showed significant improvements, with HbA_{1c} levels decreasing from 9.2±1.5% to 7.3±1.2%, and similar improvements were observed in Fasting Blood Sugar (FBS) and Postprandial Blood Sugar (PPBS) levels (*p*<0.01). **Conclusion:** The 4-month psychotherapeutic intervention significantly reduced depression levels and improved glycaemic control in patients with Type 2 Diabetes. These findings highlight the importance of addressing both mental health and glycaemic management for better overall outcomes. Integrated treatment approaches may enhance the quality of life for patients with comorbid diabetes and depression.

Keywords: Diabetes, Depression, Glycaemic profile, Intervention.

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INTRODUCTION

Diabetes is a critical health challenge impacting millions across the world. With its prevalence steadily rising, projections indicate that over 500 million individuals will live with the condition by 2030.¹ This surge is predominantly driven by urbanization, sedentary lifestyles, unhealthy dietary habits, and an aging population. Type 2 Diabetes (T2D) is the most common form of diabetes, accounting for approximately 90-95% of all diabetes cases globally.² The increasing burden of diabetes places immense pressure on healthcare systems, underscoring the urgent need for comprehensive prevention strategies, effective management approaches, and robust public health initiatives.³

In 2021, an estimated 529 million people worldwide were living with diabetes. The highest prevalence rates were recorded in North Africa and the Middle East (9.3%) and Oceania (12.3%).⁴ As of 2021, approximately 537 million adults aged 20-79 years (10% of this age group) were living with diabetes, with projections indicating a significant rise to 643 million by 2030 and 783 million by 2045.

Individuals with diabetes, particularly type 2, face a substantially elevated risk of developing depression compared to the general population. This bidirectional relationship indicates that diabetes can predispose individuals to depression, while depression, in turn, increases the likelihood of developing diabetes. When depression occurs in people with diabetes, it often exacerbates the condition by impairing glycaemic control. This is primarily due to reduced medication adherence, unhealthy lifestyle choices, and decreased motivation for effective self-care, highlighting the critical need for integrated management of both conditions.⁵ This, in turn, can worsen diabetes outcomes, creating a vicious cycle between the two conditions. A collaborative care approach



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by treating the individual through Psychotherapy along with diabetes management is essential for enhancing therapeutic outcomes.⁶

Diabetes and Mental Health: The Link

People with diabetes are about twice as likely to experience depression compared to those without diabetes. Emerging research suggests that depression and type 2 diabetes share common biological mechanisms, including chronic inflammation caused by overactive innate immunity and Hypothalamic-Pituitary-Adrenal (HPA) axis dysregulation, which leads to stress-induced hormonal imbalances. These processes contribute to the development and worsening of both conditions. These interconnected pathways play a critical role in the development of insulin resistance, cardiovascular complications, depression, and heightened mortality risk. In type 1 diabetes, studies on depression remain limited; however, evidence suggests that familial predispositions and the lifelong psychosocial burden of disease management are significant contributing factors. Longitudinal studies are essential to uncover how depression and type 2 diabetes develop and influence each other over time. Understanding these shared origins can lead to better treatments for both conditions and help create strategies to prevent type 2 diabetes, especially in people with depression or related risk factors.⁷

Impact of Depression on Glycaemic Control

Depression significantly affects glycaemic control, particularly in individuals with diabetes, creating a complex interplay between psychological and physiological factors. Depressed individuals often struggle with self-care behaviours, such as adhering to medications, maintaining a healthy diet, and regular exercise, all of which are crucial for managing blood glucose levels.⁵ Depression can lead to irregular eating patterns, either through overeating, especially of high-sugar comfort foods, or under-eating, both of which can cause fluctuations in blood sugar.⁸ Moreover, the cognitive impairments associated with depression, such as difficulty concentrating and memory issues, further complicate the daily tasks of diabetes management.⁹

