

Association and Predictive Value of Family Socioeconomic, Mental, and Physical Health Status for Glycemic Control among Children with Type 1 Diabetes

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ABSTRACT

To assess the prevalence of poor glycemic control in type 1 diabetes mellitus (T1 DM) patients and identify its key clinical, socioeconomic, behavioral, and family-related determinants. A cross-sectional descriptive analytic study. The study was conducted between January and May 2026. Information was collected from two healthcare facilities: Al-Wafaa Specialist Center for Diabetes and Endocrinology and the endocrine unit of Al-Khansaa Teaching Hospital, Mosul, Iraq. For 340 children and adolescents with T1 DM, we compared controlled (HbA1c ≤ 7 , n=38) versus uncontrolled (HbA1c $>7\%$, n=302) groups across comprehensive demographic, clinical, and behavioral variables using binary logistic regression and ROC curve analysis. About 89% of patients had poor glycemic control (mean HbA1c 9.78 ± 2.149). Uncontrolled patients were significantly older ($P = 0.021$) with longer disease duration ($P = 0.035$). Several socioeconomic and behavioral factors were significantly associated with poor glycemic control, including infrequent blood glucose monitoring, lower paternal educational level ($P = 0.002$), larger family size ($P = 0.001$), mother as a single caregiver ($P = 0.001$), and poor adherence to dietary recommendations ($P = 0.001$). On logistic regression analysis, seven factors were significantly associated with the glycemic control; four of them were protective. The strongest protective factor was family adherence to dietary recommendations (OR=0.170, 95% CI: 0.086-0.338, $P < 0.001$), while large family size increased the risk of poor control (OR=4.740, 95% CI: 1.917- 11.725, $P = 0.001$). A reduced model using only the seven significant predictors achieved good discrimination (AUC=0.860), while the full model including all 16 candidate variables achieved excellent discrimination (AUC=0.876). Glycemic control is unsatisfactory and is driven by people's behavior and family factors. Ways to introduce multidisciplinary family-centered care and to tackle issues related to dietary practices, parental education, and self-monitoring of glucose levels need to be found immediately to ensure successful treatment of affected individuals.

Keywords: Children; HbA1c; glycemic control; socioeconomic; Type1diabetes.

INTRODUCTION

Diabetes is one of the most common diseases worldwide. In children, T1DM is the most common chronic autoimmune disorder and is a major public health issue. Type 1 diabetes happens when the immune system destroys the pancreatic β -cells, leading to a complete lack of insulin and high blood sugar. About 90% of diabetes cases in children are T1DM, and the number of cases is rising by 2 to 3% each year^{1,2}. T1DM usually starts in childhood between ages 4 and 6 and again between 12 and 14 years³. Over the last forty years, the number of T1DM cases worldwide has doubled. On average, there are 15 new cases per 100,000 people each year, but this varies by region from as low as 0.1 per 100,000 in some parts of China and Venezuela to 40.7 per 100,000 in Finland. In Iraq, the rate among children under 15 increased from 7.8 to 24.7 per 100,000 between 1995 and 2014⁴.

The exact causes of T1DM are still not fully known, but it likely results from a mix of genetic risk, disorder with the immune system, and environmental factors like viral infections, low vitamin D, and diet⁵. As T1DM becomes more common, both short-term and long-

term complications such as diabetic ketoacidosis, microvascular complications, and poor glycemic control are also expected to increase. Diabetic nephropathy, retinopathy, and neuropathy can develop in children and adolescents shortly after a diagnosis. Initially, these complications are often asymptomatic but can be associated with serious health issues in the long term. Therefore, it is critical to identify these complications early and implement preventive measures⁶.

Glycosylated hemoglobin (HbA1C) is the most significant indicator in the management and monitoring of diabetes as it indicates the average blood glucose level of the past two to three months and thus enables long-term monitoring. According to international guidelines, T1DM is diagnosed at HbA1C levels exceeding 6.5% (48mmol/l), while the main treatment goal is to get the indicator below 7% in order to reduce the risk of complications⁷. However, achieving this goal in practice is frequently complicated. In Iraq, a study conducted in Karbala has revealed that only one-third of T1DM children exhibit HbA1C levels below 7%, while the majority of them have values above 8%. High levels of HbA1C indicate poor blood glucose control as a result of

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poor monitoring of the disease, irregular visits to diabetes clinics, and noncompliance of patients with insulin treatment recommendations⁸.

