FACTORS ASSOCIATED WITH HIGH HBA1C IN CHILDREN WITH DIABETES MELLITUS AT A TERTIARY CARE HOSPITAL.

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ABSTRACT:

BACKGROUND: Diabetes mellitus (DM) is a common chronic endocrine disorder among children, with type 1 diabetes (T1D) being the predominant form. Glycated hemoglobin (HbA1c) is a key biomarker used to assess long-term glycemic control. This study aimed to identify factors associated with poor glycemic control in diabetic children attending a tertiary care hospital. **METHODS:** It was a cross-sectional analytical study performed at Department of Pediatrics, Khyber Teaching Hospital Peshawar a tertiary care centre having a catchment area of primary and secondary care facilities for both urban and rural population of Khyber Pakhtunkhwa. The research was conducted between January 2024 and December 2024 for 1 year. All children aged 1–18 years diagnosed to have diabetes mellitus (mainly type 1 diabetes) who were being seen at pediatric outdoor and admitted to pediatrics wards of Khyber Teaching Hospital were included. **RESULTS:** There was a modest female dominance (54.5%) and an average age of 11.2 ± 3.5 years. Most patients (62.1%) reported living in an urban area, and 58.6% reported having a poor socioeconomic status. Diabetes lasted an average of 3.1 ± 1.8 years. Of all patients, 47 (32.4%) had HbA1c ≤7.5%, while 98 (67.6%) had poor glycemic control (HbA1c > 7.5%). **CONCLUSION:** Uncontrolled glycemia among diabetic children can be modified by caregiver education, diabetes self-management and the availability of structured educational programs. 'Family centered diabetes care and promotion of awareness may be a strategy to improve glycemic outcomes in children, particularly in low resource health care settings.

KEYWORDS: Glycemic control, children, caregiver, self management, healthcare.

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INTRODUCTION

Diabetes mellitus (DM) is one of the most common chronic endocrine conditions in children and adolescents, in which type 1 diabetes (T1D) explains the majority of child diabetes cases worldwide[1]. Glycated hemoglobin (HbA1c) is an important biomarker for monitoring long-term glycemic status and treatment approaches in diabetic children[2]. The American Diabetes Association (ADA) has also adopted HbA1c as a guideline to minimize the risk of acute and chronic complications from 7.5% and below for children and teenagers[3]. Yet, effective management of hyperglycemia is a difficult task for the majority of children, especially in treating centers with few resources.

There are some features that have been reported to affect HbA1c in children. These variables include age, duration of

diabetes, socio-economic status, parents' educational level, compliance to insulin, frequency of glucose monitoring, and dietary habits, as well as psychological support[4–6]. Inadequate glycemic control in children leads to the increased risk of diabetic ketoacidosis, early occurrence of microvascular complications and disorders of neuro-cognitive development[7]. Children's HbA1c can be significantly lowered by family-based care systems, structured diabetes education programs, and easy access to cutting-edge insulin delivery technologies, according to experience in high-income environments[8]. On the other hand, research conducted in low- and middle-income countries have found that inadequate insulin access, infrequent follow-up, and low caregiver awareness are important contributors to poor glycemic control[9].

Paediatric diabetes is becoming more common in Pakistan, and it is noted that there is a dearth of information on the factors that contribute to inadequate glycaemic management. A small number of regional studies have shown that high HbA1c in children with type 1 diabetes is associated with poor economic status, inadequate parental care, and a lack of diabetes self-management instruction [10]. However, there is a dearth of additional context-specific data to support interventions in a tertiary care setting, where a greater number of children have poorly managed diabetes.

The present study was aimed to determine factors associated with high HbA1c among children with diabetes mellitus, attending a tertiary care hospital. Characterizing these determinants may assist clinicians and policy makers in formulating effective approaches for enhancing glycemic outcomes among children with diabetes.

MATERIALS AND METHODS

It was a cross-sectional analytical study performed at Department of Pediatrics, Khyber Teaching Hospital, Peshawar, a tertiary care centre having a catchment area of primary and secondary care facilities for both urban and rural population of Khyber Pakhtunkhwa. The research was conducted between January 2024 and December 2024 for 1 year. All children aged 1–18 years diagnosed to have diabetes mellitus (mainly type 1 diabetes) who were being seen at pediatric outdoor and admitted to pediatrics wards of Khyber Teaching Hospital were included. Only individuals with one or more HbA1c measurements in the past 3 months were eligible for inclusion.

Children age range between 1-18 years, Patients diagnosed with diabetes mellitus (DM) according to the World Health Organization and American Diabetes Association (ADA), and who have been receiving treatment by an insulin preparation for a period of at least six months, documented HbA1c measurement in the last three months before inclusion in the study were included. Written permission from one parent or guardian was received for each participant. Exclusion criteria were: other chronic systemic diseases, including chronic kidney disease, or hypothyroidism; hemoglobinopathies; anemia that may interfere with the interpretation of the HbA1c level; and incomplete medical records or refusal to engage in the study.

