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Original Research Article

To Study the Impact of Sociodemographic Factors on Glycemic Control of Children with Type I Diabetes Mellitus

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Abstract: *Type 1 Diabetes Mellitus (T1DM) is a chronic autoimmune condition characterized by the destruction of insulin-producing beta cells in the pancreas, leading to lifelong dependence on insulin therapy.* ***Objective:*** *This study aims to identify the impact of sociodemographic factors on Glycemic control of children with Type 1 Diabetes Mellitus by using Sociodemographic Information.* ***Methodology:*** *This Cross-sectional Prospective study was conducted at a Diabetic clinic, children's Hospital, PIMS from 01/12/23 till 30/11/24. Data were collected through Non-probability consecutive sampling. Both inpatient and outpatient participants meeting the inclusion criteria were included in the study. Demographic and clinical data were collected through a structured questionnaire.* ***Results:*** *In comparison to older children (8–12 years), younger children (ages 1–8) showed superior glycemic control (39.6% good control), with a statistically significant difference (p = 0.001). Glycemic control was positively impacted by 98% of caregivers having either adequate or good knowledge about diabetes management. Compared to children with other caregivers, children whose mothers were their primary caregivers demonstrated improved glycemic control. Good BSR monitoring (≥3 times/day) was associated with improved glycemic control, with 49% of patients exhibiting good monitoring adherence (p = 0.001). Clinically, the mean fasting blood glucose was 195 ± 48 mg/dL, post-prandial blood glucose was 285 ± 62 mg/dL, and HbA1c averaged 9.2 ± 2.1%, indicating poor glycemic control.* ***Conclusion:*** *In our study, glycemic control was not significantly predicted by parental education or socioeconomic level; however, enhanced glycemic control was correlated with caregiver understanding of diabetes management. Additionally, it was discovered that maintaining ideal glycemic control required regular blood glucose checks and maternal involvement as the primary caregiver.*

Keywords: Diabetes Mellitus, Type 1 Glycemic Control Caregivers Blood Glucose Monitoring Sociodemographic Factors

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Introduction

Type 1 Diabetes Mellitus (T1DM) is a chronic autoimmune condition characterized by the destruction of insulin-producing beta cells in the pancreas, leading to lifelong dependence on insulin therapy. Effective glycemic control is critical for managing T1DM in children, as poor control is associated with acute complications like diabetic ketoacidosis and long-term risks such as microvascular and macrovascular damage. (1) Achieving optimal glycemic control, however, is influenced by various factors, including medical, behavioural, and social determinants. Sociodemographic factors, such as age, gender, socioeconomic status, parental education, family structure, and access to healthcare, have been increasingly recognized as significant contributors to the management and outcomes of T1DM. These factors can influence adherence to treatment regimens, frequency of monitoring blood glucose, and access to insulin and other diabetes care resources. For example, children from lower-income families may face challenges related to the affordability of diabetes management tools, while those with higher parental education levels might benefit from greater health literacy and improved self-management skills. (2)

The incidence of Type 1 diabetes mellites has greatly increased over the last decade, mostly due to increased diagnosis of the disease in younger children.(1) Both genetic and environmental factors have significant role in Etiology of Type 1 diabetes. Type 1 DM has major consequences in terms of microvascular and macrovascular complications causing increased morbidity and mortality. The Diabetes Control and Complications Trial and the Epidemiology of Diabetes Interventions and Complications study suggested that adequate glycemic control is necessary for reducing microvascular complications.(3) The American Diabetes Association(ADA) has recommended keeping HbA1c between 7.5% and 8.5% in children less than 6 years, less than 8 is recommended for children between 6 and 8 years whereas <7.5 is considered optimal.(4) The responsibility of achieving age-specific targets of glycosylated Hemoglobin HbA1c rests on children and their caregivers with close and continuous support from the Diabetic clinic. So, the metabolic control of patients with T1DM is impacted by factors related to both patients and their caregivers. These factors include the patient's age, duration of illness, socioeconomic factors, level of education of parents and parental responsibility and understanding of the disease.(5) Studies have shown great impact of sociodemographic factors on the glycemic control of children with T1DM. A study conducted in Tanzania showed younger age, mother as primary caretaker, less duration of illness, better education of parents, and proper blood glucose monitoring regime are predictors of better glycemic control.(6) This study aims to identify sociodemographic determinants of glycemic control in children presenting with T1DM. This study will help in developing appropriate interventions for better diabetic care and education. It will also assist in the identification of high-risk patients for personalized management strategies.

Objective

The aim of this study is to identify the impact of sociodemographic factors on Glycemic control of children with Type 1 Diabetes Mellitus by using Sociodemographic Information.

