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Original article

Factors Associated with Glycemic Control among Children with Type 1 Diabetes Mellitus Attending the Diabetes Clinic at Sabratha Teaching Hospital, Libya

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Abstract
Glycemic control is a cornerstone of managing Type 1 Diabetes (T1DM). The goal is to maintain blood glucose levels as close to the normal range as possible to prevent both acute complications (hypoglycemia, diabetic ketoacidosis - DKA) and long-term microvascular and macrovascular complications. In order to identify the factors associated with glycemic control among children diagnosed with T1DM who are receiving care at the diabetes clinic at Sabratha Teaching Hospital (STH), Libya, a cross-sectional interview-based study was executed from June 15 to September 30, 2025. This investigation involved a representative cohort of children aged 1 to 18 years with type 1 diabetes mellitus (T1DM), as well as their caregivers. The glycated hemoglobin (HbA1c) levels ranged between 5.8% and 15% (mean HbA1c = 9.23% ± 2.17%). High HbA1c levels (⩾ 7.5%) were observed in most children (80%). Only three statistically significant factors were found: (1) about 88.9% of children whose parents self-reported high frequency of feeling anxious or stressed showed higher levels of HbA1c compared to other groups (p = 0.004), (2) 86.8% of children with history of hospitalization had higher HbA1c levels, compared to 66.7% of children with no history of hospitalization, (p = 0.016), and (3) frequency of hospitalization appears to be associated with poorer glycemic control; 89.7% of children who were hospitalized more than twice had a higher HbA1c level, compared to 73.9% of children who were hospitalized once, (p = 0.012). Most children with T1DM attending the diabetes clinic STH showed poor glycemic control. Three factors were significantly associated with better glycemic control: reduced self-reported feelings of anxiety and stress, no history of hospitalization, and less frequency of hospitalizations. Therefore, in addition to medical treatment for children with T1DM, it is important to offer psychological and emotional support for them and their caregivers.
Keywords. Type 1 Diabetes Mellitus, Glycemic Control, Prevalence, Factors Affecting Glycemic Control, Caregivers.

Introduction

Type 1 diabetes mellitus (T1DM) is a chronic autoimmune disorder marked by pancreatic beta-cell destruction, resulting in absolute insulin deficiency [1]. The prevalence and burden of T1DM continue to rise globally, with approximately 18% of 8.4 million individuals with T1DM in 2021 being under 20 years old—an age group especially vulnerable to glycemic imbalances and their consequences [2]. Glycemic control is a cornerstone of managing Type 1 Diabetes (T1D). The primary goal is to maintain blood glucose levels as close to the normal range as possible [3]. Good glycemic control is crucial, as it reduces the risk of microvascular and macrovascular complications and helps prevent life-threatening events like hypoglycemia [4]. However, sustaining optimal glycemic control is challenging for children with diabetes, particularly in resource-limited settings [5].

Various factors contribute to poor glycemic control in children, including the physiological changes of puberty, inconsistent adherence to self-monitoring protocols, and psychosocial barriers such as needle phobia [2,4]. The management of T1DM in children is particularly complex. Lifestyle factors such as unpredictable physical activity, changing dietary habits, and limited understanding of disease management can exacerbate glycemic variability [2]. Furthermore, adherence to traditional blood glucose monitoring is often complicated by the pain and inconvenience of frequent finger-prick testing, leading to suboptimal monitoring and glycemic instability [4]. Even advances in continuous glucose monitoring (CGM) technology have not fully addressed these challenges, as non-invasive, reliable, and child-friendly alternatives remain underdeveloped [4].