Sample size was determined using the WHO sample size calculator. Considering an anticipated prevalence of poor glycemic control (HbA1c > 7.5%) among diabetized children of 60% according to local data (10), with a confidence interval of 95% and a margin of error of 8%, the sampling size was estimated in a total of 145 patients. The technique of non-probability consecutive sampling was employed. All eligible children who attended the paediatric diabetes clinic or were admitted during the study period were approached to participate until the predetermined sample size was reached.

To gather the required data, a structured questionnaire and a review of the patients' charts were used. A range of variables

pertaining to glycemic management in children with diabetes served as the basis for the variables that were gathered. The child's age, sex, social level, and urban or rural residential location were all included in the demographic details. Clinical information included the length of time the patient had been diagnosed with diabetes, the kind and quantity of insulin injections received each day, the frequency of home blood glucose checks, documented bouts of diabetic ketoacidosis (DKA), and coexisting medical problems. Parental and family variables were also evaluated (e.g. the primary caregivers' level of education, the type of family structure nuclear or extended and degree of parental involvement in diabetes care). Diet and body metrics data including dietary practice, physical activity, and whether the child or its proxy had received any controlled diabetes education courses were further collected. HbA1c data at baseline were retrieved from the laboratory records of the patients, where it was determined by standardized high-performance liquid chromatography (HPLC) methods.

Data was processed, entered and analyzed using SPSS version 25. Means, standard deviations, and frequencies were computed for all variables. Associations between HbA1c levels and categorical as well as continuous variables were evaluated through chi-square test and independent t-test, respectively. Logistic regression analysis was conducted to determine the independent factors for high HbA1c. Statistical significance was set at $p \leq 0.05$.

RESULTS
There was a modest female dominance (54.5%) and an average age of 11.2 ± 3.5 years. Most patients (62.1%) reported living in an urban area, and 58.6% reported having a poor socioeconomic status. Diabetes lasted an average of 3.1 ± 1.8 years. Of all patients, 47 (32.4%) had HbA1c ≤7.5%, while 98 (67.6%) had poor glycemic control (HbA1c > 7.5%). Table 1 Long-term diabetes (p=0.01), inconsistent blood glucose monitoring (p=0.003), and repeated DKA episodes (p=0.002) were all substantially associated with high HbA1c levels. Compared to children who followed optimal regimens, those who used less than three daily doses of insulin had poor glucose control (p=0.01). Additionally, children who lived in a large family (p=0.03), had less educated caregivers (p=0.004), and had minimal parental involvement in daily diabetes management (p=0.001) were all substantially linked to inadequate glycaemic control.

TABLE 1: BASELINE CHARACTERISTICS OF STUDY PARTICIPANTS (N = 145)

Variable	Value
Age (years), mean ± SD	11.2 ± 3.5
Sex	
Male	66 (45.5%)
Female	79 (54.5%)
Residence	
Urban	90 (62.1%)
Rural	55 (37.9%)
Socioeconomic Status	
Low	85 (58.6%)
Middle/High	60 (41.4%)
Duration of Diabetes (years)	3.1 ± 1.8
HbA1c Levels	
≤ 7.5% (Good Control)	47 (32.4%)
> 7.5% (Poor Control)	98 (67.6%)

Additionally, children who did not follow formal diet plans (p=0.005), were not physically active (p=0.02), and did not attend diabetes education sessions (p=0.001) were more likely to have high HbA1c parameters. Table 2

TABLE 2: FACTORS ASSOCIATED WITH POOR GLYCEMIC CONTROL (HBA1C >7.5%)

Factor	Poor Control (n=98)	Good Control (n=47)	p-value
Duration of Diabetes >3 years	60 (61.2%)	18 (38.3%)	0.01
Irregular Blood Glucose Monitoring	72 (73.5%)	18 (38.3%)	0.003
≥2 Episodes of DKA in Last Year	40 (40.8%)	10 (21.3%)	0.002
Insulin <3 doses/day	56 (57.1%)	14 (29.8%)	0.01
Low Parental Education	65 (66.3%)	20 (42.6%)	0.004
Extended Family Structure	58 (59.2%)	19 (40.4%)	0.03
Limited Parental Involvement	70 (71.4%)	15 (31.9%)	0.001
No Structured Dietary Plan	62 (63.3%)	18 (38.3%)	0.005
Low Physical Activity	55 (56.1%)	16 (34.0%)	0.02
No Attendance at Diabetes Education	74 (75.5%)	15 (31.9%)	0.001

