

An Exploratory study of the Spectrum of Physiological, Psychological And Social Dynamics in Individuals with type 1 Diabetes

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ABSTRACT

Background: Type 1 diabetes (T1D) accounts for a small percentage of diabetes cases but affects millions worldwide. In addition to glycemic control, psychological and social factors influence T1D management, yet understanding of their combined effect on overall health and quality of life (QoL) is limited. **Objective:** To evaluate the combined impact of physiological, psychological & social factors affecting the health and quality of life of individuals with Type-1 diabetes. **Methodology:** Eighty-two individuals with T1D participated in this cross-sectional study. Data were collected via structured interviews and clinical assessments including anthropometry, laboratory tests, and validated questionnaires on mental health (PHQ-9), social support (DSSQ), and diabetes-specific QoL (MDQoL-17). **Results:** Participants (mean age 21.96 ± 2.003 years; 76.8% male) had mean age at diagnosis 18.32 ± 1.46 years. Most (68.29%) reported anxious related to insulin use or fear of hypoglycemia. The average QoL score was 67.25 ± 12.88 . Participants with low socioeconomic conditions, inadequate dietary practices, low physical activity, or diabetes complications had significantly lower QoL. Those with good glycemic control ($HbA1c \leq 7\%$) had better QoL than those with poor control. **Conclusion:** Individuals with T1D face intertwined physiological, psychological, and social challenges. A holistic approach addressing glycemic control, psychological health, and social support may improve QoL and outcomes for people with T1D.

KEYWORDS

Glycaemic Control, Anxiety, Diabetes Quality Of Life, Social Support, Type-1 Diabetes Mellitus

INTRODUCTION

The destruction of the pancreatic β -cells that produce insulin causes Type-1 Diabetes Mellitus (T1D), a chronic autoimmune disease that leads in complete insulin insufficiency and a lifetime reliance on exogenous insulin. It usually appears in childhood or adolescence, while cases that start in adulthood are not unusual. With a projected 1.2 million children and adolescents afflicted as of 2021, the prevalence of T1D is rising globally, and India is a major contributor to this burden because of its sizable population and shifting lifestyle (1).

Beyond glucose control, managing type-1 diabetes presents many difficulties. T1D sufferers, unlike those with Type-2 Diabetes, require monitoring of their blood glucose levels, adhere strictly to their insulin regimen, engage in regular exercise, and control their food. Young individuals may find these responsibilities especially burdensome, which could negatively affect their physical, mental, and emotional health (2). Studies have demonstrated that the burden of everyday illness care, fear of hypoglycemia, social stigma, and long-term problems can greatly influence the quality of life (QoL) and mental health of people with T1D (3).

Socioeconomic inequality, restricted access to healthcare services, particularly in rural areas, and a lack of knowledge regarding diabetes management further exacerbate the problem in India. Young adults in low and middle-income environments frequently experience inadequate social support, elevated psychological distress, and poor glycemic control, all of which lead to poor health outcomes and a lower quality of life (4). In addition, the general health of people with T1D is further harmed by the existence of diabetes-related illnesses and comorbidities such as hypertension and dyslipidaemia (5).

In addition to clinical management, holistic diabetes care must include social empowerment and psychological support. While fasting blood sugar and glycemic indices like HbA1c are frequently used to assess metabolic control, measures like the Quality of Life, Social Support and Patient Health provide more in-depth information about a patient's psychological and social functioning (6,7).

MATERIAL & METHODS

This study conducted by using hospital-based cross-sectional design and was conducted in Vijayapura District, an under-developed region of north Karnataka state, South of India. Study participants comprised individuals diagnosed with Type-1 Diabetes (T1D). Data were collected through interview method using structured questionnaires.

Inclusion criteria

Inclusion criteria were as follows: a) confirmed diagnosis of T1D for minimum 6 months; b) ability to comprehend and respond to questionnaires in English or the local language; and c) those who are willing to participate (with consent).