On a physiological level, depression triggers an increase in stress hormones like cortisol, which promotes insulin resistance and higher blood glucose levels.¹⁰ Additionally, systemic inflammation, often elevated in depression, can interfere with insulin sensitivity and glucose metabolism.¹¹ The combined impact of depression and poor glycaemic control increases the risk of complications related to diabetes (such as heart disease, nerve damage, or kidney problems), putting additional strain on both mental and physical health.¹² Treating both conditions together through a combination approach-addressing both mental health and diabetes management simultaneously, can help break the cycle, improving overall health and outcomes for patients.^{13,14}

Gaps in the Existing Research

Despite the well-documented relationship between depression and poor glycaemic control in diabetic patients, existing research often overlooks the potential role of holistic interventions, such as spiritual and counseling sessions, in managing both mental health and blood glucose levels. Current treatment approaches tend to focus heavily on pharmacological or behavioural strategies to address depression and diabetes management separately, rather than considering integrated, person-centered interventions.¹⁵ The psychological well-being of patients is often addressed through traditional counseling or cognitive-behavioural therapy, but little emphasis has been placed on the role of spiritual care and its unique capacity to promote emotional resilience, reduce stress, and foster a sense of purpose.¹⁶ Furthermore, while studies have explored the impact of conventional psychological therapies on depression in diabetic patients, few have examined how spiritually oriented interventions-designed to improve mental health and promote positive coping mechanisms-might impact the physiological aspects of diabetes, particularly glycaemic control. Existing research tends to ignore how non-pharmacological, holistic therapies could influence important biomarkers such as HbA_{1c} levels and insulin sensitivity.^{17,18}

This gap underscores the importance of targeted research exploring the impact of integrating spiritual care with psychological counseling on the mental and physical health of individuals with diabetes. Investigating how these interventions enhance psychological well-being in patients with depression and improve glycaemic control is essential for designing more holistic and effective treatment strategies. This approach has the potential to effectively manage the bi-directional relationship between depression and diabetes, thereby significantly improving overall health outcomes.^{19,20}

Tertiary healthcare serves as a key provider of specialized medical services, making it critical in offering comprehensive care, including patient counseling and mental health support for diabetic patients. Currently, there is limited data on the impact of patient counseling and meditation techniques on the glycaemic profile of diabetic patients and impact of these interventions on likelihood of developing depression. This study aims to evaluate the effect of counseling and meditation techniques on improving glycaemic profile of diabetic patients, with the broader goal of lowering the risk of depression. The findings will aid in designing targeted interventions to improve metabolic control, enhance mental well-being, and reduce overall healthcare costs. Considering the unique sociodemographic makeup of the Indian population, it is hypothesized that the outcomes of these interventions may differ from those reports of the studies conducted in other countries.

MATERIALS AND METHODS

Study Design

This interventional study was conducted at Narayana Medical College and Hospital, Nellore, following approval from the institutional ethics committee. Patients were recruited based on predefined inclusion criteria. Eligible participants received a comprehensive explanation of the study objectives and procedures, and written informed consent was obtained from all participants before enrolment.²¹ According to the enrolment criteria, adult patients with Type 2 Diabetes Mellitus (T2DM), defined by an HbA_{1c} level of $\geq 7\%$, attending the outpatient or inpatient departments at Narayana General and Super Specialty Hospital, were included in the study. Individuals under 18 years of age, those with Type 1 diabetes mellitus, gestational diabetes, pre-existing depression or other psychiatric disorders, inability to communicate independently, or those on corticosteroids or medications affecting glucose metabolism, were excluded from the study.²²

The total number of volunteers selected for the population was calculated from the QualitricsSM software © 2024 version. The sample size was determined based on an estimated prevalence of depression among patients with T2DM, assuming a maximum margin of error of 6%, a confidence level of 95%, and a population size of 10,000.²³ This calculation yielded a required sample size of 260 participants. To account for potential dropouts, deaths, or other reasons for non-completion during the study intervention, an additional 5% of the calculated sample size of 260 patients was included, ensuring the study's robustness and reliability.²⁴ A structured sampling technique was employed, with selected hospitals serving as the primary sampling units.