Self-management of health behaviors in children and adolescents with T1DM is another important factor affecting the treatment outcomes and life quality. Various factors influence self-management of health behaviors, including age, family structure, whether there is a family member with diagnosed diabetes mellitus, and average monthly family income. This highlights the need for the implementation of individualized interventions for children with Type 1 diabetes with different individual characteristics to promote the children's disease management ability and quality of life [6]. In addition, the psychological stress perceived by parents of children with T1DM from factors such as the responsibility felt toward the

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child's diabetes management and anxious states concerning the fear of hypoglycemia [7–10] can affect both their own and their child's well-being, thereby potentially influencing the child's glycemic control [11–13]. Achieving and maintaining optimal glycemic control in children with T1DM remains a significant challenge, with poor glycemic control predisposing patients to both acute and chronic complications. Despite this, data on glycemic control and its associated factors among children with T1DM in Libya remain limited. Therefore, this study aims to assess the level of glycemic control among children and adolescents with T1DM attending the diabetes clinic at STH and investigate its potential associated factors.

Methods

A cross-sectional interview study was conducted between 15 June and 30 September 2025, with a consecutive sample of 104 children with T1DM and their caregivers attending the diabetes clinic in Sabratha Teaching Hospital in Sabratha, Northwestern Libya. The inclusion criteria in this study were children aged younger than 18 years.

A consecutive sampling technique was used to include all eligible children with T1DM attending the clinic until the sample size was reached. Children with T1DM and their caregivers were enrolled in the study by a junior physician and introduced to data collectors. Data was collected by face-to-face interviews with the family members in the clinic and by electronic questionnaires sent to the children and their caregivers. The questionnaire was developed with a thorough literature review on the topic (14–17). It involved demographic data, including age at diagnosis, gender, caregiver, current parental marital status, educational level of caregiver, parents´ self-reported frequency of feeling anxious or stressed since their child´s DM diagnosis, level of support received from family and friends in managing DM, and family income. In addition to the demographic data, the questionnaire included questions about criteria affecting the disease and its management, as the duration of DM, type of insulin, history and frequency of hospitalizations, intensive care unit (ICU) admission, number of times of glucose monitoring/day, use of carbohydrate counting, number of meals/day, number of snacks/day, number of days of physical activity/week, adherence to insulin therapy, physician revisit interval, level of confidence in managing DM, knowledge in management of sick days, availability of diabetes educator, and attending official workshops or training programs on managing DM. Glycated hemoglobin (HbA1c) was used as an indicator for glycemic control (18).

In our study, the children were said to have good glycemic control if their HbA1c was less than 7.5% and were said to have poor glycemic control if their HbA1c was equal to or higher than 7.5% (18). The levels of HbA1c were documented from the patient's medical records from the clinic.

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences, version 31.0.0.0 (117) (SPSS, Inc., Chicago, IL, USA). Data were presented as frequencies and percentages; analyses were performed using the chi-square test to assess the association between glycemic control and its possible associated factors, and when the expected frequency was <5 in one or more of the cells, the Fisher's exact test was applied instead. The level of statistical significance was $p < 0.05$.

Results

This study included 104 children with T1DM attending the diabetes clinic at STH. Their ages ranged from 1 to 18 years, with a mean of 10.98 years. Their age at diagnosis ranged from 11 months to 14 years, with a mean age at diagnosis of 7.14 years. Approximately 63.5% of the children were females (n = 66). The glycated hemoglobin (HbA1c) levels ranged between 5.8% and 15%, with a mean and standard deviation (SD) of 9.23% ± 2.17%. As observed in (Figure 1), the majority of the children attending the diabetes clinic in STH (80%) had uncontrolled T1DM, with high levels of HbA1c (≥7.5%). As shown in (Table 1), among the studied socio-demographic factors, only parents' self-reported frequency of feeling anxious or stressed since their child's DM diagnosis appeared to be statistically significant. Parents who report feeling anxious or stressed "Mostly" or "Often" since the diagnosis have a significantly higher percentage of children with poor glycemic control (88.9% and 89.3%, respectively).