Exclusion criteria

Exclusion criteria were as follows: a) History of psychiatric disorders diagnosed prior to T1D diagnosis; b) Patient with previous history of any Hemoglobinopathies; c) Physical disabilities that interfered with exercise; d) Pregnant or lactating women.

Sampling Method

Purposive sampling was employed to select participants from General Medicine outpatient departments of tertiary care hospital in the region of north Karnataka state, India. All the cases presented with T1D with minimum duration of 6 months were enrolled in to the study. Ethical Committee approval from the Institutional Ethics committee (BLDE (DU)/IEC/1155/2024-25) was obtained before the data collection. The study was conducted for a total duration of six months.

Verbal informed consent for participation in to the study was obtained from the participants or

participants' legal guardian or persons taking care of them.

Sampling

It was assumed that 25% of T1D patients had impaired quality of life (8). The confidence level was set at 95%, with a 5% significance level and a margin of error of 0.10.

The sample size was determined by use the subsequent formula: Sample size (n) = $(Z^2 p (1-p)) / d^2$ here,

z = 1.96 for 95% confidence (value from the standard normal distribution reflecting the confidence level)

d = 0.1 (margin of error)

n = population size

p = 0.254 (population proportion)

based on the calculation, the estimated sample size was approximately 73 participants. To ensure adequate data collection, a 10% dropout rate was anticipated, resulting in a final sample size of 80.

Data Collection Tools

To comprehensively assess the physiological, psychological, and social aspects of T1D patients, the following structured questionnaires were utilized:

Psychological well-being was evaluated using PHQ-9 and T1D-specific psychological assessment, measuring the severity of depression and emotional challenges.

Using the Diabetes Social Support Questionnaire (DSSQ), the degree and kind of social support that people with T1D received in areas such as blood glucose monitoring, insulin administration, meal planning, exercise and emotional support (3 items for each domain) were evaluated. Participants rated the frequency of each behavior with 0 = never, 1 = less than 2 times a month, 2 = twice a month, 3 = once a week, 4 = several times a week, or 5 = at least once a day. The composite score was scaled to 100 points (9).

Quality of Life (QoL) was assessed using MDQoL-17 (Diabetes-Specific QoL Scale). MDQoL-17 questionnaire consists of 17 questions that encompass seven domains. This includes physically functioning, limitations of role due to physical health problems or due to personal or emotional problems, emotional wellbeing, social functioning, energy or fatigue, and general health perceptions. Each component is assigned a score, with a high score signifying better health. Scores range from 0 to 100, with 0 indicating the lowest possible score and 100 representing the highest. The different domains, number of items in each domain and item numbers that come in that particular dimension

and their scores are shown in Table-1 and Table-2 (10).

Table 1: MDQoL-17 Domains and item numbers (10)

Domains	Number of items	Item numbers
Physical functioning	3	4, 5, 6
Role limitation due to physical health	1	7
Role limitation due to emotional	2	11, 12
Energy fatigue	1	17
Emotional wellbeing	3	8, 9, 10
Social functioning	4	13, 14, 15, 16
General health	3	1, 2, 3

To ease comparison and analysis, the MDQoL-17 QoL score was stated as a percentage of the overall QoL Score. Patients with a QoL score of more than 70 had a superior QoL, those with a QoL score of 50-70 had an intermediate QoL, and those with less than 50 had a poor QoL (10).

Table 2: Response category and scores of MDQoL-17 (10).

Item number	Response category and Scores
1, 2, 7, 13	1→100, 2→75, 3→50, 4→25, 5→0
3	1→0, 2→25, 3→50, 4→75, 5→100
4, 5, 6	1→0, 2→50, 3→100
8, 9, 10, 11, 12, 14, 15, 16	1→0, 2→20, 3→40, 4→60, 5→80, 6→100
17	1→100, 2→80, 3→60, 4→40, 5→20, 6→0

Anthropometrics: Participants were weighed (to the nearest of 0.1 kg) and measured (to the nearest of 0.1 cm) using an Apollo digital scale and Secastadiometer, respectively, in an upright position without shoes or bulky clothing. BMI and WHR were used to assess nutritional status, based on WHO age- and sex-specific standards.