A total of 783 diabetic patients were identified in a period of 4 months from OPD and IPD of the hospital. All the 783 patients were checked for depression by PHQ-9. 300 patients were with depression and recruited into the study. Of these, 22(7.3%) patients were dropped, and 5(1.7%) patients were expired during the study. The remaining patients continued in the study till the end were 273. The result of the intervention was analysed in 273 patients. The final sample size aligns with a 6% margin of error, a 95% confidence interval, and a population size of 100,000, ensuring the statistical robustness of the study findings.²⁵ 273 patients participated in the study. They were asked to complete the PHQ-9 questionnaire, which is a tool used to assess the severity of their depression symptoms. The glycaemic profiles (blood sugar levels) of these participants were measured both before and after the intervention. Statistical analysis was then conducted to assess the significance of the findings, helping to determine whether the intervention had a meaningful impact on both depression and glycaemic control.

Intervention

The psychotherapeutic interventions in this study were categorized into Cognitive Behavioral Therapy (CBT), Mindfulness-Based Therapy (MBT), and counseling therapy. CBT was introduced to diabetic patients through walking meditation and journaling, aimed at addressing and restructuring negative thought patterns along with all essential factors in diabetes management.²⁶ Mindfulness-based therapies were incorporated to help patients manage stress, improve self-awareness, and regulate emotions. MBT intervention included meditation and deep breathing exercises, which patients were encouraged to practice consistently over four months. During their regular hospital visits, patients participated in structured sessions involving 10 min of guided meditation followed by 10 min of deep breathing, designed to enhance relaxation and mindfulness. Telephonic counseling, offered by psychotherapists, clinical pharmacists, and supportive staff, was available to patients as needed.²⁷ This counseling focused on addressing emotional challenges, promoting adherence to therapy, and offering coping strategies. Through these psychotherapeutic interventions, the study aimed to assess the effectiveness of psychotherapies in improving both psychological well-being and glycaemic profile.

Data Collection Tools

For this interventional study, selected subjects were interviewed by a clinical pharmacist to collect key patient information, including sex, gender, age, marital status, smoking status, and other relevant details as outlined in Table 1. Additionally, physical examination data from the past three months, including blood glucose levels, were retrieved from the patient's medical records.^{28,29} The depression status of participants was assessed at the time of recruitment using the Patient Health Questionnaire-9 (PHQ-9), a validated tool based on the nine diagnostic criteria for major depressive disorder as defined by the DSM-IV. Depression severity was categorized as mild (PHQ-9 score of 5-9), moderate (10-19), or severe (≥ 20), to evaluate the impact of the intervention. Glycaemic control was classified as good (HbA_{1c} $\leq 7\%$, fasting blood glucose 80-130 mg/dL, and postprandial glucose < 180 mg/dL).

Data Processing and Analyses

The data were analyzed on categorical variables using frequencies and percentages. The Chi-square test was employed to evaluate the impact of psychotherapeutic treatment on the population. To compare the glycaemic profiles of patients with depression, a *t*-test was conducted for HbA_{1c}, fasting blood glucose, and postprandial glucose levels. A *p*-value of ≤ 0.05 was set as the threshold for statistical significance in all analyses.

RESULTS

Demographic Characteristics of the Study Population

A total of 300 patients were initially enrolled in this study. After accounting for 22 dropouts (7.3%) and 5 deaths (1.7%), the final cohort consisted of 273 patients whose data were analysed. Among them, 183 (67%) were male, and 117 (33%) were female. In terms of age, 145 patients (53.1%) were 60 years or younger, while 128 (46.9%) were older than 60. Majority of the patients were married (91.5%), with only 8.5% being single, widowed, or divorced. A strong family history of diabetes was noted, with 74.7% of patients reporting a positive family history, while 25.3% had no family history of the disease. Regarding smoking habits, 75.5% were non-smokers, 22.7% were current smokers, and 1.8% were ex-smokers. When it came to treatment for diabetes, the majority (69.5%) were on oral hypoglycaemic agents alone, while 27.5% were using both oral hypoglycaemic agents and insulin, and only 2.9% were managing their condition through lifestyle changes alone. A significant proportion of patients (67.4%) had developed diabetic complications, while 32.6% were free of any complications. These characteristics provide a comprehensive overview of the patient population included in the analysis and represented in Table 1.