There are various factors that have an impact on glycemic control among children and adolescents diagnosed with T1DM. Factors like parental education especially that of mothers have a negative relationship with blood glucose levels⁹. The social-economical status and income of families is also crucial. Families with lower incomes have high HbA1c levels most possibly because of lack of resources that are used for managing diabetes^{10,11}. Family density, or the ratio of children to adults in the family also plays a role in glycemic control. High family density causes poorer levels of family monitoring and higher levels of family conflicts which leads to insufficient treatment¹². Similarly, health parameters and other health problems might be a barrier for attaining HbA1c objectives since they influence glucose metabolism as well as treatment plans^{13,14}.

The purpose of the study was to evaluate the level of poor glycemic control, to investigate how family characteristics affect the glycemic control results, to identify families that are at risk and may need additional help besides taking insulin.

METHODS

Study design: This cross-sectional descriptive-analytic study was conducted between January and May 2026. A convenience hospital-based sample was drawn from two healthcare facilities: Al-Wafaa Specialist Center for Diabetes and Endocrinology and the endocrine unit of Al-Khansaa Teaching Hospital. Because these facilities are major referral centers that handle the vast majority of pediatric T1DM cases in Ninevah Governorate of Mosul city.

Study population: Data were collected from 340 patients aged from 1 to 18 years who were diagnosed with T1DM and attended the participating centers for follow-up. A sample size of 340 subjects was calculated using Cochran's formula: $N = \frac{Z^2 P Q}{d^2}$; Where, N = sample size, Z = statistical certainty at 95 % CI (1.96), P = probability of the problem under study (taken as an approximate prevalence of poor glycemic control from previous national studies of 0.73), Q = 1.0 – p, d = desired margin of error set at 5%, the initial sample size was 303. To account for a potential dropout or missing data rate of 10–15%, we aimed to oversample. Adding an approximate 12.2% buffer (n=37) to the base requirement yielded our target of 340. Fortunately, all 340 recruited participants had complete data and were included in the final analysis.

Inclusion and Exclusion criteria: Patients included those who have been diagnosed with T1 DM for at least one year. Patients diagnosed with other types of diabetes (type 2 or MODY), those diagnosed with T1DM for less than one year, and those with incomplete information were excluded from the study.

Ethical approval: was obtained from the "Ethical Committee of Nineveh University- College of Medicine". The ethical license approval number (13) on

(27th of July), 2026

Data collection: Information was collected using a structured, pretested Arabic questionnaire administered to the patient or their caregiver during a scheduled follow-up visit. Participants were informed about the study's goal, written consent was obtained, and patient confidentiality was confirmed. The assessment questionnaire was divided into three main sections:

1. **Demographic and clinical data:** including age at diagnosis, disease duration, insulin type, frequency of blood glucose monitoring, last HbA1c, and its duration.
2. **Socioeconomic data:** These data included parental educational level, family structure, income, and family size, which was divided into three groups: small (3 or fewer members), medium (4-6 members), and large (7 or more members)¹⁵. Family monthly income was divided into three levels: low, middle, and high¹⁶.
3. **Psychological and physical health status:** Patients' and their caregivers' illnesses or comorbidities other than diabetes, the presence of one or more siblings with diabetes, and family care, including adherence to insulin, dietary recommendations, and follow-up, were recorded and evaluated.

The primary outcome variable was HbA1c, based on the most recent value recorded in the last few months.

According to the updated recommendation from the International Society for Pediatric and Adolescent Diabetes (ISPAD) and the American Diabetes Association (ADA) an HbA1c of $\leq 7.0\%$ is considered the standard target for children and adolescents without access to advanced automated insulin delivery technology¹⁷. To ensure consistency throughout the analysis, participants were classified into two groups: the controlled group (group 1) (HbA1c level $\leq 7.0\%$) and the uncontrolled group (group2) (HbA1c level $> 7.0\%$)

Statistical Analysis: Data were analyzed using IBM SPSS Version 26.0. Categorical variables were summarized with frequencies and percentages, while continuous variables were shown as means and standard deviations. The chi-square test was applied to examine associations between categorical variables and glycemic control. Independent samples t-tests and ANOVA were used to assess mean differences. Binary logistic regression was performed to identify factors associated with glycemic control (controlled vs. uncontrolled HbA1c) among the 340 patients with T1 DM. Initially, 19 variables were assessed; those with $P < 0.05$ in the initial univariate analysis were included in the multivariate logistic regression model. Sixteen related variables (frequency of blood glucose monitoring, parental educational level and their employment, housing status, monthly income, family size, patients' and their caregivers' illnesses or comorbidities other than diabetes, the presence of one or more siblings with diabetes, and family care, including main caregiver responsible for care, adherence to dietary recommendations, and follow-up) were entered simultaneously using the Enter method while other variables including (insulin regimen, number of hospitalization in the last year, presence of psychological disease in the family) were excluded as they did not reach threshold for inclusion. Model fitness was assessed using the Hosmer-Lemeshow goodness-of-fit test and Nagelkerke R^2 Odds ratios (OR) with 95% confidence intervals (CI) were calculated. Statistical significance was set at $P < 0.05$.

