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Academic Achievement in Children and Adolescents with Type 1 Diabetes: Tripoli University Hospital Experience, Libya.

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Original Research Article

ABSTRACT

Background: Type 1 diabetes (T1D) is a chronic disease affecting children and adolescents, which may impact their academic achievement.

Objective: To evaluate the clinical impact of T1D on academic achievement in children and adolescents and compare scholastic achievement with their non-diabetic peers.

Method and Materials: A prospective case-control study was conducted in the Pediatric Endocrinology Department at Tripoli University Hospital between February and May 2025, after obtaining ethical approval and parental consent. The study included 120 Libyan children and adolescents with T1D, aged 6–18 years, who were enrolled in formal schooling. Data on demographics, disease characteristics, glycemic control, and academic achievement were collected. Statistical analyses assessed associations between variables.

Results: Good glycemic control (HbA1c 6–8%) was observed in 55% of patients and was strongly associated with better academic achievement (P = 0.001). Children with well-controlled diabetes demonstrated academic achievement similar to that of their non-diabetic peers. Conversely, non-diabetic children achieved significantly higher mean grades than diabetic children with poor glycemic control. No significant associations were found between academic achievement and age, gender, or age at disease onset, including onset before school entry (P > 0.05). Parental education was significantly associated with academic achievement (father: P = 0.008; mother: p = 0.001). Factors significantly associated with glycemic control included hypoglycemia frequency (p = 0.030), hospital admissions (p = 0.046), ICU admissions (P = 0.02), and treatment modality (p = 0.001). Chronic complications and associated diseases had no significant impact on academic achievement.

Conclusion: Good glycemic control and effective diabetes management were associated with a better academic achievement. Parental education and treatment modality significantly influence glycemic control. T1D, in the absence of poor glycemic control, does not significantly impair academic achievement.

KEYWORDS: Type 1 diabetes; school achievement; glycemic control.

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INTRODUCTION

Diabetes mellitus (DM) is among the most prevalent chronic diseases affecting children and adolescents [1] and is widely recognized as one of the most significant health challenges of the 21st century. Its incidence continues to rise across all age groups and both sexes, impacting populations in both developing and developed countries. Globally, an estimated 2.58 million individuals aged ≤19 years are living with type 1 diabetes (T1D) [2], with approximately 132,000 new cases diagnosed annually [3].

Although type 2 diabetes is increasingly recognized in pediatric populations, T1D remains the most common form of diabetes in children and adolescents and is the focus of the present study.

T1D exerts substantial effects on multiple domains of a child's life, including social interactions, family dynamics, school attendance, and academic achievement [10].

The management of T1D in young children remains particularly complex, as maintaining optimal glycemic control is essential for preventing acute complications such as hypoglycemia and diabetic ketoacidosis (DKA) [1], as well as long-term complications including retinopathy, neuropathy, and nephropathy [1]. Emerging evidence further suggests that children and adolescents with T1D may experience impairments in cognitive and motor functioning [11]. Suboptimal glycemic control—particularly when associated with recurrent hypoglycemia or episodes of DKA—has been linked to adverse neurodevelopmental outcomes, including deficits in memory, attention, and executive functioning [12,13].

The interplay between health and education has traditionally been examined from the perspective of how educational attainment influences health outcomes. However, increasing attention is being directed toward the reverse relationship—namely, how early-life health conditions shape educational trajectories [14]. T1D represents a salient example of a chronic pediatric condition that may adversely affect academic achievement. Evidence indicates that children with T1D tend to exhibit poorer educational outcomes compared with their peers, particularly in the context of suboptimal glycemic control or elevated HbA1c levels [15]. Nevertheless, this relationship is multifactorial and may be influenced by several mediating variables. Advances in diabetes management technologies, alongside improved patient education, have the potential to enhance glycemic control and overall health outcomes [14]. More profound understanding of these dynamics is essential for informing strategies aimed at mitigating the educational impact of chronic diseases.

The extent to which T1D impacts cognitive functioning and academic achievement remains inconclusive. While numerous studies report that children with T1D generally demonstrate intelligence levels within the normative range, findings across the literature exhibit considerable variability. Several investigations have documented neuropsychological deficits within this population, including impairments in verbal intelligence [17], memory [18,19], processing speed [17], attention [20], visuospatial abilities [20], visual reasoning [21], and achievement on timed motor tasks.