Prevalence of Depression in Diabetic Patients

According to the survey, the severity of depression before the intervention is categorized into four groups: No Depression, Mild Depression, Moderate Depression, and Severe Depression represented in Figure 1. A significant majority of individuals, 65.2%, reported experiencing no depression at all. The next largest group, making up 17.6%, had mild depression, while 12.8% of individuals experienced moderate depression. Finally, 4.5% of the population reported severe depression.

Statistical Analysis and Interpretation

The analysis was based on the data for depression severity before and after intervention among diabetic patients. Before intervention, 510 patients (65.10%) were classified as having no depression, which increased to 586 patients (74.84%) after the intervention, indicating a significant improvement in depression status. There were 138 patients (50.50%) with mild depression before the intervention, but this number dropped to 94 patients (34.40%) post-intervention, showing a reduction in mild depression cases. Moderate depression was observed in 100 patients (36.60%) before treatment, which decreased to 80 patients (29.30%) after the intervention. The number of patients with severe depression decreased from 35 patients (12.88%) before the intervention to 23 patients (8.40%) afterward, reflecting an improvement in the severity of depression. The chi-square statistic for the depression severity changes before and after the intervention was 17.5594. The corresponding

p -value was 0.000028, which is highly significant at the $p < 0.05$ level. The significant chi-square result ($p < 0.05$) indicates that the psychotherapeutic intervention had a statistically significant effect on reducing the severity of depression in diabetic patients.

There was a noticeable shift from moderate and severe depression categories to either mild depression or no depression after the intervention, suggesting that the treatment was effective in improving mental health outcomes represented in Table 2, Figure 2.

The results of the psychotherapeutic intervention on the clinical variables of HbA_{1c}, Fasting Blood Sugar (FBS), and Postprandial Blood Sugar (PPBS) demonstrate a significant improvement in the management of blood glucose levels in diabetic patients

Table 1: Sociodemographic and Clinical Characteristics of the Studied Group.

Characteristic	No. of Patients	%
Total Patients	300	100%
Dropout	22	7.30%
Expired	5	1.70%
Total	273	
Gender		
Male	183	67.00%
Female	117	33.00%
Age Group		
Lower than or equal to 60 years	145	53.10%
More than 60 years	128	46.90%
Marital Status		
Married	250	91.50%
Single, widow, divorced	23	8.50%
Family History of Diabetes		
No	69	25.30%
Yes	204	74.70%
Smoking		
Non-smoker	206	75.50%
Smoker	62	22.70%
Ex-smoker	5	1.80%
Treatment for Diabetes		
Lifestyle only	8	2.90%
Oral Hypoglycaemic Agents only	190	69.50%
Oral Hypoglycaemic Agents and insulin	75	27.50%
Diabetic Complications		
Free	89	32.60%
Have complications	184	67.40%

(Table 3). These findings not only underscore the potential of psychotherapeutic interventions in improving diabetes control but also highlight the importance of comprehensive treatment approaches that include both physiological and psychological elements.

Glycated Haemoglobin (HbA_{1c})

The reduction in HbA_{1c} from 9.2±1.5% to 7.3±1.2% represents a clinically significant improvement in long-term blood glucose control. HbA_{1c} is widely used as an indicator of average blood glucose over the past 2-3 months, and values above 8% are typically associated with poor diabetes control, which is common in patients prior to intervention in India. The observed decrease in HbA_{1c} suggests that the psychotherapeutic intervention led to better overall management of blood glucose levels over time. The statistical significance of this reduction, with a highly significant *t*-statistic of 14.70 and a *p*-value of 1.66×10⁻⁴⁰, further supports the effectiveness of the intervention in improving glycaemic control. These findings suggest that the psychological and behavioural changes associated with the intervention, such as stress reduction and improved lifestyle management, contributed to a more favourable glycaemic response. Given that patients with poorly controlled diabetes often struggle with issues like anxiety, stress, and poor self-management, this improvement may reflect better adherence to treatment regimens, healthier lifestyle choices, and improved coping mechanisms.

