

# Glycemic Control Among Children with Type 1 Diabetes Mellitus in Northern Areas of Pakistan

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## ABSTRACT

**Objective:** To find the glycemic control in type 1 diabetes mellitus (T1DM) children and highlight the factors associated with its poor control.

**Study Design:** Cross-sectional study

**Place and Duration of Study:** This study was conducted at the Ayub Teaching Hospital, Pediatrics ward for a duration of two years from January 2019 to April 2021.

**Materials and Methods:** By convenient sampling technique, total 53 patients were included in the study. After ethical approval from institutional ethical review committee, and ensuring the inclusion/exclusion criteria, HbA1C was measured in all patients. Children with glycated haemoglobin (HbA1C) equal to 8.0% or less were categorized as having good control. Data were recorded on a proforma and then entered in IBM SPSS (Version 21). For seeing the association between dependent (glycemic control) and independent variables (age, gender, anthropometric variables and) chi square test was used. A P-value less than 0.05 was considered significant.

**Results:** Total 53(100%) children of mean age  $10.18 \pm 5.278$  years with a mean height of  $123.01 \pm 25.909$  centimeters, the weight of  $25.22 \pm 14.066$  kilograms were included in the study. Their mean HbA1C level was  $10.90 \pm 2.475\%$ . The incidence of poor glycemic control (PGC) appeared alarming i.e., 46(86.8%). While comparing glycemic controls of T1DM patients with gender, socioeconomic status, parents' literacy etc., none of the p-values was significant. The majority of patients i.e., 22(41.5%) with PGC presented with diabetes ketoacidosis.

**Conclusion:** The PGC with a high level of HbA1c in the Northern area of Pakistan is perturbing. Educating caregivers especially about recognizing early clinical presentation and adhering to strict glycemic control is required.

**Key Words:** Glycemic Control, Children, Diabetes Mellitus, Northern Areas

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## INTRODUCTION

Diabetes mellitus is as emerging as an epidemic and affects almost all ages and ethnicity.<sup>1, 2</sup> It is a chronic metabolic disease of the pancreas and is either insulin-dependent or not. The former is type 1 diabetes mellitus (T1DM) which presents earlier in life and constitutes about 5-10% of all cases of diabetes.<sup>3</sup> Insulin is a hormone that regulates blood glucose level i.e. glycosylated hemoglobin (HbA1c) and plasma

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glucose level. Uncontrolled T1DM pose serious complications and increase the rate of morbidity and earlier age mortality. This appears as a dilemma for the younger population especially in developing countries like Pakistan. What are the reasons behind poor glycemic control (PGC) of T1DM in the Northern area of Pakistan, prompted pediatricians for conducting the study?

The incidence of T1DM varies worldwide. Worldwide it is 15/100000, in Africa 8/100000 and America as 20/100000.<sup>3</sup> In Pakistan, it lies between 1/100000 per year and 8/100000 per years in Egypt with the highest incidence rate in European regions.<sup>4,5</sup> Good glycemic control (GGC) is the key to offsetting short- and long-term complications.<sup>6</sup> and requires compliance to insulin regimen as well as dietary compliance. Measuring the HbA1c levels gives a good idea of the glycemic control over the previous 120 days.<sup>7</sup> Ideal average HbA1c in children is taken as 7.5% or less.<sup>8</sup> In our study we kept it at 8.0%.

The association of personal and family attributes with T1DM is not documented for the Northern area of Pakistan. This makes the current study unique and will highlight an important personal and sociocultural aspect

of T1DM. Thereby, the current study aims to documents the occurrence of T1DM over 2 years period of clinical practice and find the association of PGC with certain personal and socio-cultural attributes among the paediatric population of Northern area of Pakistan.

## MATERIALS AND METHODS

This cross-sectional study was conducted at Ayub Teaching Hospital Abbottabad from January 2019 to April 2021. By convenient sampling technique, total 53 patients were included in the study. Children of age less than 18 years, of either gender and those who had clinical symptoms of T1DM or already diagnosed were included in the study. However, any child with T2DM, any metabolic disorders or with any congenital anomaly or urinary-genital tract disease were excluded. After ethical approval from the same institutional ethical review committee, HbA1C was measured in all patients. Children with HbA1C equal to 8.0% or less were categorized as having good control while those with HBA1C levels above 8.0% were taken poorly controlled diabetics. Data were recorded on a proforma and then entered in IBM SPSS (Version 21). Quantitative variables are presented in frequencies and percentages with mean  $\pm$  standard deviation. For seeing the association between dependent (glycemic control) and independent variables (age, gender, anthropometric variables and) chi square test was used. A P-value less than 0.05 was considered significant.