Blood pressure: Participants were asked to relax and sit for 10 minutes before blood pressure measurements. The left arm was positioned at heart level, and three readings were taken at three-minute intervals, with the average of the last two used for analysis. Blood pressure categories were: normal (<120/80 mmHg, below 90th percentile), prehypertension (120-129/<80 mmHg, 90th to <95th percentile), stage I hypertension (130/139/80-89 mmHg, 95th to 99th percentile), and stage II

hypertension (≥140/≥90 mmHg, above 99th percentile) based on age, gender and height.

Fasting Blood Sugar (FBS) Measurement: The FreeStyle Libre glucometer, a continuous glucose monitoring device with excellent accuracy and user-friendliness, was used to measure fasting blood glucose levels. The device complies with ISO 15197:2013 standards, which mandate that 95% of glucose results must fall within ±15 mg/dL of the reference measurement for blood glucose concentrations <100 mg/dL, and within ±15% for concentrations ≥100 mg/dL. Capillary blood samples were obtained after an overnight fast of 8-10 hours. This system was chosen for its reliability, real-time glucose trend tracking, and ability to reduce patient discomfort during frequent testing. To ensure uniformity among all participants, skilled healthcare professionals made sure standard operating procedures (SOPs) for calibration and quality assurance were followed.

HbA1c Measurement: The SD Biosensor HbA1c Analyzer, a point-of-care testing (POCT) instrument, was used to quantify glycated-hemoglobin (HbA1c). Biosensor has a high specificity for HbA1c and is based on a boronate affinity chromatography technique. It requires a minimal volume of capillary or venous whole blood and provides results in less than five minutes, making it well-suited for field and outpatient clinical settings. The device meets the NGSP (National Glycohemoglobin Standardization Program) certification and is IFCC (International Federation of Clinical Chemistry) traceable, ensuring accuracy and comparability with standardized lab-based results. The use of this device allowed for rapid, on-site assessment of glycemic control.

Statistical analysis

Collected data were imported into Microsoft Office Excel and analyzed with SPSS version 26. Descriptive statistics like mean, standard deviation, and percentages were used to summarize the variables. Inferential statistics such as chi-square test, t-tests and ANOVA were performed to compare QoL scores across different demographic and clinical variables, with a p-value of <0.05 considered statistically significant.

RESULTS

Study was conducted with 82 individuals with T1D, with 63 (76.8%) male and 19 (23.2%) female.

Demographic and Clinical Characteristics

The mean age of participants was 21.96 ± 2.00 years, with a higher proportion of males. Majority belonged to middle socio-economic-class families (modified B.G.Prasad classification), with a higher representation from rural areas (73.2%). The mean BMI was 20.1 ± 1.94 kg/m². The mean age of

diagnosis of T1D onset was 18.32 ± 1.46 years. Most participants (97%) were on insulin therapy, demonstrating good adherence. Glycemic Control

Mean FBS was 107.02 ± 15.38 mg/dL, and mean HbA1c was $7.05 \pm 0.47\%$, indicating satisfactory glycemic control. (Table 3)

Table 3: Mean & Std. deviations of different parameters (n=82)

	Age	Age onset of T1D diagnosis	Duration	BMI	FBS	HbA1C	PHQ-9	MDQoL Score
Mean	21.96	18.32	3.65	20.1	107.02	7.05	9.28	67.25
Std. Deviation	2.00	1.46	0.74	1.94	15.38	0.47	2.98	12.88

Psychological Well-being

68% of participants reported anxiety related to insulin administration, fear of hypoglycemia, long-term complications, and treatment adherence. PHQ-9 scores indicated mild to moderate depression in a significant proportion of participants. Higher levels of depressive symptoms were reported by female participants, area of residence, increased duration of illness, those with comorbidities and HbA1C significantly (Table-4).