Fasting Blood Sugar (FBS)

Fasting blood sugar levels also showed a substantial reduction, from 180±25 mg/dL to 142±20 mg/dL. FBS values above 126 mg/dL are diagnostic for diabetes, and this decrease indicates that the intervention helped in better managing the patient's blood sugar levels after an overnight fast. The *t*-statistic of 19.61 and the extremely small *p*-value of 3.61×10⁻⁶⁵ point to the statistical significance of this reduction, reinforcing the intervention's effectiveness in controlling blood sugar levels during periods of fasting. The improvement in FBS can be attributed to the psychotherapeutic effects on stress and emotional well-being, which have been shown to influence glucose metabolism. Psychosocial stress has been linked to dysregulation of glucose metabolism, potentially through the activation of the Hypothalamic-Pituitary-Adrenal (HPA) axis, leading to insulin resistance and hyperglycemia. By reducing stress, the intervention may have directly impacted the physiological pathways involved in glucose regulation, leading to improved fasting blood sugar levels.

Postprandial Blood Sugar (PPBS)

The postprandial blood sugar, which reflects glucose handling after meals, also decreased significantly, from 245±35 mg/dL to 210±30 mg/dL. Normal PPBS levels should be under 140 mg/dL, and while the decrease observed in this study still leaves patients with elevated postprandial glucose levels, the reduction is noteworthy. The *t*-statistic of 12.55 and the very small *p*-value

Table 2: Severity of Depression before and after Intervention in the Population.

Depression Severity	Before Intervention	% of Total Patients	After Intervention	% of Total Patients
No Depression	510	65.10%	586	74.84%
Mild Depression	138	50.50%	94	34.40%
Moderate Depression	100	36.60%	80	29.30%
Severe Depression	35	12.88%	23	8.40%

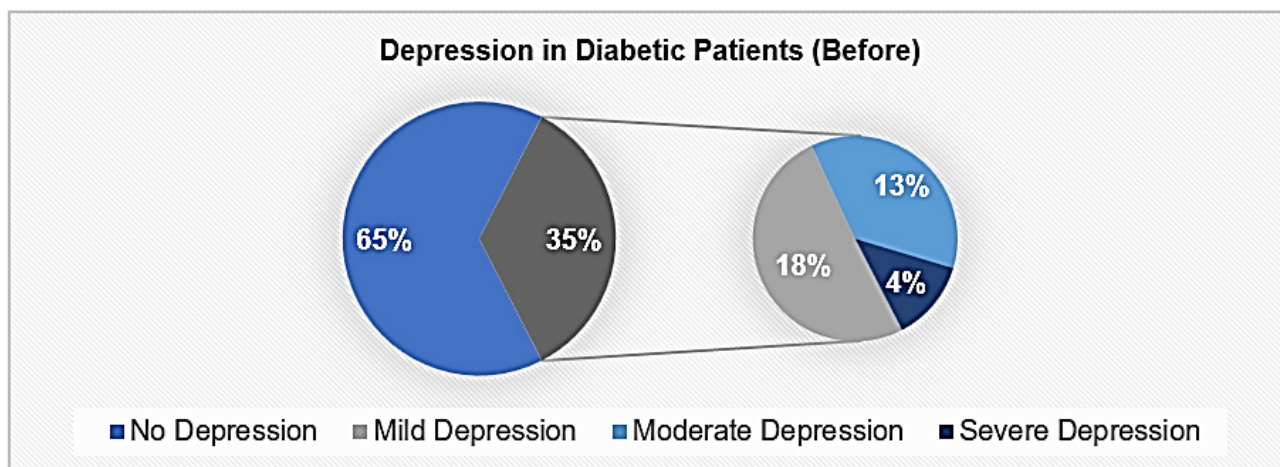


Figure 1: Percentage of Depression in Diabetes Population (Before Intervention).

further support the statistical significance of the observed change. The improvement in PPBS levels may be indicative of a combination of better meal-related glycaemic control and improved insulin sensitivity following the intervention. Psychological factors such as eating behaviour, emotional eating, and stress-induced hyperglycemia are known to affect postprandial glucose excursions. By addressing these psychological components through psychotherapy, the intervention may have contributed to more mindful eating, improved dietary choices, and enhanced insulin response post-meal.