RESULTS

A total of 340 participants with T1DM were enrolled in this study; 157 (46.8%) were males, yielding a male-to-female ratio of 1:1.17. The mean age of the patients $\pm$ SD was 11.36 ± 3.41 years (age range 1 to 18 years) and 95% CI for age =11.005-11.076. The mean HbA1c of participants $\pm$ SD was 9.78 ± 2.14 (Figure 1). Group 1 patients (HbA1c ≤ 7), numbered 38 (11%), while Group 2 (HbA1c > 7) comprised the remaining 302 patients (89%) (Figure 2).

In Table 1, three continuous variables were evaluated: the patient's age at the time of study, the patient's age at the diagnosis, and the disease duration. Children with target glycemic control (HbA1c $\leq 7\%$) had a

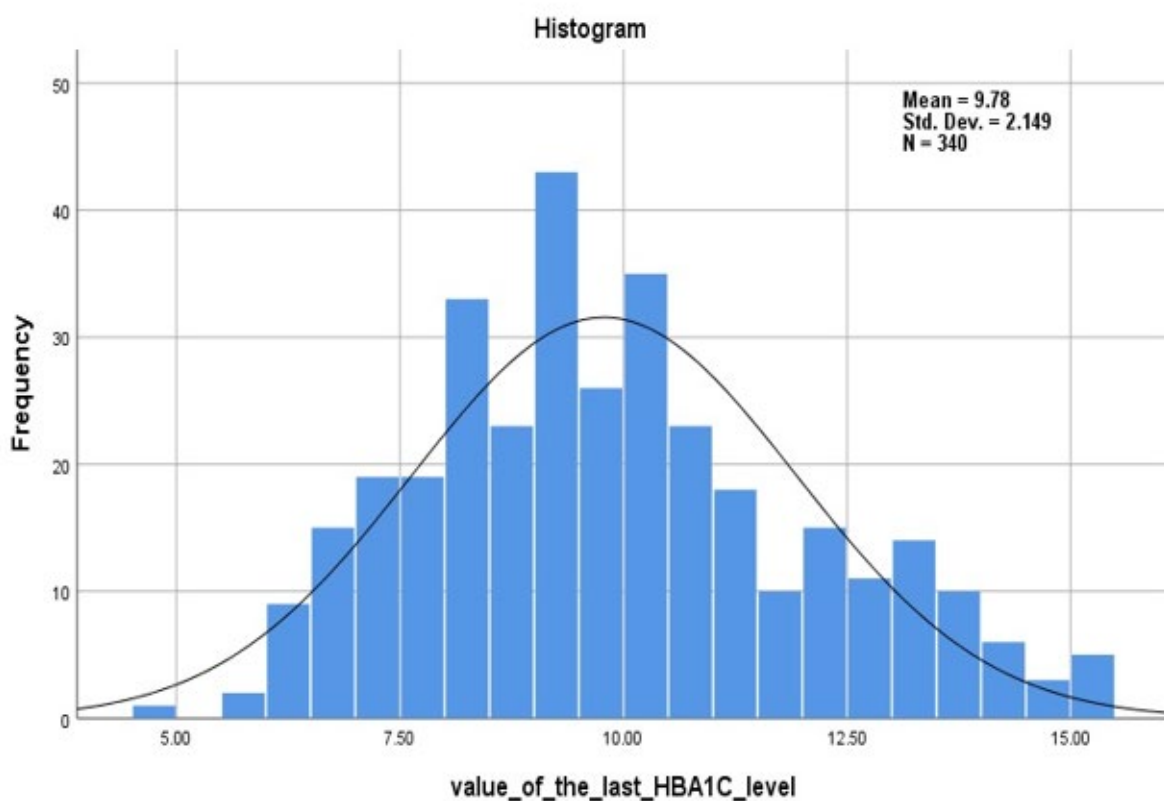


Figure 1. Distribution and frequencies of the Latest HbA1c values

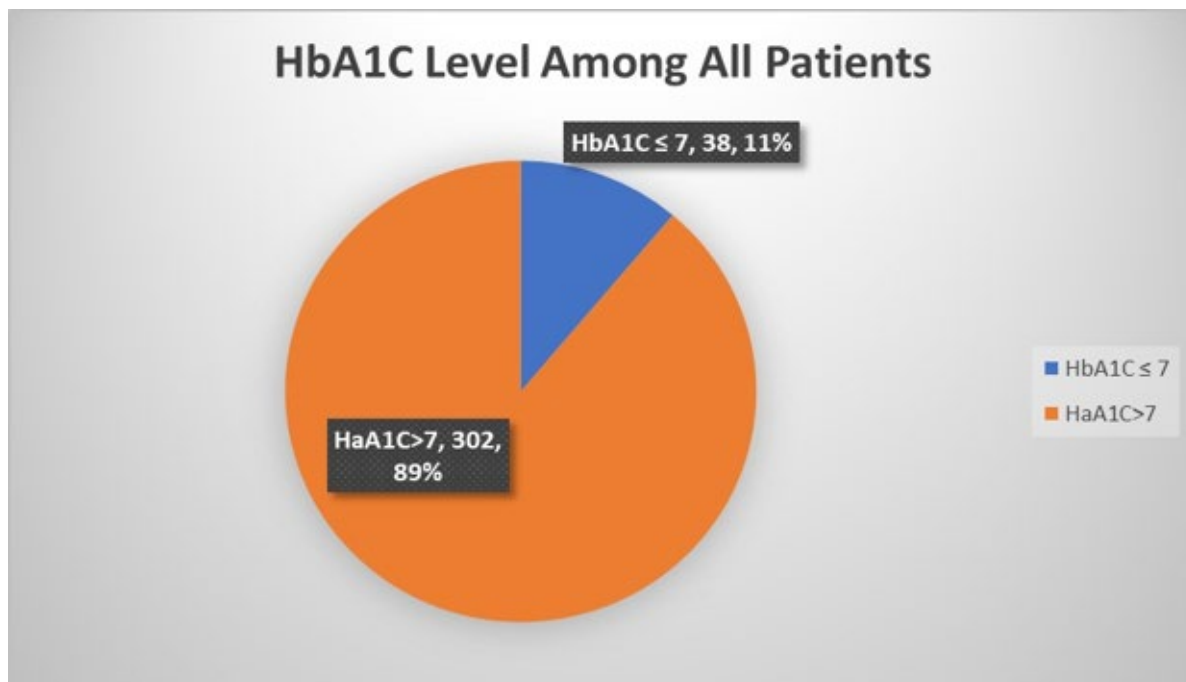


Figure 2. Percentage of patients with target HbA1c level

significantly lower mean age compared with those with poor glycemic control (HbA1c >7%) (10.16 $\pm$ 3.78 vs 11.51 $\pm$ 3.34 years, respectively) ($P=0.021$). Similarly, the mean duration of the disease was shorter among group 1 compared to group 2 (3.59 $\pm$ 2.86 vs 4.73 $\pm$ 3.14) years, respectively ($P=0.035$). At the same time, the patients' age at diagnosis showed no significant association ($P=0.744$).

The associations between demographic, socioeconomic, psychological, and behavioral factors and HbA1c were evaluated in the two groups. A statistically significant association was found between the frequency of blood glucose monitoring and glycemic control ($P=0.034$). Good glycemic control was achieved in (50%) of those who monitor fewer than 3 times daily, (28.9%) of those who monitor 3-4 times daily, and (21.1%) of those who monitor more than 5 times per day. Regarding paternal educational level, a statistically significant difference was observed between the two groups ($P=0.002$) (Table 2).