## RESULTS

Total 53(100%) children of mean age  $10.18 \pm 5.278$  years with a mean height of  $123.01 \pm 25.909$  centimeters, the weight of  $25.22 \pm 14.066$  kilograms was included in the study. Their mean glycated haemoglobin level was  $10.90 \pm 2.475$ . table 1

Among the total, 24(45.3%) were males and 7-12 years of age was most common presentation 25(47.2%). The majority were with poor socioeconomic status i.e 38(71.7%) and were having illiterate parents i.e.29(54.7%). The incidence of PGC appeared alarming i.e., 46(86.8%). Table 2

While comparing glycemic controls of T1DM patients with gender, socioeconomic status, parents' literacy etc., none of the p-values was significant. However, percentages show that POC was greater in females 20(37.7%) than males, among the age group of 7-12 years 24(45.3%), underweight 26(49.1%). Table 3.

Among total 53 cases, the majority of patients i.e., 22(41.5%) with POC presented with DKA. Figure 1. Among 46(86.8%) patients with PGC, the majority used BID 70:30 insulin regime, family history of diabetes were negative 22(41.5%) and mothers appeared the primary caregivers 14(26.4%). None of the p-values were significant. Table 4.

**Table No.1: Characteristics of T1DM patients included in the study. (n=53)**

Characteristics	Min.	Max.	Mean	Std. Deviation
Age of patient in years	1.5	20.0	10.184	5.278
Height of patient in centimeters	75.00	174.0	123.90	25.910
Weight of patient in kilograms	8.00	85.0	25.22	14.066
Body mass index	7.90	30.2	15.88	4.620
Glycated hemoglobin Level (%)	7.5	17.0	10.90	2.474
Total duration of illness in years after first diagnosis	0.00	7.0	2.75	2.213

**Table No.2: Frequencies and percentages of patients' demographics and dependent variables**

Variables	Categories	Frequency	Percentage
Gender	Male	24	45.3
	Female	29	54.7
Age group	1-6 years	14	26.4
	7-12 years	25	47.2
	$\geq 13$ years	14	26.4
socioeconomic status	Well	15	28.3
	Poor	38	71.7
Parent's literacy	Illiterate	29	54.7
	Literate	23	45.3
BMI classification	Underweight	30	56.6
	Ideal	19	35.8
	Obese	4	7.5
Family history of diabetes and other illness	None	25	47.2
	Diabetes	16	30.2
	Hypertension	8	15.1
	Misc	4	7.5
Status of T1DM	New cases	8	15.1
	Old cases	45	84.9
Glycemic control	Poor (HbA1c $\geq 8.0$ )	46	86.8
	Good (HbA1c $< 8.0$ )	7	13.2
Total		53	100

**Table No.3: Comparison of glycemic control with patients' characteristics**

Independent variables	Categories	Glycemic control		P value
		Poor (HbA1c $\geq 8.0$ )	Good (HbA1c $< 8.0$ )	
Gender	Male	20(37.7)	4(7.5)	0.499
	Female	26(49.1)	3(5.7)	
Age group	1-6 years	12(22.6)	2(3.8)	0.093
	7-12 years	24(45.3)	1(1.9)	
	$\geq 13$ years	10(18.9)	4(7.4)	
socioeconomic	Poor	34(64.2)	4(7.5)	0.359

status	Well	12(22.6)	3(5.7)	
Parents literacy	Illiterate	25(47.1)	4(7.5)	0.499
	Literate	20(37.7)	3(5.6)	
BMI classification	Underweight	26(49.1)	4(7.5)	0.698
	Ideal	16(30.2)	3(5.7)	
	Obese	4(7.5)	0(0.0)	
Status of T1DM	Old	39(73.6)	6(11.3)	0.949
	New	6(11.3)	1(1.9)	
Presentation with DKA	No	24(45.3)	3(5.7)	0.646
	Yes	22(41.5)	4(7.5)	
Total		46(86.8)	7(13.2)	

p-value <0.005 significant

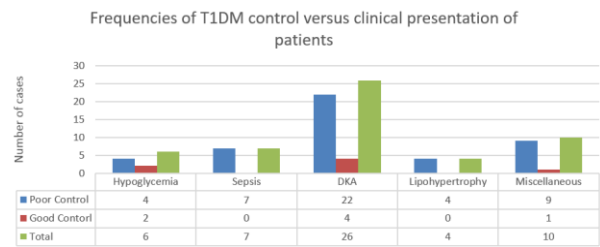


Figure No.1: Frequencies of clinical presentation of patients' with T1DM

Table No.4: Different questions about glycemic control and their response by 53 T1DM patients