Conversely, only a small fraction of children in these high-stress categories (11.1% and 10.7%) achieved good glycemic control (p = 0.004). Among the studied factors related to diabetes, only history of hospitalization and frequency of hospitalization (Table 2) showed statistical significance. A history of hospitalization is strongly associated with poor glycemic control. Children with a history of hospitalization are significantly less likely to achieve good glycemic control (13.2%) compared to those with no history of hospitalization (33.3%) (p = 0.016). An increase in the frequency of hospitalization is associated with poorer glycemic control. Children hospitalized once had the best glycemic control (26.1%) among the hospitalization frequency groups (p = 0.012).

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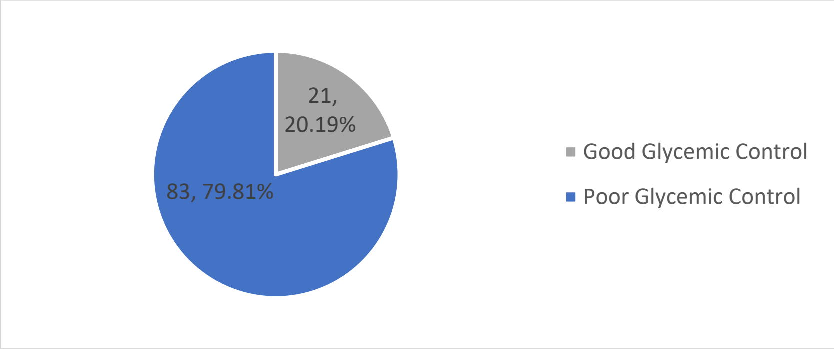

Figure 1. Prevalence of uncontrolled type 1 diabetes mellitus among children attending the diabetes clinic, STH

Table 1. Socio-demographic factors associated with the level of HbA1c among children attending the diabetes clinic at STH

Socio-demographics	**HbA1c**		***p*-Value**
	Good Glycemic Control *n* =21 *n* (%)	**Poor Glycemic Control *n* =83 *n* (%)**	
Gender			
Female (*n* =66)	15 (22.7%)	51 (77.3%)	0.279**
Male (*n* =38)	6 (15.8%)	32 (84.2%)	
Age at diagnosis (years)			
<3 (*n* =12)	3 (25%)	9 (75%)	0.407*
3-6 (*n* =32)	4 (12.5%)	28 (87.5%)	
>6 (*n* =60)	14 (23.3%)	46 (76.7%)	
Caregiver			
Patient self-care (*n* =37)	8 (21.6%)	29 (78.4%)	0.298*
Mothers only (*n* =64)	12 (18.8%)	52 (81.3%)	
Fathers (*n* =0)	0 (0)	0 (0)	
Guardian (*n* = 1)	1 (100%)	0 (0)	
Others (*n* =2)	0 (0)	2 (100%)	
Current Parental Marital Status			
Married (*n* =100)	20 (20%)	80 (80%)	0.600*
Divorced (*n* =1)	0 (0)	1 (100%)	
Widow (*n* =3)	1 (33.3%)	2 (66.7%)	
Educational Level of Caregiver			
Illiterate (*n* =1)	0 (0)	1 (100%)	0.305*
Elementary School (*n* =3)	0 (0)	3 (100%)	
Intermediate School(*n*=13)	1 (7.7%)	12 (92.3%)	
High School (*n* =17)	1 (5.9%)	16 (94.1%)	
Vocational School (*n*=19)	6 (31.6%)	13 (68.4%)	
University (*n* =39)	11 (28.2%)	28 (71.8%)	
Higher Degree (*n* =12)	2 (16.7%)	10 (83.3%)	
Family Income (LYD/ month)			
<500 (*n* =2)	0 (0)	2 (100%)	0.903*
500-1000 (*n* =31)	7 (22.6%)	24 (77.4%)	
1000-2000 (*n* =35)	6 (17.1%)	29 (82.9%)	
>2000 (*n* =23)	6 (26.1%)	17 (73.9%)	
No answer (*n* =13)	2 (15.4%)	11 (84.6%)	
Level of support from family and friends in managing DM			
A lot of support (*n* = 47)	12 (25.5%)	35 (74.5%)	0.276*
Some support (*n* = 43)	8 (18.6%)	35 (81.4%)	
Little support (*n* = 10)	0 (0)	10 (100%)	
No support (*n* = 4)	1 (25%)	3 (75%)	
Parents´ self-reported frequency of feeling anxious or stressed since their child´s DM diagnosis			
Mostly (*n* = 18)	2 (11.1%)	16 (88.9%)	0.004*
Often (*n* = 56)	6 (10.7%)	50 (89.3%)	
Sometimes (*n* = 22)	10 (45.5%)	12 (54.5%)	
Rarely (*n* = 3)	1 (33.3%)	2 (66.7%)	
Never (*n* = 5)	2 (40%)	3 (60%)	