Social Support

DSSQ scores revealed moderate to high levels of perceived social support, with family being the primary source. Participants from rural areas reported higher social support scores compared to those from urban areas, with females receiving lower social support significantly (Table-4).

Quality of Life

The average MDQoL-17 score was 67.25 ± 12.88 . Lower QoL scores were associated significantly with presence of complications or comorbidities, increased duration of illness and high HbA1C level (Table-4).

HbA1c

Among the participants, **57.3% had HbA1c $\leq 7\%$** , indicating good glycemic control, while **42.7% had HbA1c $> 7\%$** , reflecting poor glycemic control.

Participants with HbA1c $\leq 7\%$ demonstrated **better quality of life (QoL score: 74.26 ± 9.58)** and **lower psychological distress** (mean scores: **PHQ-9: 8.19 ± 2.06**) compared to those with higher HbA1c levels, who showed **reduced QoL (67.08 ± 13.87)** and significantly **higher psychological burden** (PHQ-9: **10.74 ± 3.41**). These differences were statistically significant ($p < 0.05$), emphasizing the connection between poor glycemic control, elevated psychological distress, and diminished quality of life. This underscores the importance of achieving optimal HbA1c targets not only for physical health but also for maintaining mental well-being in individuals with Type 1 Diabetes.

In addition, **social support**, a critical determinant of diabetes self-management, also showed a positive correlation with glycemic status. Participants with HbA1c $\leq 7\%$ had a **higher DSSQ score (75.34 ± 13.12)**, reflecting enhance perceived social support, compared to those with HbA1c $> 7\%$, who had a **mean DSSQ score of 67.08 ± 13.87 ($p = 0.007$)**. These results suggest that individuals with strong social and family support systems are more likely to maintain optimal glycemic control, which in turn is associated with improved psychological health and enhanced quality of life. (Table-4)

Table-4: Association of QoL, PHQ and DSSQ with various demographics and health characteristics of diabetic patients

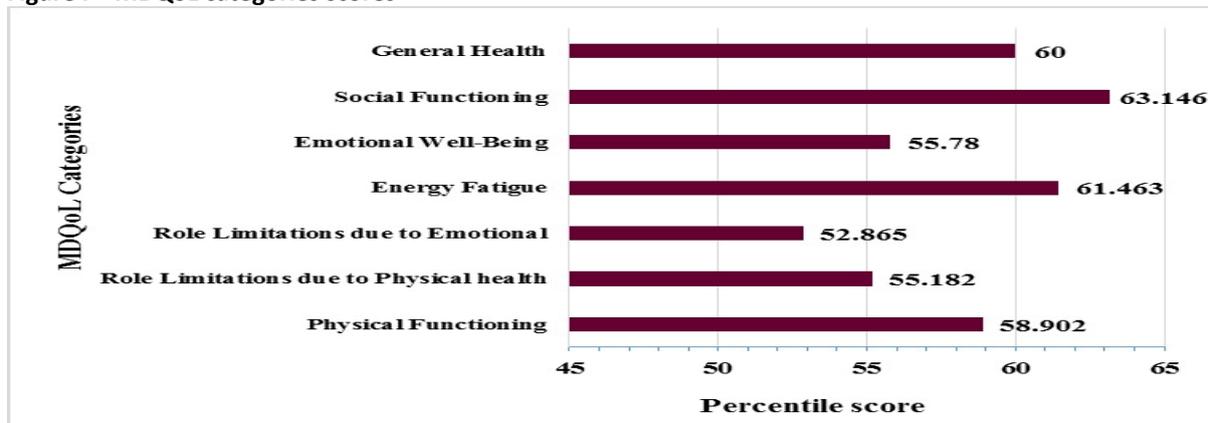
Sl NO.	Covariate factors	Category	Number of patients (%)	QOL SCORES			PHQ		DSSQ	
				MEAN	\pm SD	p values	MEAN	p values	MEAN	p values
1	Gender	male	63(76.8%)	67.64	\pm 13.64	0.502	8.62	\pm 2.55	78.06	0.0001
		female	19(23.2%)	65.94	\pm 10.18		11.47	\pm 3.32	49.63	
2	Age (yrs)	17-19	10(12.2%)	69.12	\pm 18.31	0.501	8.60	\pm 2.79	73.47	0.824
		20-23	53(64.6%)	67.97	\pm 12.7		9.13	\pm 2.73	72.07	
								14.61		