DISCUSSION

The result of the study outlines changes in the severity of depression in patients before and after an intervention, categorized into four categories i.e., No Depression, Mild Depression, Moderate Depression, and Severe Depression. After the intervention, there were significant improvements in glycaemic profile as well as in levels of depression.

There is a significant shift in HbA_{1c}, FBS, and PPBS levels in all the patients who are under intervention. The HbA_{1c} levels shifted in the patients from 9.2±1.5 to 7.3±1.2 after the intervention. There was a significant change in the levels of FBS from 180±25 mg/dL to 142±20 mg/dL after the intervention. Significant improvements in PPBS also observed in patients after the intervention from 245±35 mg/dL to 210±30 mg/dL. Based on the glycaemic profile of the patient, it is proved that addressing the depression levels can make significant improvements in patients' glycaemic profile and Quality of life (QoL).

The number of patients with no depression before the psychotherapeutic intervention was 510 and the count increased to 586 after the intervention stating the positive impact of the psychotherapeutic intervention. Similar trends were observed in patients with mild depression, moderate depression, and severe

depression. After the intervention, the percentage of patients with mild depression reduced from 50.50% to 34.40% stating a significant improvement in depression in this group. Significant improvements were observed in moderate and severe depression groups.

Similar observations have been reported in studies evaluating psychosocial interventions. A meta-analysis by Cuijpers *et al.*, (2020) identified that Cognitive-Behavioral Therapy (CBT) significantly reduced the levels of depression, with mild and moderate depression categories showing the most notable improvements.³⁰ In another study by Kilbourne *et al.*, (2017) focusing on collaborative care models for patients with comorbid conditions, there was a reduction of over 10% in the moderate-to-severe depression group post-intervention, consistent with our findings.³¹ The findings in the severe depression group are correlated with the randomized control trial by Kroenke *et al.*, (2019) found that pharmacotherapy with patient-centric counseling particularly effective in severe depression cases, reducing prevalence by 30%.³² However, many studies and reviews suggest depression and glycaemic control are closely interlinked, as noted in studies by Lustman *et al.*, (2019). The improvement in cognitive functions of the patients might have significant benefits for glycaemic and therapeutic outcomes.³³

Table 3: Average Glycaemic Profile before and after Psychotherapeutic Intervention.

Variable	Before Intervention (Mean±SD)	After Intervention (Mean±SD)
HbA _{1c} (%)	9.2±1.5	7.3±1.2
Fasting Blood Sugar (mg/dL)	180±25	142±20
Postprandial Blood Sugar (mg/dL)	245±35	210±30