Studies conducted in Sweden and Arizona demonstrate that children with diabetes exhibit poorer academic achievement compared with their siblings and non-diabetic peers [15,16]. Conversely, studies from Australia, Scotland, and Washington report no significant differences in academic outcomes between children with T1D and healthy controls [22,16]. A number of researchers propose that academic achievement in children with T1D is closely associated with glycemic regulation. Specifically, children who achieve and maintain optimal metabolic control tend to demonstrate superior academic outcomes compared with those exhibiting poor control [11, 24, 22]. These findings emphasize the importance of glycemic stability not only for physical health but also for cognitive development and educational attainment. However, some longitudinal studies have failed to establish a definitive causal relationship between glycemic variability and academic achievement, suggesting that psychosocial and environmental factors may play a critical mediating role.

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The present study seeks to evaluate academic achievement among children and adolescents with T1D in Libya, thereby addressing the relative scarcity of regional data on this topic.

METHODS AND MATERIALS

The study was a retrospective case-control study conducted on 120 Libyan children aged 6–18 years diagnosed with T1D and currently enrolled in school attending the pediatric endocrinology department, Tripoli University Hospital, during the period from February to May 2025. T1D group: 120 children and adolescents. Control group: 100 children (matched by age and selected from cousins or classmates).

Inclusion Criteria:

- Age 6–18 years, diagnosed with T1D.
- Currently enrolled in formal schooling.

Exclusion Criteria:

- Chronic illnesses affecting academic achievement, except autoimmune conditions associated with T1D (e.g., celiac disease, and hypothyroidism).

Data Collection: A pre-tested structured questionnaire was used to collect the following data:

- Demographics: age, gender, age at diagnosis.
- Parental education.
- School enrollment and attendance.
- Academic achievement was assessed using the official school average grades obtained from school records for the previous academic year. Grades were categorized into Excellent, Very Good, Good, and Fail according to the Libyan educational grading system. The same grading criteria were applied to both study groups.
-Glycemic control (average HbA1c over one year).
-Diabetes-related complications: hypoglycemia, DKA, ICU and hospital admissions.
-Treatment modality (MDI or insulin pump).

Statistical Analysis: Data were analyzed using SPSS version 20. Descriptive statistics were presented as means ± standard deviations and frequencies. Associations between categorical variables were assessed using the Chi-square test. Independent predictors of excellent academic achievement were evaluated using multivariate logistic regression analysis. Variables entered into the model included age, sex, glycemic control, treatment modality, father's education, and mother's education. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were calculated. Statistical significance was set at $P < 0.05$.

Ethical Considerations: Approval was obtained from Tripoli University Hospital. Study objectives and procedures were explained to participants and parents. Parental consent was obtained. Data confidentiality and anonymity were maintained.

RESULTS

A total of 120 children and adolescents with T1D included in this study. All participants were under regular follow-up at the endocrine outpatient department of Tripoli University Hospital, Tripoli, Libya. A control group of 100 non-diabetic children was included for comparison. Good glycemic control (HbA1c 6–8%) was achieved in 55% of patients, while 45% had poor control (HbA1c ≥ 9%).

Demographic characteristics and baseline data

The mean age of children with T1D was 12.88 ± 3.24 years, compared to 11.74 ± 2.72 years in the control group. Females were more predominant in the diabetic group (60%) compared to males (40%). Approximately 47.5% of patients developed diabetes before school entry, while 52.5% developed it after school entry. (Table 1)

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Table (1): Demographic characteristics and baseline data

Variable	(T1D (n=120	(Control (n=100
(Age (mean ± SD	3.24 ± 12.88	2.72 ± 11.74
Age range	18–7	17–7
Male	(40%) 48	(51%) 51
Female	(60%) 72	(49%) 49
Onset before school	(47.5%) 57	—
Onset after school	(52.5%) 63	—

Glycemic control and associated factors

There was no statistically significant association between glycemic control and age group (P = 0.416) or gender (P = 0.133).