		24-26	19(23.2%)	64.26 ±10.01		10.05 ± 3.67		70.24 ± 13.12	
3	Residency	Urban	22(26.8%)	66.74 ± 11.96	0.831	11.68 ±3.12	0.0001	51.68 ± 7.18	0.0001
		Rural	60(73.2%)	67.43 ± 13.29		8.40 ± 2.30		78.73 ± 7.08	
4	Comorbidity	Present	43(52.5%)	57.49 ± 8.15	0.0001	9.63 ± 3.24	0.27	71.53 ± 13.54	0.85
		Absent	39(47.5%)	78.01 ± 7.35		8.9 ± 2.65		72.13 ± 14.62	
5	T1D with and without complication	0 complication	39(47.5%)	78.01 ± 7.35	0.0001	8.9 ± 2.65	0.147	72.13 ± 14.62	0.271
		1 complication	14(17.1%)	66.21 ± 2.04		8.57 ± 2.24		76.49 ± 11.23	
		>1 complication	29(35.4%)	53.29 ± 6.43		10.14 ± 3.55		69.15 ± 14.09	
6	Duration of illness	≤ 3 years	47(57.3%)	74.01 ± 10.93	0.0001	8.62 ± 2.44	0.019	74.32 ± 13.58	0.06
		>3 years	35(42.7%)	58.16 ± 9.24		10.17 ± 3.43		68.46 ± 13.99	
7	HbA1c (%)	≤ 7	47(57.3%)	74.26 ± 9.58	0.0001	8.19 ± 2.06	0.0001	75.34 ± 13.12	0.007
		>7	35(42.7%)	57.83 ± 10.58		10.74 ± 3.41		67.08 ± 13.87	

Figure I presents the MDQoL (Diabetes-Specific Quality of Life) score percentiles across different categories. It uses horizontal bars to illustrate

scores across various domains of quality of life for individuals with Type-1 Diabetes.

Figure I – MDQoL categories scores



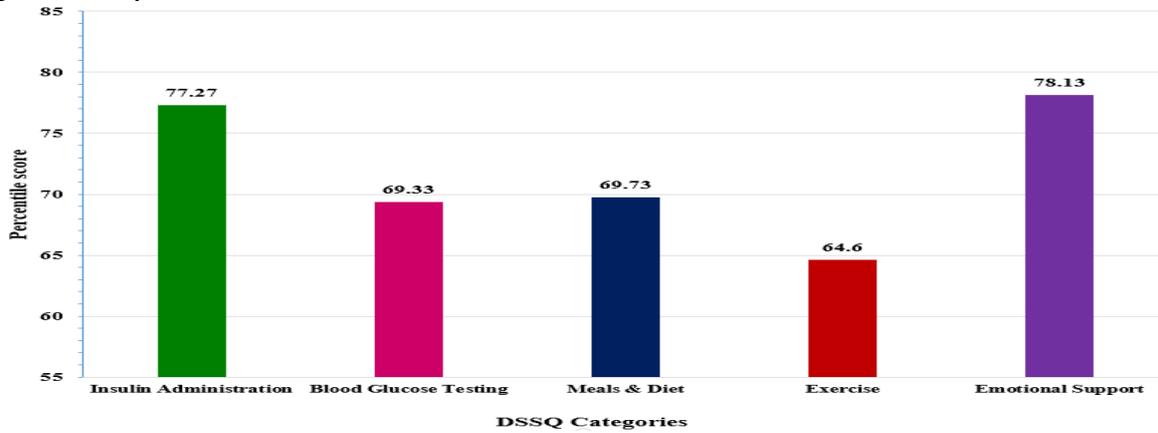
Social Functioning has the highest score (63.15), indicating that individuals generally maintain social interactions despite diabetes. General Health (60) and Energy/Fatigue (61.46) also score relatively high, indicating moderate well-being and perceived