*Fischer exact test; **Chi-square test.*

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Table 2. Diabetes mellitus-related factors associated with HbA1c levels among children attending a diabetes clinic at STH

Diabetes mellitus-related factors	HbA1c		*p*-Value
	Good Glycemic Control *n* = 21 *n* (%)	**Poor Glycemic Control *n* = 83 *n* (%)**	
Duration of DM (years)			
≤ 3 (*n* =53)	9 (17%)	44 (83%)	0.279**
> 3 (*n* =51)	12 (23.5%)	39 (76.5%)	
History of hospitalization			
No (*n* = 36)	12 (33.3%)	24 (66.7%)	0.016**
Yes (*n* = 68)	9 (13.2%)	59 (86.8%)	
Frequency of hospitalization			
Once (*n* = 23)	6 (26.1%)	17 (73.9%)	0.012*
Twice (*n* = 16)	0 (0)	16 (100%)	
>Twice (*n* =29)	3 (10.3%)	26 (89.7%)	
ICU admission			
No (*n* = 73)	18 (24.7%)	55 (75.3%)	0.066**
Yes (*n* = 31)	3 (9.7%)	28 (90.3%)	
Type of insulin			
Multi-dosage/day (*n* = 102)	21 (20.6%)	81 (79.4%)	0.635*
Insulin pump (*n* = 2)	0 (0)	2 (100%)	
Adherence to insulin therapy			
Excellent (*n* = 77)	15 (19.5%)	62 (80.5%)	0.784*
Good (*n* = 24)	6 (25%)	18 (75%)	
Bad (*n* = 3)	0 (0)	3 (100%)	
Number of times of blood glucose monitoring			
Once / week (*n* = 3)	2 (66.7%	1 (33.3%)	0.253*
Once / day (*n* = 10)	3 (30%)	7 (70%)	
2-3 Times/day (*n* = 36)	6 (16.7%)	30 (83.3%)	
⩾ 4 times/day (*n* = 50)	9 (18%)	41 (82%)	
Continuous glucose monitoring (CGM) (*n* = 5)	1 (20%)	4 (80%)	
Carbohydrate count usage			
No (*n* = 74)	18 (24.3%)	56 (75.7%)	0.080**
Yes (*n* = 30)	3 (10%)	27 (90%)	
Number of meals/days			
<Three meals/day (*n* = 10)	1 (10%)	9 (90%)	0.624*
Three meals/day (*n* = 73)	17 (23.3%)	56 (76.7%)	
>Three meals/day (*n* = 21)	3 (14.3%)	18 (85.7%)	
Number of snacks/days			
No (*n* = 7)	2 (28.6%)	5 (71.4%)	0.629*
<Three snacks/day (*n* = 71)	15 (21.1%)	56 (78.9%)	
Three snacks/day (*n* = 19)	4 (21.1%)	15 (78.9%)	
>Three snacks/day (*n* = 7)	0 (0)	7 (100%)	
Physician revisit interval			
Once/month (*n* = 30)	3 (10%)	27 (90%)	0.223*
Once/3 months (*n* = 52)	12 (23.1%)	40 (76.9%)	
Once/6 months (*n* = 22)	6 (27.3%)	16 (72.7%)	
Availability of a diabetes educator			
Yes (*n* = 75)	16 (21.3%)	59 (78.7%)	0.053*
No (*n* = 14)	0 (0)	14 (100%)	
Do not know (*n* = 15)	5 (33.3%)	10 (66.7%)	
Number of days of physical activity/week			
< Three days/ week (*n* = 42)	9 (21.4%)	33 (78.6%)	0.413**
Three days/ week (*n* = 26)	3 (11.5%)	23 (88.5%)	
> Three days/ week (*n* = 36)	9 (25%)	27 (75%)	
Knowledge in the management of sick days			
Excellent (*n* = 48)	11 (22.9%)	37 (77.1%)	0.625*
Good (*n* = 52)	9 (17.3%)	43 (82.7%)	
Bad (*n* = 4)	1 (25%)	3 (75%)	
Attending official workshops/ training programs on managing diabetes			
Yes (*n* = 28)	5 (17.9%)	23 (82.1%)	0.477**
No (*n* = 76)	16 (21.1%)	60 (78.9%)	
Family history of DM			
No (*n* = 48)	6 (12.5%	42 (87.5%	0.238*
Not sure (*n* = 16)	4 (25%)	12 (75%)	
Yes, T1DM (*n* = 13)	5 (38.5%)	8 (61.5%)	