However, a statistically significant association was observed between glycemic control and hypoglycemia frequency (P = 0.030), hospital admissions (P = 0.046), ICU admissions (P = 0.020), and treatment modality (P = 0.001). In contrast, no significant association was found between glycemic control and DKA episodes (P = 0.887). (Table 2)

Table (2): Glycemic control and associated factors

Variable	Category	Good	Poor	Total	P-value
Age group	6–10 yrs	13	14	27	0.416
	>10 yrs	53	40	93	
Gender	Male	31	18	49	0.133
	Female	35	36	71	
Hypoglycemia	Daily	2	10	12	0.030
	Weekly	23	17	40	
	Monthly	6	4	10	
	Every few months	4	0	4	
	None	31	23	54	
DKA	None	45	36	81	0.887
	1	18	14	32	
	≥2	3	4	7	
Hospital admission	None	48	36	84	0.046
	1	16	10	26	
	≥2	2	8	10	
ICU admission	None	64	46	110	0.020
	≥1	2	8	10	
Treatment	MDI	44	50	94	0.001
	Insulin pump	22	4	26	

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Glycemic control and academic achievement

A highly statistically significant association was observed (P = 0.001), with children who had good glycemic control more likely to achieve excellent and very good grades, while those with poor control had a higher proportion of failure. Logistic regression analysis showed that children with good glycemic control were nearly twice as likely to achieve excellent academic achievement compared to those with poor control (OR = 1.99; 95% CI: 0.95–4.19; P = 0.07), although this did not reach statistical significance. (Table 3)

Table (3): Glycemic control and academic achievement

Glycemic Control	Excellent	Very Good	Good	Fail	Total	P-value
Good	45	18	3	0	66	0.001
Poor	28	15	0	11	54	
Total	73	33	3	11	120	

Chi-square test: P = 0.001.

There was a statistically significant difference in mean academic grades between groups. Non-diabetic children had significantly higher mean grades compared to diabetic children (12.4 ± 2.6 vs. 9.3 ± 1.8, p < 0.001). (Table 4)

Table(4): Comparison between academic grades among diabetic and control groups

Group	Mean ± SD	P-value
Non-diabetic children	12.4 ± 2.6	<0.001
Diabetic children	9.3 ± 1.8	

Multivariate Logistic Regression Analysis

To adjust for potential confounding variables, a multivariate logistic regression analysis was performed. The model included age, sex, glycemic control, treatment modality, father's education, and mother's education. After adjustment, glycemic control was not independently associated with excellent academic achievement (AOR = 1.07, 95% CI: 0.41–2.80, P = 0.887). Age remained a significant predictor of academic achievement (AOR = 0.76, 95% CI: 0.65–0.89, P = 0.001). Treatment modality was also independently associated with better academic outcomes (AOR = 8.78, 95% CI: 2.28–33.81, P = 0.002). No significant independent associations were observed for sex, father's education, or mother's education. (Table 5)

Table (5): Multivariate Logistic Regression Analysis for Predictors of Excellent Academic Achievement

Variable	Adjusted OR	95% CI	P-Value
Glycemic control	1.07	0.41–2.80	0.887
Age	0.76	0.65–0.89	0.001
Gender	0.86	0.34–2.13	0.738
Father's education	0.90	0.66–1.23	0.523
Mother's education	1.27	0.95–1.69	0.112
Treatment modality	8.78	2.28–33.81	0.002

There was no statistically significant association between academic achievement and age at onset of diabetes (P = 0.59), chronic diabetic complications (P = 0.559), or associated diseases such as celiac disease and hypothyroidism (P = 0.214). (Table 6)

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Table (6): Academic Achievement and Clinical Factors

Variable	Category	Excellent	Very Good	Good	Fail	P-value
Onset	Before school	37	12	0	8	0.59
	After school	36	21	3	3	
Complications	Ophthalmopathy	6	6	0	0	0.559
	None	66	27	3	11	
Associated diseases	Celiac disease	6	7	1	0	0.214
	Hypothyroidism	3	0	0	0	
	None	64	26	2	11	

There was a statistically significant association between parental education and glycemic control. Father's education level was significantly associated with glycemic control (P = 0.008), and an even stronger association was observed with mother's education level (P = 0.001), indicating better glycemic outcomes with higher parental education. (Table 7)

Table (7): Parental education and glycemic control

Variable	Category	Good	Poor	P-value
Father	Preparatory	9	11	0.008
	Intermediate	19	13	
	Higher Institute	9	20	
	Bachelor/Master	29	10	
Mother	Primary	6	4	0.001
	Preparatory	2	10	
	Secondary	11	8	
	Intermediate	7	16	
	Higher/Bachelor	40	16	

DISCUSSION

The present study highlighted an important aspect of pediatric diabetes by contributing to the understanding of how T1D affected academic achievement among school-aged children and adolescents in Libya. The findings demonstrated that glycemic control was a key determinant of academic achievement, with poorer control significantly associated with lower achievement.