Methodology

This Cross-sectional Prospective study was conducted at the Diabetic clinic, children's Hospital, PIMS from 01/12/23 till 30/11/24. Data were collected through Non-probability consecutive sampling.

By using the WHO calculator, a sample size of 165 was calculated by using a confidence level of 95%, an anticipated population of 0.096 and an Absolute precision of 4.5%. (3)

165 children diagnosed with Type 1 Diabetes Mellitus, aged between 1-12yrs visiting the diabetic clinic of Children Hospital PIMs were enrolled. Those not willing to participate in the study, patients with chronic illnesses other than Type-1 Diabetes Mellitus and those aged less than 1 year or more than 12 years were excluded from the study.

Ethical approval was obtained from the Ethical Review Committee of Shaheed Zulfiqar Ali Bhutto Medical University, PIMS, Islamabad, before commencing the study. Informed consent was obtained from the parents or guardians of all study participants. Both inpatient and outpatient participants meeting the inclusion criteria were included in the study. Demographic and clinical data were collected through a structured questionnaire. This included details such as age, weight, gender, and contact information. Clinical information such as fasting blood glucose levels, pre- and post-prandial blood glucose levels, HbA1c, and urine R/E were also gathered. Specific sociodemographic factors associated with glycemic control were documented. Strict adherence to the exclusion criteria was maintained to minimize bias and control for effect modifiers. The collected data were compiled and analyzed using the Statistical Package for Social Sciences (SPSS) version 24. Descriptive statistics were employed to summarize the data. Quantitative variables, such as age, weight, blood glucose levels, and HbA1c, were expressed as mean ± standard deviation. Qualitative variables, including gender, residence, and parental education levels, were presented as frequencies and percentages. Associations between sociodemographic factors and glycemic control were evaluated using appropriate statistical tests.

Results

Data were collected from 165 patients, with a nearly equal distribution of genders (41.2 % male, 58.8% female). Most participants were aged 8-12 (55.2%), followed by 5-8 years (24.2 %). The majority resided in urban areas (54.5%), while rural residents accounted for 45.5%. Parental education varied, with secondary education (37%) being the most common level. The majority of patients were diabetic for more than 5 years (43.6%). Most patients were on long-acting insulin with analogues and a lesser number were on intermediate-acting with short-acting (77% vs 23%). Clinically, the mean fasting blood glucose was 195 ± 48 mg/dL, post-prandial blood glucose was 285 ± 62 mg/dL, and HbA1c averaged 9.2 ± 2.1%, indicating poor glycemic control. (Table 1) The glycemic control analysis revealed that the majority of participants (67.9%) had poor control with HbA1c levels ≥ 7.5%, while only 32.1% achieved good control with HbA1c levels < 7.5%, reflecting varying levels of disease management. (Table 2)

Children with parents having secondary or higher education showed better glycemic control (41.5% and 39.6%). Urban and rural residents did not significantly affect glycemic control as seen by *p value of 0.3*. Younger children (1-8 years) demonstrated better control (39.6% and 32% good) compared to older age groups (67.9% poor for 8-12 years, $p = 0.001$). Socioeconomic status did not affect glycemic control significantly either (*p=0.34).* Even though in our study the education of the caregivers did not significantly affect the glycemic control of patients knowledge of the caregivers regarding disease treatment improved glycemic control in patients (98% having either adequate or good knowledge). The majority of the patients in the study had mothers as primary caregivers and they showed better glycemic control as compared to when other caregivers were involved. (Table 3)

Other parameters to note were insulin regime which did not significantly affect glycemic control in children but BSR monitoring when good showed improved glycemic control. (43.4% average, 49% good monitoring, *p=0.001*). (Table 4)

The study also assessed blood glucose monitoring adherence, treatment adherence, caregiver knowledge, and recent HbA1c levels among participants. Monitoring adherence was average in 47.3% (1–2 times/week), good in 32.1% of cases (≥3 times/day), and poor in 20.6% (none). Caregiver knowledge about the disease was rated as good in 24.8%, adequate in 61.8%, and poor in 13.3%. (Table 5).