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Yes, T2DM (n = 26)	6 (23.1%)	20 (76.9%)	
Both, T1DM+T2DM (n = 1)	0 (0)	1 (100%)	

**Fischer exact test; **Chi-square test.*

Discussion

Type 1 Diabetes Mellitus (T1DM) represents a significant public health challenge worldwide, particularly among pediatric populations. The need for continuous glycemic control complicates the management of T1DM, as poor management can lead to acute and chronic complications. Glycated hemoglobin (HbA1c) serves as a reliable biomarker for long-term glycemic control, with values above 7.5% indicating suboptimal management [15,16]. In the context of Libyan children with T1DM, recent findings highlight a high prevalence of poor glycemic control, with mean HbA1c values surpassing recommended targets [17–20]. This discussion aims to analyze these findings in relation to regional variations in glycemic control, explore the psychosocial and clinical determinants associated with poor outcomes, and consider the implications for disease management by integrating insights from recent advances in technology, genetics, adherence to carbohydrate counting and physical exercise, frequency of clinic visits, and duration of T1DM in years.

The current study underscores a concerning trend: Libyan children with T1DM exhibit a high prevalence of suboptimal glycemic control, as denoted by HbA1c levels ≥7.5%. The reported HbA1c values ranged from 5.8% to 15%, with a mean of 9.23%. While this mean remains above the recommended threshold, it is notably lower than values documented in comparable studies from Saudi Arabia (10.39%)[21] and Ethiopia (9.6%) [22], suggesting regional variations in disease management and healthcare practices. These differences may be attributed to multiple factors, including disparities in access to healthcare resources, socioeconomic status, cultural practices, and the implementation of structured diabetes education programs. Additionally, the variability in glycemic control across regions may reflect differences in genetic predisposition, environmental exposures, and the availability of advanced therapeutic modalities such as continuous glucose monitoring and automated insulin delivery systems [23]. Despite the relatively lower mean HbA1c in the Libyan cohort, the findings highlight an urgent need for targeted interventions to improve glycemic outcomes and reduce the long-term burden of diabetes-related complications.