health status. Emotional Well-being (55.78) is slightly lower, suggesting psychological distress associated with T1D. Physical Functioning (58.90) remains moderate, suggesting some limitations due to diabetes. Role limitations due to Physical Health

(55.18) and Emotional Health (52.87) have the lowest scores, indicating that diabetes significantly impacts day-to-day activities and mental well-being.

The Diabetes Social Support Questionnaire (DSSQ), which measures perceived social support in people with Type-1 Diabetes, has five domains. **Figure II** shows the percentile scores for each domain.

Figure II – the percentile scores for each domain.



The highest social support was reported in the domain of Emotional Support (78.13%) and Insulin Administration (77.27%), suggesting that participants feel adequately supported emotionally and, in their insulin, -taking routines. Moderate support was noted in the domains of Meals & Diet (69.75%) and Blood Glucose Testing (69.33%), indicating partial assistance in managing dietary habits and regular glucose monitoring. Low perceived support for exercise (64.5%) likely stems from a lack of knowledge, motivation, or encouragement from peers/family. This highlights a potential barrier to regular physical activity.

DISCUSSION

This study underscores the intricate interplay between glycemic control, psychological well-being, social support, and QoL among individuals with T1D. Findings indicate that participants with HbA1c levels ≤7% exhibit significantly better QoL, reduced psychological distress, and enhanced social support compared to those with poorer glycemic control.

Physical Aspects in Individuals with T1D

In our study, participants with higher HbA1c levels reported poor physical health scores (as captured by the MDQoL-17). This supports previous research by Strandberg RB et al. and Gonder-Frederick L et al. suggesting that high blood sugar contributes to issues like fatigue, reduced physical stamina, and difficulty with daily activities (11,12).

Additionally, the presence of other comorbid conditions like hypertension and dyslipidaemia among our participants, has been shown to compound the physical burden in T1D patients. A multicenter study in India by Singh H et al. found that adolescents with T1D & additional non-

communicable comorbidities had poorer physical functioning and exercise capacity compared to those without such comorbidities (13). Additionally, physical complications such as neuropathy and retinopathy were noted to impair physical independence, further deteriorating QoL (14).

Psychological Distress and Glycemic Control

The correlation between inadequate glycemic control and elevated psychological distress observed in our study are consistent with findings from various Indian studies. Kalra et al. reported that 20% of children with T1D exhibited psychosocial problems, with depression showing a strong correlation with elevated HbA1c levels (15). Similarly, Patel et al. found that psychosocial distress was present in 55.95% of children with T1D, with a higher frequency among those with HbA1c >7.5. These studies underscore the reciprocal connection between glycemic control and psychological health (16).

Internationally, a Hungarian study reflected that higher levels of diabetes-related distress were related to poorer self-management behaviors and glycemic control, as well as lower diabetes-specific QoL (17). Similarly, a cohort study by Joensen LE et al. found that greater diabetes distress scores were significantly linked with higher HbA1c levels and lower social support scores (18).

Quality of Life (QoL)

Our observation of diminished QoL in participants with poor blood sugar control aligns with Kerala study conducted by Sasidharanpillai S et al. where children with T1D reported lower Health-related QoL scores compared to non-diabetic peers (77.43 vs. 87.45; p < 0.001) (19). A Brazilian study by Negrato CA et al. found that individuals with T1D had lower health-related QoL compared to their European counterparts, while better glycemic

control positively impacting QoL (20). Additionally, a Finnish study by Hietavala EM *et al.* observed that poor glycemic control and diabetes complications were associated with a lower QoL (21).