Table 1: Demographic Characteristics and Clinical Parameters of Study Participants

Characteristic		**n (%)**
Age Groups	1–5 years	34 (20.6%)
	5–8 years	40 (24.2%)
	8–12 years	91 (55.2%)
Gender	Male	68 (41.2%)
	Female	97 (58.8%)
Residence	Urban	90 (54.5%)
	Rural	75 (45.5%)
Duration of diabetes	< 1 year	35 (21.2%)
	1-5 years	58 (35.2%)
	>5 years	72 (43.6%)
Parental Education	No formal education	26 (15.8%)
	Primary education	26 (15.8%)
	Secondary education	61 (37 %)
	Higher education	52 (31.5%)
Primary caregiver	Mother	88 (53.3%)
	Father	24 (14.5%)
	self	27 (16.4%)
	Siblings/other family members	26 (15.8%)
Insulin Regime	Long-acting with analogues	127 (77%)
	Intermediate-acting with short-acting	38 (23%)
Clinical Parameter		Mean ± SD
	Fasting Blood Glucose	195 ± 48 mg/dL
	Post-Prandial Blood Glucose	285 ± 62 mg/dL
	HbA1c	9.2 ± 2.1%

Table 2: Glycemic Control Based on HbA1c Levels

Glycemic Control	HbA1c (%)	n (%)
Good control	<7.5%	53 (32.1%)
Poor control	≥7.5%	112 (67.9%)

Table 3: Association between Sociodemographic Factors and Glycemic Control

Factor		Good Control (%) n=53	Poor Control (%) n=112	p-value
Age	1-5 years	21 (39.6%)	13 (11.6%)	
	5-8 years	17 (32%)	23 (20.5%)	0.001
	8-12 years	15 (28.3%)	76 (67.9%)	
Gender	Male	17 (32%)	51 (45.5%)	
	Female	36 (67.9)	61 (54.5%)	0.1
Parental Education	No formal education	6 (11.3%)	20 (17.8%)	
	Primary education	4 (7.5%)	22 (19.6%)	
	Secondary education	22 (41.5%)	39 (34.8%)	
	Higher education	21 (39.6%)	31 (27.7%)	0.095
Duration of diabetes	Less than 1	12 (22.6%)	23 (20.5%)	
	1-5 years	25 (47.2%)	33 (29.5%)	
	More than 5 years	16 (30.2%)	56 (50%)	0.03
Knowledge regarding disease and treatment	Poor	1 (2%)	21 (18.8%)	
	Adequate	26 (49%)	76 (67.9%)	
	Good	26 (49%)	15 (13.4%)	
Primary caregiver	Mother	41 (77.4%)	47 (41.9%)	
	Father	11 (20.8%)	13 (11.6%)	
	self	0	27 (24.1%)	
	Siblings/other family members	1 (1.8%)	25 (22.4%)	0.001
Residence	Urban	21 (39.6%)	54 (48.2%)	0.3
	Rural	32 (60.4%)	58 (51.8%)	
Socioeconomic Status	Low	11 (20.8%)	26 (23.2%)	
	Middle	28 (52.8%)	46 (41%)	0.34
	High	14 (26.4)	40 (35.7%)	

Table 4: Association between management strategies and Glycemic Control

Factor		Good Control (%) n=53	Poor Control (%) n=112	p-value
Insulin Regime	Long-acting with analogues	43 (81.1%)	84 (75%)	
	Intermediate-acting with short-acting	10 (18.9%)	28 (25%)	0.38
BSR Monitoring	Poor	4 (7.5%)	30 (26.8%)	
	Average	23 (43.4%)	55 (49.1%)	
	Good	26 (49%)	27 (24.1%)	0.001

Table 5: Disease Management and Glycemic Control

Category	Subcategory	n (%)
Blood Glucose Monitoring	Good (≥3 times/day)	53 (32.1%)
	Average (1–2 times/week)	78 (47.3%)
	Poor (none)	34(20.6%)
Adherence to treatment	Poor	20 (12.1%)
	Adequate	64 (38.8%)
	Good	81 (49.1%)
Knowledge of Caregiver About Disease	Good	41 (24.8%)
	Adequate	102 (61.8 %)
	Poor	22 (13.3%)
Recent HbA1c	Good control (<7.5%)	53 (32.1%)
	Poor control (>7.5%)	112 (67.9%)

Discussion

This study assessed the impact of sociodemographic factors on glycemic control in children with Type 1 Diabetes Mellitus (T1DM). The results pointed out the connection between glycemic control and other factors including parental education, socioeconomic status, age, and residence to show that diabetes management is a complex process in children. A total of 67.9% of participants had poor glycemic control with an HbA1c of

≥7.5% this is in concordance with the previous research done on patients with type 1 diabetes in a similar population. (7) The statistical relationship between age and glucose management (p-value = 0.001) reveals that children older than 8 years usually measure worse glycemic control than children aged 1-8 years. Ogugua et al., 2021 reported significant deterioration of glycemic control with increasing age in a study conducted on type 1 diabetics in Nigeria. (7) Better glycemic control is observed in younger children because their caregivers monitor them more intensely and as the children age the responsibility of disease management falls solely on them. Younger children are less likely to participate in risky behaviours that are frequent among older children and adolescents with type 1 diabetes, such as missing meals or insulin which lowers the risk of poor glycemic control. (8,9) Poor glycemic control in older children can also be attributed to changes in hormonal changes during puberty. The increases in growth hormone, cortisol, and sex hormones (oestrogen and testosterone), which negate the benefits of insulin cause an increase in insulin resistance. Higher insulin requirements to maintain blood glucose control are frequently the outcome of this hormonal change. (10)