A key finding of the study is the statistically significant association between psychosocial stress—as reported by parents—and poor glycemic control, highlighting the importance of parental mental health in diabetes management outcomes among children [24]. This relationship is well-supported in the literature; for example, Tsiouli et al. reported that family stress negatively correlates with glycemic control [25], while Mahler et al. emphasized the role of psychological stress in undermining treatment adherence and metabolic outcomes [26]. The mechanisms underlying this association are multifaceted. Stress can disrupt self-management behaviors, including adherence to insulin therapy, dietary regulation, and glucose monitoring [27,28]. Moreover, stress-induced neuroendocrine changes, such as increased cortisol secretion, can exacerbate insulin resistance and glycemic instability [29–31]. The integration of psychosocial support and stress management interventions into pediatric diabetes care thus emerges as a critical strategy for optimizing glycemic control. Technological advances offer promising avenues for addressing these psychosocial dimensions. The integration of Internet of Things (IoT) devices and machine learning algorithms enables the continuous monitoring of not only glycemic indices but also behavioral and physiological variables such as physical activity, heart rate, and sleep patterns [32]. These multidimensional data streams can inform personalized interventions, identify early signs of distress, and facilitate timely support from healthcare providers, thereby potentially mitigating the negative impact of psychosocial stress on disease management.

The study demonstrates a significant association between a history of hospitalization and poor glycemic control, a finding corroborated by research conducted at Tripoli University Hospital [17]and in Ethiopia [33]. Notably, Bat-Sheva Levine et al. established that individuals in the highest HbA1c tertile exhibit a markedly increased incidence of hospitalization, reinforcing the bidirectional relationship between metabolic instability and acute health events [34]. Previous reports have shown that type 1 diabetic patients with more frequent clinic visits had better metabolic control [35,36]. Kaufman et al. showed a significant difference in the mean HbA1c levels between subjects with 1 to 2 visits vs. 3 to 4 visits per year (9.0 ± 2.0% vs. 8.3 ± 1.6%, $p<0.05$). This association was statistically insignificant in our study, as it showed that 90% of patients who had one visit per month had poor glycemic control compared to 76.9% and 72.7% of patients with 3 and 6 months visit intervals, respectively, with poor glycemic control. This finding may be explained by the need for more frequent follow-up visits among patients with higher HbA1c levels. Hospitalizations in T1DM often result from episodes of diabetic ketoacidosis, severe hypoglycemia, or intercurrent illnesses, all of which are more likely in the context of poor glycemic regulation [37–39]. Conversely, frequent hospitalizations can disrupt daily routines, exacerbate stress, and impair self-management, creating a cycle of deteriorating control. These observations underscore the necessity of proactive outpatient management, comprehensive patient education, and the deployment of technologies that enable remote monitoring and early intervention.

Glycemic monitoring is a basic part of the management of type 1 diabetes [3]. Lower HbA1c levels were observed with more frequent self-monitoring of blood sugar [40,41]. Our study has shown that only 33.3%

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of those who monitored blood sugar once per week had poor glycemic control, compared to 83% of those who monitored 2-3 times per day, and 80% of those who used CGM had poor glycemic control; however, no statistically significant association was found. This may be due to over-reporting in the frequency of glucose monitoring by the caregivers and patients, and the minimal number of patients on CGM (n = 5).

Carbohydrate counting is a dietary management strategy that involves monitoring the amount of carbohydrates consumed to adjust insulin doses accordingly [42,43]. In our study, no significant correlation was found between carbohydrate counting and glycemic control. This lack of association may be attributed to the fact that more than half of the patients did not utilize carbohydrate counting as part of their diabetes management. However, carbohydrate counting is widely recognized as a crucial component in achieving optimal glycemic control in pediatric patients with Type 1 Diabetes Mellitus (T1DM) [44]. For example, a study conducted in Saudi Arabia reported a significant association between carbohydrate counting and improved glycemic control [21]. Similarly, research from Turkey demonstrated that carbohydrate counting contributed to better metabolic control in children and adolescents with T1DM, without leading to increased body weight or insulin requirements [42].