Social Support

The pivotal role of social support in diabetes management is evident in our findings. Participants with better glycemic control reported higher social support scores. A study from Tamil Nadu showed active caregiver involvement led to better glycemic outcomes and fewer missed insulin doses in adolescents with T1D (22). Similarly, a qualitative investigation in urban-area North India found that emotional and logistical support from immediate family was vital for consistent care, especially during episodes of hypoglycemia or school/work-related challenges (23). Study by Karademas EC *et al.* highlighted that health-related QoL in T1D patients was strongly predicted by perceived social support (24). Moreover, a study from China by Luo D *et al.* showed that peer relationships and constructive coping strategies were crucial in relieving diabetes distress and enhancing QoL among adolescents with T1D (6).

Caregiver Burden

In the Indian context, managing T1D also heavily depends on the mental health and general wellbeing of caregivers. The IDREAM study by Streisand R *et al.* found that caregivers who felt a high burden of care were most likely to experience severe depression and poor health (25). This highlights the necessity for supportive interventions focusing both patients and their caregivers.

CONCLUSION

T1D significantly affects quality of life (QoL), with comorbidities and complications further worsening outcomes. Poor glycemic control and psychological distress contribute to reduced well-being, highlighting the need for mental health support alongside standard diabetes care. Social support will play a key role in self-management, emphasizing the importance of holistic and patient-centered interventions.

RECOMMENDATION

Integrate mental health care into diabetes management. Routine psychosocial screening (e.g., PHQ-9 for depression/anxiety) should be incorporated into T1D clinics, with referral pathways for counseling or psychiatric care. International guidelines and evidence recommend collaborative care models to address the high co-occurrence of diabetes and mental health disorders.

- Strengthen patient and family education. Diabetes education programs must emphasize not only glycemic targets but also lifestyle modification, stress management, and coping skills. Educating families about the psychological challenges of T1D can foster empathy and improve support at home.
- Promote peer and community support networks. Establishing support groups or peer mentoring can help patients share experiences, reduce stigma, and enhance motivation for self-care. Community health workers and peer supporters can be trained to provide ongoing encouragement for treatment adherence and healthy behaviors.
- Improve access to care in underserved areas. Public health initiatives should ensure affordability and availability of insulin, glucose monitors, and diabetes supplies, especially in rural and low-resource settings. Efforts to raise awareness about T1D and reduce cultural myths are important to encourage early diagnosis and reduce stigma.
- Enforce holistic policy measures. Policymakers should recognize T1D as a significant public health issue and allocate resources for integrated care programs that combine medical, psychological, and social interventions.

RELEVANCE OF THE STUDY

Our study provides new insights into the Indian experience of T1D by examining how metabolic control, mental health, and social factors jointly affect patient outcomes. It adds to existing knowledge by highlighting the psychosocial dimensions of diabetes that are often underappreciated in low-resource settings. In line with international recommendations to integrate psychological care into diabetes management, these findings emphasize the need for comprehensive care models. By demonstrating the importance of emotional and social support in addition to physiological management, this study supports a shift toward more holistic approaches in diabetes care in India.

LIMITATION OF THE STUDY

The cross-sectional design of present study limits the ability to determine causal links between glycemic control, psychological well-being, and QoL. Longitudinal follow-up would be necessary to establish temporal relationships and better understand the progression of psychosocial challenges over time. Self-reported data collected through structured questionnaires. This may be subject to response bias, including underreporting or overreporting of psychological symptoms, lifestyle behaviors, or treatment adherence. Even though we used validated tools and had

interviewers help; limited literacy in some participants could have affected response accuracy.

AUTHORS CONTRIBUTION

All authors have contributed equally.

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Nil

CONFLICT OF INTEREST

There are no conflict of Interest.

DECLARATION OF GENERATIVE AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors haven't used any generative AI/AI assisted technologies in the writing process.

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