Questions	Categories	Glycemic control		Total	P-value
		Poor Control (HbA1c more than 8.0)	Good Control (HbA1c 8.0 or less)		
Types of insulin regimen in use	none	4(7.5%)	1(1.9%)	5(9.4%)	0.061
	bid 70:30	39(73.6%)	5(9.4%)	44(83.0%)	
	long-acting glargine	3(5.7%)	0(0.0%)	3(5.7%)	
	others	0(0.0%)	1(1.9%)	1(1.9%)	
Family history of diabetes and other illness	None	22(41.5)	3(5.7)	25(47.2)	0.113
	Diabetes in family	14(26.4)	2(3.8)	16(15.1)	
	Hypertension in family	8(15.1)	0(0.0)	8(15.1)	
	Misc. T.B. CARDIAC etc.	2(3.8)	2(3.8)	4(7.5)	
Administration of insulin by	Self	6(11.3)	0(0.0)	6(11.3)	0.865
	Mother	14(26.4)	2(3.8)	16(30.2)	
	New	7(13.2)	1(1.9)	8(15.1)	
	Father	5(9.4)	1(1.9)	6(11.3)	
	others/siblings/staff	14(26.4)	3(5.7)	17(32.1)	
Presence of electricity at home	No	5(9.4)	1(1.9)	6(11.3)	0.790
	Yes	41(77.4)	6(11.3)	47(88.7)	
Awareness among family about Diabetes	Poor	15(28.3)	3(5.7)	18(34.0)	0.594
	Good	31(58.5)	4(7.5)	35(66.0)	
Willingness on part of parents and patient to treat disease	Poor	6(11.3)	2(3.8)	8(15.1)	0.285
	Good	46(75.5)	5(9.4)	45(84.9)	
Knowledge about insulin regimen and method of injecting	Poor	15(28.3)	2(3.8)	17(32.1)	0.831
	Good	31(58.5)	5(9.4)	36(67.9)	
Knowledge and understanding about insulin injection site	Poor	8(15.1)	2(3.8)	10(18.9)	0.481
	Good	38(71.7)	5(9.4)	43(81.1)	
Knowledge about dietary compliance of diabetes	Poor	21(39.6)	1(1.9)	22(41.5)	0.117
	Good	25(47.2)	6(11.3)	31(58.5)	
Availability of fridge/cold storage at home	Not available	9(17.0)	2(3.8)	11(20.8)	0.584
	Available	37(69.8)	5(9.4)	42(79.2)	
Total		46(86.8)	7(13.2)	53(100)	

p-value <0.005 significant.

## DISCUSSION

T1DM is the most common type of diabetes mellitus in people younger than 20 years.<sup>9</sup> Its association with health determinants, early diagnosis and prompt management reduces the early as well as a late-onset complication in a younger population.<sup>5</sup> Furthermore, GGC with optimal HbA1c is the key factor in

controlling T1DM. This study explored different factors and association of demographic variants among T1DM children of the Northern area of Pakistan. Circumstantially, the study revealed a very high rate of PGC i.e., 86.8% with a mean value of HbA1c equaled to 10.90±2.475%.

In the current study, a very low rate of GGC and high levels of HbA1c in the majority of patients put the

pediatric population at risk. This statement is supported by a WHO report stating that T1DM cases with PGC and high level of HbA1c in low and middle-income countries is staggering.<sup>10</sup> Moreover, Djonou C et al., from Cameroon and Taha Z et al., from Sudan mentioned a close percentage of PGC as 67.4% and 76% respectively.<sup>11-12</sup> The closest HbA1c (10.90±2.475%) level of the current study is reported by other authors as 9.2±2.5%, 12.5±2.7% and 13±5.9%.<sup>13</sup> Contrary to this, Patitti DB et al., from the US ensued 17%.<sup>14</sup> This is obvious that a resource-restricted country and socio-economically staggered area like Northern Pakistan has a high value of HbA1c.