Our study demonstrated that children with more educated parents had better glycemic control but this was not statistically significant. Parental education is presumably associated with improved health literacy and comprehensibility of the disease and its management. Caregivers who have earned higher degrees tend to grasp diabetes management principles better thus they understand diet needs insulin requirements and blood glucose surveillance practices. The child achieves better glycemic control because well-informed caregivers give stable care and support. (11, 12, 13) Our study however did find a positive relation between the caregiver's knowledge of disease management and better glycemic control (p-value 0.001). This is by Araszkiewicz et al., 2008 who reported better long-term metabolic control and a decreased risk of diabetic complications were linked to increased diabetic knowledge following a 5-day intensive insulin therapy teaching program. (14)

Parental socioeconomic status was not found to be a predictor of glycemic control in our study. Gillani et al., 2021 and Ogugua et al., 2021 showed similar findings of glycemic control not being affected by the socioeconomic status of patients. (7,15) There are several reasons why glycemic control in children and adolescents with type 1 diabetes may not be directly impacted by lower socioeconomic status, even though it may be linked to restricted access to healthcare services. Even though lower SES may restrict access to healthcare, if medical care is easily accessible and regular monitoring is possible, it does not always result in worse glycemic control. (16)

Findings indicate that the type of primary caregivers directly affected glycemic control based on statistical significance at 0.001 (p-value). Children under maternal primary caregiver stewardship demonstrated better glycemic control so it appears that when mothers are involved in diabetes management it leads to improved consistent disease monitoring and treatment compliance and diabetes outcome improvements. Mothers as primary caregivers serve as crucial figures in overseeing the chronic health conditions of children according to research findings. (17)

Children who consistently monitored their blood glucose achieved superior glycemic control. Daily blood glucose tests emerge as essential to diabetes management because proper observation enables healthcare providers to adjust treatment effectively thus maintaining blood glucose control properly. The clinical markers of patients' glycemic control included fasting and 2-h post-prandial glucose levels and HbA1c; thus, higher levels of these parameters suggested poor glycemic control. Similar findings were observed in other studies as well. (4, 15) On the other hand, the high prevalence of poor control in this study could be blamed on resource and awareness constraints in the study group. Glycemic control remained unaffected by using either Long-acting insulin with analogues or Intermediate with short-acting insulin as treatment in this research (p-value = 0.38). The findings might stem from how both insulin regimes work effectively when employed correctly in Type 1 Diabetes Mellitus children to achieve optimal glycemic control. (7,15) The study findings did not show significance due to possible differences between children's insulin response patterns (19).

The major limitations of the study include the relatively small sample size, single-centre study, average duration of follow-up and the absence of fasting-glucose measurement. The study involves cross-sectional data and thus does not include causality conclusions and some selection bias might be in-built by using the non-probability method of sampling. Also, the sociodemographic data were self-reported, and the validity of some of those survey-based quantification could be questionable.

Conclusion

The key factors affecting glycemic control in children with Type 1 Diabetes Mellitus (T1DM) are highlighted in this study. Younger children typically exhibit better control than older children, maybe as a result of difficulties associated with puberty-related hormonal changes that increase insulin resistance. While parental education and socioeconomic status were not significant predictors of glycemic control in this study, caregiver knowledge of diabetes treatment was highly associated with improved glycemic control emphasizing the significance of health literacy. Furthermore, frequent blood glucose monitoring and maternal participation as the primary caregiver were found to be essential components for maintaining optimal glycemic control. In summary, effective diabetes management in children with type 1 diabetes depends on caregiver involvement, caregiver education, and access to care. The study highlights the importance of consistent healthcare access and educational support for families to ensure better outcomes as children age.

Declarations

Data Availability statement
All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate
Approved by the department concerned. (IRBEC-CHL-0701-24)

Consent for publication
Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

SA
Manuscript drafting, Study Design,
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Review of Literature, Data entry, Data analysis, and drafting article.
MT (Medical Officer**)**
Conception of Study, Development of Research Methodology Design,
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Study Design, manuscript review, critical input.
FTZ (Medical Officer)
Manuscript drafting, Study Design,
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Review of Literature, Data entry, Data analysis, and drafting article.

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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