University-level education represents the most striking point of divergence between the two groups, with a higher prevalence among the controlled group (52.6%) than in the uncontrolled group (24.2%). A higher prevalence of illiteracy and lower educational attainment were more pronounced in the uncontrolled group. Family structure, including family size, strongly affects glycemic control and HbA1c levels ($P=0.000$). It was found that (0.6%) (2/340) of all patients came from small families (fewer than 3 members). Notably, 71.1% of those who achieved good glycemic control came from medium-sized families, 23.7% from large-sized families, and only 5.3% from small-sized families (Table 2).

The primary caregiver's identity significantly influenced diabetic control ($P=0.001$), with maternal care being most dominant in the uncontrolled group (74.5%) compared to the controlled group (52.6%). Conversely, joined care by both parents was more effective, representing 31.6% in the controlled group versus only 10.6% in the uncontrolled group. Patients' adherence to dietary recommendations was also significantly associated with glycemic control ($P=0.000$). While adherence at a fair level was nearly the same in both groups (50% vs 50.7%), a striking difference was observed at a good adherence level, more pronounced in the controlled group (39.5%) than in the uncontrolled group (11.3%). Conversely, poor dietary adherence was more prevalent in the uncontrolled group (38.1%) (Table 2).

Sex distribution had no significant effect on HbA1c levels ($P=0.060$). Similarly, other factors, including type of insulin regimen, hospitalization during the last year, parental employment, parental disease, and the presence of other diseases, including psychological diseases, in the patient or their siblings, all had no significant association with glycemic control ($P>0.05$).