Irregular glucose monitoring (AOR: 3.2; 95% CI: 1.6–6.5), low parental education (AOR: 2.7; 95% CI: 1.3–5.4) and absence for diabetes education sessions (AOR: 4.1; 95% CI: 2.0–8.5) were independent predictors of high HbA1c on multivariate logistic regression analysis. Table-3

TABLE 3: MULTIVARIATE LOGISTIC REGRESSION ANALYSIS OF FACTORS ASSOCIATED WITH POOR GLYCEMIC CONTROL (HBA1C >7.5%)

Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval (CI)	p-value
Irregular Blood Glucose Monitoring	3.2	1.6 – 6.5	0.001
Low Parental Education	2.7	1.3 – 5.4	0.004
No Attendance at Education Sessions	4.1	2.0 – 8.5	<0.001
Duration of Diabetes >3 years	1.9	1.0 – 3.7	0.045
Limited Parental Involvement	2.5	1.2 – 5.0	0.012

DISCUSSION

A significant number of children (67.6%) had inadequate glycemic control (HbA1c >7.5%), which is nearly identical to findings from studies conducted in other low- and middle-income nations due to a lack of resources and an increase in medical visits for diabetes treatment [11].

Another powerful predictor of high HbA1c in our analysis was irregular blood glucose monitoring (AOR: 3.2; p=0.001). This is in line with the findings of Mayer DE et al [12] who previously reported that improved glycemic control in young individuals with type 1 diabetes is favorably correlated with frequent self-monitoring of blood glucose (SMBG). Similarly, frequent SMBG was found to be a strong predictor of low HbA1c levels by Mobessari M et al [13]. These observations' similarities highlight the necessity of routine glucose testing as a foundational component of DSME.

Parental Education Level was also a determining factor and those had low educational level had more likely to have higher HbA1c (AOR: 2.7; p=0.004). Our results are in line with that of Gann D et al [14] who found that children of better

educated parents had better glycemic control. Parents with a higher educational level are meanwhile more likely to comprehend the mechanisms of the disease, comply with the therapy, and contribute to the care of their children. However, a study conducted in Bangladesh by Shibeshi MS et al [15] found no (statistically) significant correlation between parental education and diabetes in children under the age of five. This could be because different healthcare delivery models or community-based support systems in some places lessen the impact of parental education.

The strongest independent predictor in our cohort was not attending diabetes education sessions (AOR 4.1; p<0.001). Taha Z et al [16] observed that structured diabetes education improved children's adherence and metabolic management, which is a good complement to the latter. Alassaf A et al [17] study confirmed that DSME therapies in children and adolescents had the same effect on SDM reduction (0.8% HbA1c). The lack of formal and universal standardized education programs in many countries may further contribute to the substantial effect size shown in our study among our sample, suggesting that even minimal exposure to DSME may have an influence. Another risk factor for inadequate control in our study was longer duration of diabetes over three years (AOR:1.9; p=0.045). A number of studies have found this link, pointing to factors like waning motivation, the transfer of parental care responsibilities to adolescents, or the onset of insulin resistance as a result of puberty are some of the reasons why metabolic control gradually deteriorates[18]. However, the study by Care D et al [19] did not find any correlation with insulin in Saudi Arabia, this maybe due to different availability to insulin and medical services. Low parental participation was linked to noticeably greater odds of having poor glycemic control (AOR: 2.5; p=0.012), suggesting that parental involvement is a protective factor. This result was in line with earlier research by Djonou C et al [20], who found that children's HbA1c levels were often lower when parents were involved in their daily diabetes treatment. Similarly, Abdulseed NA et al [21] has underlined the fact that family cohesion and supportive parenting were significantly associated with better metabolic outcomes. Our findings also supported the notion that family-based care should be a cornerstone of pediatric diabetes programs in our environment.

Additional contributors including physical inactivity, absence of a dietary schedule, and joint families were univariately associated with poor glycemic control yet were no longer significant in multivariate models. However, their contribution cannot be completely ignored. For example, findings from studies by Hashemipour M et al [22] underline lifestyle factors such as physical activity and dietary adherence affect the glycemic fluctuation in pediatric diabetic patients.

CONCLUSION

This research demonstrates a higher proportion of children with diabetes mellitus with uncontrolled glucose among tertiary care hospitals in Peshawar where 67.6% were over the established target of HbA1c. Major independent determinants of high HbA1c were irregular blood glucose monitoring, low parental educational level, nonparticipation at the diabetes education session, and poor parental involvement in daily treatment. The present results underscore the multivariate nature of glycemic control and the importance of both medical and psychosocial predictors in pediatric diabetes care.

ETHICS APPROVAL: The ERC gave ethical review approval.
CONSENT TO PARTICIPATE: written and verbal consent was taken from subjects and next of kin.

AUTHORS' CONTRIBUTIONS:
All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated in the work to take public responsibility of this manuscript. All authors read and approved the final manuscript.

CONFLICT OF INTEREST: No competing interest declared

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