In contrast to the present study, data by other researchers found that older children tend to have better glycemic control [25]. While gender distribution showed a slight predominance of females, which was consistent with findings of other studies conducted in Iraq [27] as well as Australia and Japan [28, 29].Gender was not significantly associated with glycemic control, although some studies have reported poorer control among females [20].

The difference in the academic achievement between children diagnosed before versus after school entry was consistent with a Scottish study [15], which reported no association between age of diabetes onset and school achievement. In contrast, a study from Sudan suggested that longer disease duration may negatively affect academic outcomes [30].

In the present study, good glycemic control (HbA1c 6–8%) was better than findings reported in Sudan [32] and comparable to results from Saudi Arabia and Egypt [33, 34]. Importantly, hypoglycemia frequency, hospital admissions, ICU admissions, and treatment modality were significantly associated with glycemic control. These findings highlighted the clinical burden of poor metabolic control and its

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impact on disease stability.

Most participants maintained regular follow-up, and neither chronic diabetic complications nor associated conditions such as celiac disease and hypothyroidism had a significant impact on academic achievement. School attendance was generally regular, with absenteeism mainly related to clinic visits. These findings were consistent with previous studies [12,27], although some reports linked poor glycemic control with increased absenteeism [35]. Using the Libyan grading system, children with well-controlled diabetes had an academic achievement comparable to their non-diabetic peers, whereas those with poor glycemic control demonstrated significantly lower mean grades. This supports previous evidence indicating that T1D did not inherently impair academic achievement when adequately controlled [13], although some studies have reported slightly lower achievement among diabetic children [8].

The multivariate logistic regression model, suggested that the relationship between glycemic control and academic achievement might be partly influenced by other factors such as age, treatment modality, and family characteristics. Nevertheless, the strong unadjusted association observed in the study remains clinically relevant and warrants further investigation in larger multicenter studies.

Regarding treatment, the majority of participants managed with multiple daily injections (MDI), while a smaller proportion used insulin pumps. Treatment modality was significantly associated with glycemic control, with better outcomes observed among insulin pump users.

Parental education, particularly maternal education, was also significantly associated with glycemic control. This finding was consistent with previous studies demonstrating that higher parental education levels contributed to improved disease management and better glycemic outcomes in children [36, 39]. In addition to glycemic control, academic achievement may be influenced by several socioeconomic and psychosocial factors. Parental support, family socioeconomic status, access to healthcare services, school support systems, and psychological well-being might all contribute to educational outcomes. Children with T1D might also experience diabetes-related stress, anxiety, or difficulties in self-management, which could affect school achievement regardless of metabolic control. These factors should be considered when interpreting the relationship between diabetes and academic achievement. Overall, the findings suggested that T1D itself did not necessarily impair academic achievement when appropriately managed. Rather, suboptimal glycemic control appeared to be associated with poorer educational outcomes, highlighting the importance of effective diabetes management in school-aged children.

Study Limitations: This study had several limitations that should be considered when interpreting the findings. First, it was conducted at a single tertiary care center, which might limit the generalizability of the results to other populations. Second, the sample size was relatively small, which might reduce the statistical power to detect certain associations. Third, the study period was relatively short. In addition, academic achievement was assessed using school grades, which might not fully capture all aspects of cognitive and educational achievement. Finally, important socioeconomic and psychosocial variables, including family income, parental support, psychological well-being, school support, healthcare accessibility, and diabetes-related stress, were not comprehensively assessed.

CONCLUSION

Children with well-managed diabetes generally demonstrated academic achievement comparable to non-diabetic peers. Effective glucose management and awareness of strategies for managing T1D were associated with better academic outcomes, while inadequate monitoring correlated with poorer achievement. Parental education and treatment modality significantly influence glycemic control.

Recommendation

The association of poorer glycemic control with poorer school achievement serves as further evidence for clinicians to focus on improving glycemic control, which would help those children to achieve

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their life goals.

The new technology used, like the use of continuous glucose monitoring and insulin pumps were methods to monitor the glucose level effectively, which could give a clue to the decision makers to assess the need for additional support for children with T1D.

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