The logistic regression model was conducted, and it was statistically significant ($X^2=71.873$, $df=16$, $P<0.001$), explaining 37.8% of the variance in glycemic control (Nagelkerke $R^2=0.378$). The Hosmer-Lemeshow test indicated good model fit ($X^2=6.688$, $df=8$, $P=0.571$). The model correctly classified 89.4% of cases, with a sensitivity of 97.4% for uncontrolled glycemic control and a specificity of 26.3% for controlled glycemic control.

Table 3 presents a binary logistic regression analysis identifying seven significant independent predictors of poor glycemic control (HbA1C

Table 1. Analysis of age and disease-related characteristics by HbA1c level

Factors	HbA1c level $\leq$ 7% (NO=38)	HbA1c level > 7% (NO=302)	P
Age (yrs) Mean $\pm$ STD	10.16 $\pm$ 3.78	11.51 $\pm$ 3.34	0.021
Age at diagnosis (yrs) Mean $\pm$ STD	6.57 $\pm$ 3.83	6.78 $\pm$ 3.62	0.744
Duration of the disease(yrs)Mean $\pm$ STD	3.59 $\pm$ 2.86	4.73 $\pm$ 3.14	0.035

Table 2. Association of Socioeconomic, Family care, and Clinical factors with HbA1c Levels

Factors		HbA1c level $\leq$ 7 (n=38) (%)	HbA1c level > 7 (n=302) (%)	Total (n=340) (%)	P
Frequency of blood glucose monitoring per day	<3	19 (50)	212 (70.2)	231 (67.9)	0.034
	3-4	11 (28.9)	58 (19.2)	69 (20.3)	
	> 5	8 (21.1)	32 (10.6)	40 (11.8)	
father education level	illiterate	5 (13.2)	68 (22.5)	73 (21.5)	0.002
	primary	11 (28.9)	107 (35.4)	118 (34.7)	
	secondary	2 (5.3)	54 (17.9)	56 (16.5)	
	university	20 (52.6)	73 (24.2)	93 (27.4)	
Family NO.	Small size($\leq$ 3)	2 (5.3)	0 (0.0)	2 (0.6)	0.000
	Medium size(4-6)	27 (71.1)	149 (49.3)	176 (51.8)	
	Large size($\geq$ 7)	9 (23.7)	153 (50.7)	162 (47.6)	
Main person Responsible for diabetic care	mother	20 (52.6)	225 (74.5)	245 (72.1)	0.001
	father	1 (2.6)	16 (5.3)	17 (5.0)	
	Both parents	12 (31.6)	32 (10.6)	44 (12.9)	
	Other caregiver	3 (7.9)	6 (2.0)	9 (2.6)	
	Patient himself	2 (5.3)	23 (7.6)	25 (7.4)	
Family adherence to dietary recommendation	poor	4 (10.5)	115 (38.1)	119 (35)	0.000
	fair	19 (50)	153 (50.7)	172 (50.6)	
	good	15 (39.5)	34 (11.3)	49 (14.4)	

Table 3. Multivariable Binary Logistic Regression Analysis of Factors Associated with Poor Glycemic Control (HbA1c > 7%)

Variable	Coding / Reference category	B	SE	Wald	P-value	Adjusted OR	95% CI
Sex	Female vs Male (ref)	0.519	0.426	1.485	0.223	1.680	0.729–3.871
Frequency of blood glucose monitoring per day	Ordinal: <3 / 3–4 / ≥5 times per day (per 1-level increase)	-0.672	0.313	4.626	0.031	0.511	0.277–0.942
Father's educational level	Ordinal: none / primary / secondary / university (per 1-level increase)	-0.752	0.267	7.914	0.005	0.471	0.279–0.796
Mother's educational level	Ordinal: none / primary / secondary / university (per 1-level increase)	0.662	0.278	5.683	0.017	1.938	1.125–3.338
Father's employment status	Ordinal: employed / unemployed / retired (per 1-level increase)	-0.481	0.550	0.765	0.382	0.618	0.211–1.816
Mother's employment status	Ordinal: employed / unemployed / retired (per 1-level increase)	-0.265	0.724	0.134	0.715	0.767	0.185–3.174
Monthly family income	Ordinal: low / middle / high (per 1-level increase)	0.126	0.595	0.045	0.832	1.134	0.354–3.637
Family size group	Ordinal: small (≤3) / medium (4–6) / large (≥7) (per 1-level increase)	1.556	0.462	11.346	0.001	4.740	1.917–11.721
Chronic disease in a parent	No vs Yes (ref)	0.293	0.438	0.450	0.502	1.341	0.569–3.161
Main person responsible for diabetic care	Nominal, entered continuous: mother / father / both / other caregiver / self (see note)	-0.472	0.158	8.967	0.003	0.624	0.458–0.850
Family adherence to insulin administration	Ordinal: poor / fair / good / excellent (per 1-level increase)	0.696	0.456	2.325	0.127	2.005	0.820–4.905
Family adherence to dietary recommendations	Ordinal: poor / fair / good / excellent (per 1-level increase)	-1.771	0.379	21.872	<0.001	0.170	0.081–0.357
Adherence to clinical follow-up	Irregular vs Regular (ref)	0.239	0.476	0.251	0.617	1.269	0.499–3.229
Housing status	Nominal, entered continuous: owned / rented / other (see note)	-0.127	0.315	0.161	0.688	0.881	0.475–1.635
Child has no other chronic illness	No vs Yes (ref)	1.885	0.574	10.766	0.001	6.585	2.136–20.301
Siblings with diabetes	>0 vs 0 (ref)	0.771	0.854	0.815	0.367	2.162	0.405–11.530
Constant	—	-1.248	3.200	0.152	0.696	0.287	—