Physical activity is a cornerstone of diabetes management, alongside insulin therapy and dietary regulation [45]. It plays a vital role in improving glycemic control, enhancing insulin sensitivity, and promoting overall health in children and adolescents with diabetes [46–48]. However, in the present study, no significant correlation was found between physical activity and glycemic control. This lack of association may be attributed to higher caloric intake or inadequate dietary control, as well as the wide age range of participants, which could have influenced the relationship between these variables. In contrast, Aman et al. reported a significant association between physical activity and improved glycemic control [49]. Similarly, Nidia et al. observed that low levels of physical activity and cardiorespiratory fitness, combined with prolonged sedentary behavior, may partly explain the variance in glycated hemoglobin levels and contribute to an increased risk of poor glycemic control among youth (50,51).

Beyond psychosocial and clinical factors, the pathophysiology of T1DM and its management are profoundly influenced by genetic and environmental determinants. Yahaya and Salisu (2020) cataloged over 73 genes implicated in T1DM pathogenesis, with the human leukocyte antigen (HLA) complex, insulin gene, and cytotoxic T lymphocyte-associated antigen 4 (CTLA4) accounting for a substantial proportion of cases. Mutations in these genes, often interacting with environmental triggers, can precipitate β-cell autoimmunity, insulin deficiency, and resultant hyperglycemia (25). The high prevalence of suboptimal glycemic control among Libyan children may, in part, reflect underlying genetic susceptibilities that modulate immune responses and metabolic resilience. Understanding these genetic profiles could inform precision medicine approaches, enabling the identification of high-risk individuals and the tailoring of therapeutic regimens. Moreover, environmental factors such as infections, dietary practices, and exposure to toxins may further modulate disease expression and management outcomes [52].

Recent advances in automated insulin delivery and predictive modeling have the potential to revolutionize T1DM management. Ortmann et al. (2017, 2021) introduced model predictive control (MPC) algorithms augmented with Gaussian Process (GP) machine learning techniques to anticipate fluctuations in insulin sensitivity—an inherently time-varying parameter with circadian rhythmicity. By leveraging continuous glucose monitoring data and real-time adaptation, these systems achieved tighter glucose control in simulation models, reducing the risk of both hyperglycemia and hypoglycemia [53,54]. The practical implementation of these technologies in clinical settings remains a challenge, particularly in resource-limited environments. Nonetheless, the evidence suggests that adaptive control systems, coupled with biosensor data collection and cloud-based analytics, can enhance individualized care, minimize treatment errors, and improve overall glycemic outcomes [32]. The ongoing integration of IoT [the internet of things] devices, mobile health platforms, and machine learning algorithms is poised to transform the landscape of pediatric diabetes management, offering scalable solutions to address regional disparities and optimize care [55,56]. One limitation of this study was its cross-sectional observational design, which does not allow for the determination of cause-and-effect relationships. Additionally, much of the data was self-reported by patients or their caregivers, potentially leading to an overreporting of adherence to insulin or how often blood glucose was monitored. Nevertheless, this research represents one of the first in the region to include this number of T1DM patients. The findings highlight the need for additional research and the use of more reliable and valid scales for measuring psycho-social stress in patients and caregivers, such as the Perceived Stress Scale (PSS). Future prospective studies are recommended to examine the effects of various insulin therapy regimens and the adequacy of medical follow-up.

Conclusion

The findings from this study of Libyan children with T1DM highlight a persistently high prevalence of suboptimal glycemic control, reflecting a complex interplay of psychosocial stressors, clinical histories, potential genetic susceptibilities, and healthcare system factors. Regional comparisons suggest that while mean HbA1c values may be lower than in some neighboring countries, the overall burden remains unacceptably high. Addressing these challenges requires a multifaceted approach: integrating psychosocial support, leveraging genetic and environmental insights for precision medicine, and adopting technological

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innovations in monitoring and management. The management of T1DM in this setting likely requires coordinated efforts across clinical, educational, and health system levels.

Conflicts of Interest
The authors declare no conflicts of interest.

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