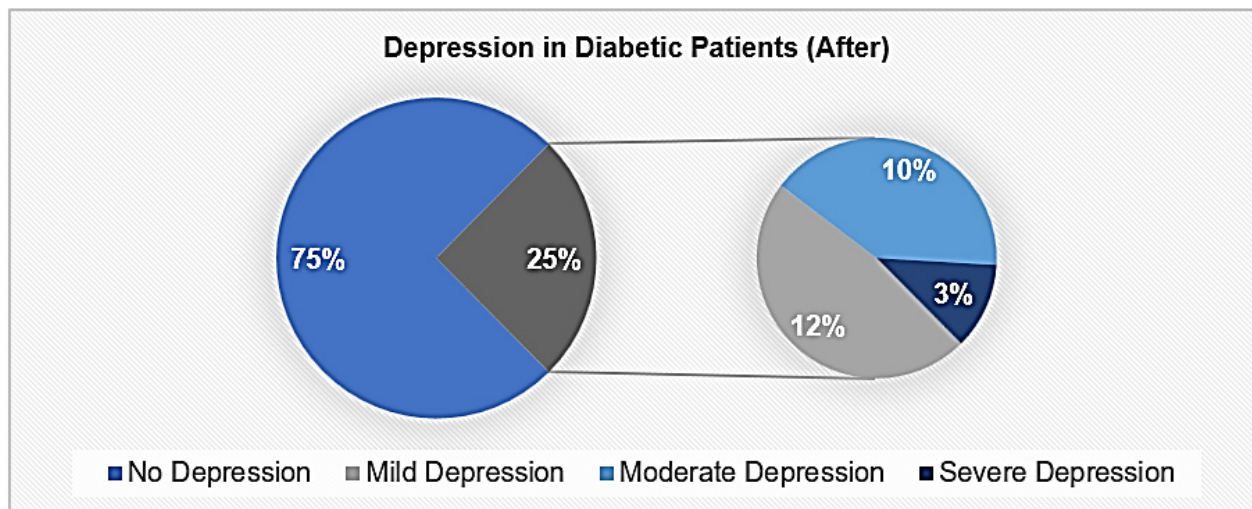


Figure 2: Percentage of Depression in Diabetes Population (After Intervention).

India's prevalence of diabetes is increased due to the complex interplay of lifestyle, genetic, and socio-economic factors. Urbanization and sedentary lifestyles significantly reduced physical activity and energy expenditure, promoting obesity—a major risk factor for type 2 Diabetes Mellitus.³⁴ Shift in dietary habits from traditional to processed food had lots of impact on health due to the presence of refined carbohydrates, sugars and unhealthy fats. All the processed foods and sugary drinks increased the risk of diabetes.³⁵ Many studies report that a high-sugar-loaded diet directly contributes to insulin resistance. High fat percentage and low BMI are two of the major reasons for genetic susceptibility to diabetes in Indians.³⁶

Increased work-related stress and urban living pressures can predispose the individual to diabetes and depression. Chronic psychological stress activates the hypothalamic-pituitary-adrenal axis, leading to the aggravated levels of cortisol causing insulin resistance.¹⁰ The bidirectional relationship between depression and diabetes is pertinent in Indian patients. Depression causes poor glycemic control by behavioral changes such as poor medication adherence, poor dietary habits, and reduced physical activity. Addressing depression in the diabetic population is very essential to bring the glycemic profile under control.³⁷

CONCLUSION

The study results were broadly aligned with existing literature, showing improvements across all categories of depression severity. The significant improvement in the "no depression" group and the decline in the percentage of patients in the severe depression group reflect that the psychotherapeutic intervention is effective. However, the slightly smaller reductions in severe depression compared to some studies highlight the potential need for tailored strategies for this subgroup. Significant improvements in glycaemic profile after addressing depression by Cognitive behavioural therapy will state that patient-centric counselling is very essential for the best results in diabetes management.

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ABBREVIATIONS

T2DM: Type 2 Diabetes Mellitus; **PHQ-9:** Patient Health Questionnaire-9; **FBS:** Fasting Blood Sugar; **PPBS:** Postprandial blood sugar; **HPA:** Hypothalamic-Pituitary-Adrenal axis; **CBT:** Cognitive Behavioural Therapy; **MBT:** Mindfulness-Based Therapy; **HbA_{1c}:** Glycated Haemoglobin.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Ethics Committee of the Narayana Medical College and Hospital. Prior to the subject recruitment into the study, all the participants were provided with informed consent, and the research was carried out in accordance with the Helsinki Declaration.

SUMMARY

Depression is one of the major contributors to uncontrolled hyperglycaemia in individuals with diabetes. Most diabetic clinics primarily focus on dietary management and regular monitoring of glycemic levels, which often results in therapy failure. Incorporating psychotherapy alongside existing treatments is essential for effectively managing patients' glycemic levels. Adopting such measures can significantly improve the quality of life for diabetic patients.

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