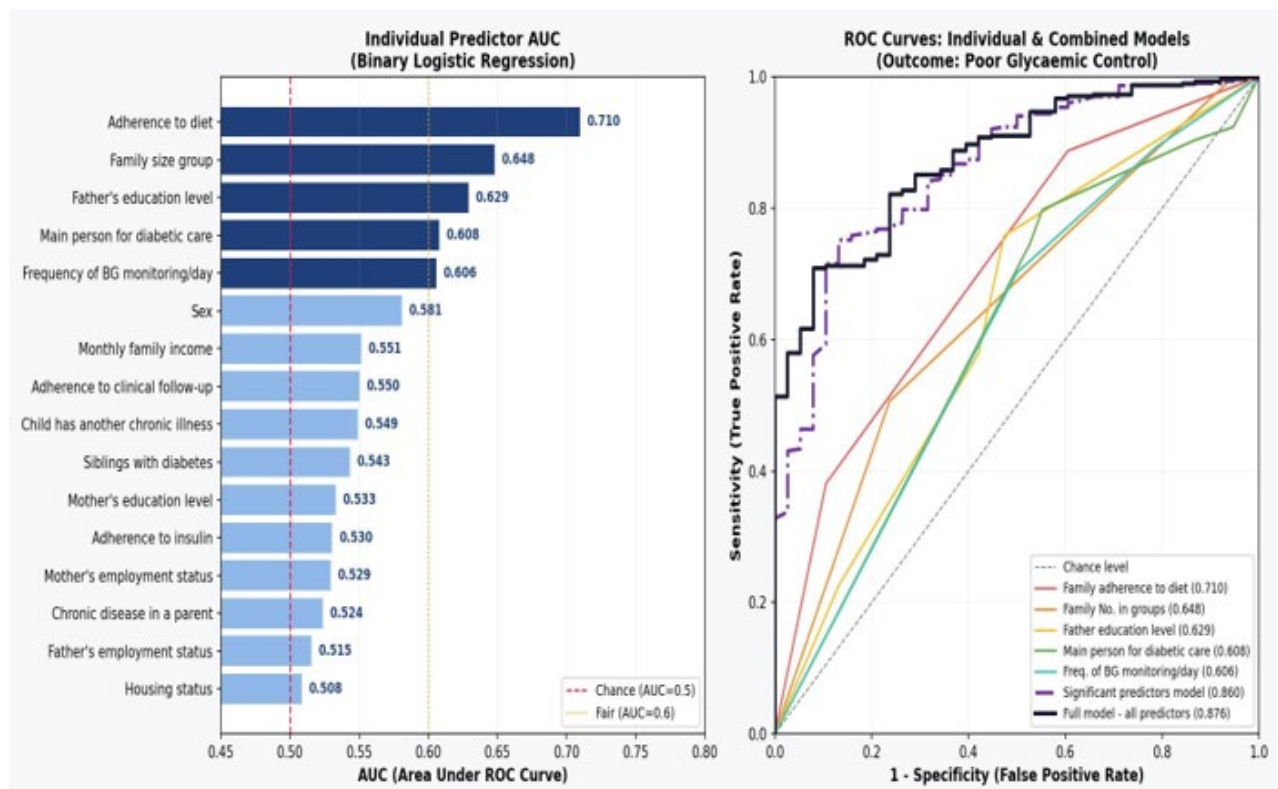


Figure3. Binary logistic regression showing ROC Analysis of Individual and Combined Associated factors of Poor glycemic control

>7%) among 16 evaluated variables. Four of these variables were protective. The strongest protective factor was family adherence to dietary recommendations (OR=0.170, 95% CI: 0.086-0.338, $P < 0.001$). The type of main caregiver also offered protection (OR=0.624, 95% CI: 0.458-0.851, $P=0.006$). Higher paternal education was associated with improved glycemic control (OR=0.471, 95% CI: 0.276-0.804, $P=0.006$). The presence of other chronic illnesses in the child was the most significant risk factor (OR=6.585, 95% CI: 2.136-21.718, $P=0.002$), while family group membership increased risk (OR=4.740, 95% CI: 1.917- 11.725, $P=0.001$).