Demographic attributes like age and gender may or may not be associated with PGC. In the current study, no such association was found for both variables. This is supported by Mark AC's study, done in the Midwest of USA.<sup>15</sup> Besides, the percentages among female 54.7% and mean age of 10.18±5.2 years were high among PGC. This is in accordance with 51.5%, 63% among females and with mean age of 13±5.7 and 12±2.7 years respectively.<sup>12, 13</sup> A very close mean age of 9.2±2.5 years is resulted by Djonou C et al.,<sup>11</sup> The possible reason for late years of the first decade are probably due to late diagnosis of the disease or more parental supervision of the sick child.

For a resource-restricted country, the total duration of illness since initial diagnosis and presentation of T1DM to a tertiary care hospital, seeking specialist care is also subtle. The mean duration since diagnosis of T1DM in Northern areas of Pakistan appeared as 2.75±2.2 years. This lies in close proximity to a study done by Noorani M et al., i.e. 3.74 years.<sup>9</sup> Moreover, Djonou C et al., mentioned 4.1 years and Clements MA et al., from the US reported 5.2 years.<sup>11, 15</sup> This is even more concerning, the earlier presentation of T1DM in the first decade of life.

As younger aged children are more dependent on caregivers and parents are sole caregivers in the present setup. Therefore, their literacy rate and awareness about diabetes are among the other factors which affect glycemic control. Literate parents and good awareness about insulin storage and the regime should ensue better outcomes with less complication of the disease. Despite negative correlation of such attributes in current study, illiterate parents with good awareness had more cases of PGC. This conforms with other studies.<sup>15, 16</sup> About 66% of parents of the current study had good awareness about T1DM which is close to 70% of children studied in Tanzania.<sup>9</sup>

When comparing socioeconomic status, 64.2% of families with PGC belonged to poor background. In spite of their non-significant association (p-value>0.005), other studies found a positive relation of low socioeconomic status with glycemic control.<sup>17,18</sup> Another important determinant i.e., family history with positive T1DM in our study came out 30.2%. Not very

close yet this also appeared comparable with that of another study, 21%.<sup>12</sup>

T1DM decreases the life expectancy by 10-20 years and this is even more with children presenting with complication.<sup>19</sup> It is worth noting that earlier detection or proper management of T1DM will lessen mortality. In the current study, DKA resulted as the top presenting complication, 41% among all which is staggering. Similarly, most of the cases reported by Taha Z<sup>12</sup> et al., had DKA 80% and 81% by Eliadarous H.<sup>18</sup> Ziegler R et al., mentioned 21.1% of children and adolescents and resulted in a low rate of 4.9% had presented with DKA.<sup>23</sup> In addition to this, hypoglycemia is associated with unexpected dead by 4-10% and children with age less than 5 years are more prone to hypoglycemia than any other age group.<sup>20</sup>

Proper use of insulin syringes and timely rotation of injectable site decreases another serious complication like lipohypertrophy. It is the most occurring issue especially among younger patients of T1DM.<sup>21</sup> The percentage of lipohypertrophy, 7.5% were observed in the current study. In contrast to the current study, Gupta SS reported it as 69.8% cases among adults.<sup>22</sup> Despite less occurrence in our setup, it could not be overlooked and seek special attention for education of caregivers. Up to the best knowledge of the author, literature lacks any data for comparing other complications like sepsis, hypoglycemia.

The study does not evade the limitation. In spite of 2 years of data collection in only tertiary care facility of the Northern area of Pakistan, the sample size of study is small and the results cannot be generalized over the diabetic pediatric population. The socioeconomic determinants are prone to recall biased. This could be minimized by indept interview of caregiver with qualitative approaches. Moreover, further research with a systematic approach to acute and chronic complication of T1DM is needed with a random sampling technique.

## CONCLUSION

Owing to lesser life expectancy and more morbidity and mortality of T1DM among the pediatric population, the poor glycemic control with a high level of HbA1c in the Northern area of Pakistan is perturbing. Educating caregivers especially about recognizing early clinical presentation and adhering to strict glycemic control is required. Governmental actions with an epidemiological approach and caregiver's awareness training can ensure a better life with less mortality among such population.

### Author's Contribution:

Concept & Design of Study:	Saima Gillani
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Revisiting Critically: Ahmed, Shazia Sadaat  
Saima Gillani,  
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Final Approval of version: Saima Gillani

**Conflict of Interest:** The study has no conflict of interest to declare by any author.

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