The discriminative ability of a binary logistic regression model to identify poor glycemic control (HbA1c $\geq 7\%$) in children with T1D was examined. The AUC-ROC was calculated for each factor separately and for the combined model. Family adherence to dietary guidelines showed the strongest discriminative power (AUC=0.710), followed by family size (AUC=0.648), father's education level (AUC=0.629), the main caregiver for diabetes management (AUC=0.608), and blood glucose monitoring frequency per day (AUC=0.606). These factors also reached statistical significance in the logistic regression ($P < 0.05$). Factors like parental employment, family income, and the presence of other chronic illnesses in parents or children had AUCs below 0.60, indicating limited predictive ability. When all 16 related factors were put into consideration in logistic regression, the overall AUC was 0.876 (Figure 3), which is indicative of a good to excellent capacity of distinguishing between groups. The reduced model comprising the seven significant predictors had an AUC of 0.860 indicating that the model still accomplished good discrimination even with lesser variables. Overall, it would seem that no single sociodemographic or behavioral factor is able to identify poor control independently and accurately, but rather in combination they create a clinically useful model.

DISCUSSION

This study involved 340 children and teenagers with type 1 diabetes (T1DM), with nearly equal numbers of boys and girls (M:F ratio 1:1.17), which is consistent with previous research showing no major sex difference in pediatric T1DM¹⁸. The mean age was 11.36 ± 3.41 years, so most participants were school-aged or in early adolescence. This is a critical period, making managing blood glucose especially challenging at this age because of hormonal changes associated with puberty that increase insulin resistance, in addition to psychosocial changes¹⁹. The mean HbA1c was $9.78 \pm 2.14\%$, which is much higher than the international recommended target of less than 7% for children with T1DM, indicating that most patients in this population had poor blood glucose control²⁰. Only 38 patients (11%) reached the target HbA1c of 7% or less, while 89% did not. The finding that this rate of uncontrolled blood glucose is comparable to that published in other areas and developing countries with insufficient access to insulin and follow-up care illustrates the need for improved, more cooperative ways of managing diabetes²¹. It appears that we need to work on ways of increasing the access of diabetic patients to insulin, information about diabetes management, and psychological assistance²².

Children with less-regulated blood sugar control tended to be older than others (11.51 ± 3.34 vs. 10.16 ± 3.78 years; $P=0.021$). Presumably, this is because adolescents are usually more vulnerable to challenges posed by diabetes management, which is explained by behavioral and hormonal changes that happen during this period of life²³. The age at which diabetes was diagnosed for the first time appeared to be similar for both groups ($P = 0.744$), which indicates that the age at onset of diabetes does not correlate with glucose control. These results are supported by some other pieces of research, which suggest that the

effectiveness of care received after the diagnosis overrides the date of diagnosis itself²⁴. Nonetheless, the duration of diabetes is associated with poorly controlled blood sugar levels (4.73 vs. 3.59 years; $P = 0.035$), which correlates with the decrease in insulin production and increase in insulin resistance²⁵. Overall, the results demonstrate that the longer patients suffer from poorly controlled diabetes, the higher the chances of developing complications²⁶. Therefore, it is important to initiate the process of team-based care as early as possible, especially with respect to young children and those diagnosed with diabetes long ago²⁷.

This research found that various factors such as socioeconomic, family, and life habits are linked to controlling blood glucose levels. The majority of the individuals with poor control (70.2%) had their blood sugar checked less than three times a day compared to 50% of those with optimal control ($P = 0.034$). As found in other studies more frequent blood glucose testing per day is reflected as better glycemic control due to the better meals and insulin regulation²⁸. The father's education level influenced the process as well ($P = 0.002$); more children with good control had fathers with higher education (52.6% vs. 24.2%). It has been proved that more educated fathers can possess better health literacy, enable parents to understand how to apply insulin for the benefit of diabetes management²⁹. Family size was also significant ($P = 0.000$); large families (with seven and more members in them) are represented among individuals suffering from poor control more often (50.7% vs. 23.7%). One can suppose that it happens due to the fact parents in large families have neither enough time nor enough resources for each child, which makes diabetes management more difficult³⁰.

Mothers were the main caregivers in approximately (72.1%) of the cases while patients were at risk of bad control when the mother was the only caregiver. On the other hand, both parents assumed the role of care providers, a situation that occurred more among the controlled group (31.6% vs. 10.6%). This is helpful since sharing the caregiving load could produce a more conducive atmosphere, thus easing the stress put on one parent and enabling patients to undertake the treatment³¹. In addition, diet adherence emerged as one of the leading correlators to good control ($P = 0.000$), as (39.5%) of the people with good control had maintained appropriate diet adherence while uncontrolled subjects demonstrated poor adherence (38.1% vs. 10.5%). It is important to maintain diet adherence in children with T1DM as eating regularly and counting carbohydrates and dosing insulin will help avoid sugar spikes^{32,33}. Also, it has been demonstrated that family-based diet programs can increase HbA1c in the course of diabetes education³⁴. Overall, it can be stated that blood sugar control in children with T1DM depends on many factors, including research results showing that blood sugar control of children with T1DM is affected by more factors than just medical treatment, since there are also some family and social factors³⁵. Such factors as insulin therapy, hospitalization, parents' occupations, family income, and residence type were found to have an insignificant effect (all $P > 0.05$); thus, no single factor identifies control³⁶. Besides, having family members with some psychological and/or chronic diseases as well as siblings with diabetes has not been proven to have a significant influence on the results of awareness or care³⁷.

The main associated factors for unsatisfactory blood glucose control in this population were identified through statistical analysis, including binary logistic regression and ROC curve analysis. Adherence of the family members to the dietary recommendations emerged as the most important associated factor (AUC=0.710), implying that well-structured meal planning is an important element of management of children with Type 1 Diabetes Mellitus (T1DM). Healthy eating

habits help in controlling blood glucose levels after meals and dosing insulin appropriately; thus, the message should be that families respond together in diabetes education³⁸. Family size has turned out to be number two (AUC=0.648), which could mean that larger families face more difficulties in the process of regular checking and treatment³⁹. The father's education was the third strongest associated factor (AUC=0.629), implying that a father being educated provides a better understanding of health and better communication with providers, ensuring better blood glucose control⁴⁰. Also, the identity of the main caregiver (AUC=0.608) and the frequency of blood checking (AUC=0.606) were important in the context that frequent monitoring allows appropriate insulin adjustments, preventing high levels of blood glucose⁴¹. Two further predictors reached significance in the multivariable model. A higher maternal educational level was associated with increased odds of poor control (adjusted OR=1.938), a direction opposite to that seen for paternal education, which may reflect differences in caregiving role or working status among more educated mothers rather than a direct effect of education itself. Children without another chronic illness also had higher odds of poor control (adjusted OR=6.585), which may reflect closer medical supervision and more structured follow-up among children already being managed for a second chronic condition.

Other factors like housing, parents' jobs, family income, insulin adherence, and regular clinic visits do not have much effect, instead having an effect only when used with other factors. Creating a model that incorporates only significant associated factors yields a good result (AUC = 0.860), while having a model that utilizes all factors produces an even better result (AUC = 0.876). This indicates that taking into consideration the social, educational, dietary-related, and caregiving factors jointly renders much better results than studying these factors independently⁴². All results indicate that combined factors can be used as screening tools to help detect children with T1DM with poor blood glucose control and target families in need of help.

Study Limitations

This study has some significant shortcomings. The sample predominantly reflects patients seeking specialized public health clinic care and may underrepresent those managed in private clinics or those with limited access to referral centers. Secondly, we employed only the latest HbA1c measurement, whereas following its changes over time would have provided a more accurate picture of glycemic control. Finally, we did not consider psychological factors (diabetes distress, depression, quality of life), which, though, can exert influence on thermoregulation in children.

CONCLUSION

Almost all of the sampled group in this particular research, that is approximately 90% of children and teenagers with Type 1 diabetes (T1DM), have shown poor control of blood sugar levels. Blood glucose results do not depend only on medical care, but also on behavior, education and family conditions. What has been revealed as the most important related factors were how families adhere to dietary recommendations, family size, father's education, who the main caregiver is, the frequency of blood sugar control, mother's education, and whether the child has another chronic illness. Thus, it becomes apparent that diabetes care should be focused on addressing the needs of the entire family to enhance the overall efficiency of treatment and improve health outcomes.

Authorship Contribution: All authors share equal effort contribution towards (1) substantial contributions to conception and design,

acquisition, analysis and interpretation of data; (2) drafting the article and revising it critically for important intellectual content; and (3) final approval of the manuscript version to be published. Yes.

Potential Conflicts of Interest: None

Competing Interest: None

Acceptance Date: 16 August 2026

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