DETERMINANTS OF BLOOD SUGAR REGULATION IN PATIENTS WITH TYPE 1 DIABETES: A SYSTEMATIC LONGITUDINAL ANALYSIS.

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Abstract

Aim/Objective: To assess glycemic control and discover characteristics that predict glycemic outcomes among people with type 1 diabetes.

Methodology: This study observed 130 adults with type 1 diabetes, assessing their glycemic control monthly over three months. Data on sociodemographic, clinical, and behavioral factors were collected using structured questionnaires and clinical records. Laboratory tests followed standardized protocols. Statistical analyses identified predictors of suboptimal glycemic control using SPSS software. Ethical approval and informed consent were obtained.

Results: The study included 130 participants, predominantly male (60%) and aged 41-60 years. Most had primary education (54.6%) and were engaged in farming (34.2%). About 76.1% never smoked, and 63.6% had a healthy weight. Non-adherence to treatment was reported by 59.1% of participants. The most prevalent comorbidity was hypertension. (39.1%). Poor glycemic control was detected in 72.7% of participants, with a mean HbA1c of $8.2 \pm 1.5\%$.

Conclusion: This study highlights the widespread issue of diabetics having poor glycemic control, emphasizing the need for targeted interventions. Lifestyle factors like overweight/obesity play a crucial role, alongside challenges related to renal function. Moving forward, personalized approaches focusing on adherence and weight management are imperative for improving diabetes care and reducing complications.

Keywords: Glycemic control, Diabetes, Insulin, Predictors, Type 1 diabetes.

Introduction

Diabetes mellitus, a lifelong metabolic disorder characterized by abnormalities in secretion of insulin and/or action, represents a rising global health issue. [1]. Diabetes mellitus type-1(T1DM) stands as a formidable challenge in contemporary healthcare, marked by the stark absence of insulin production owing to the relentless assault on pancreatic beta cells. This autoimmune assault precipitates a cascade

of metabolic dysregulation, catapulting individuals into a perpetual struggle against hyperglycemia and its attendant complications. While the etiological cornerstone of T1DM remains anchored in insulin deficiency, a nuanced understanding reveals a spectrum of residual beta cell function, where the existence of intrinsic insulin secretion is assessed as C-peptide at the time of diagnosis [2].

The global burden of T1DM portrays a sobering picture, with an estimated 8.4 million individuals grappling with its complexities in 2021. The World Health Organization's surveillance indicates a daunting trajectory, with the diabetic populace soaring from 108 million in 1980 to a staggering 422 million by 2014, with projections soaring to 700 million by 2045. This alarming surge is propelled by multifaceted determinants including population growth, demographic shifts towards aging, sedentary lifestyles, and dietary patterns fostering metabolic dysregulation [3,4].

Against the backdrop of an escalating epidemiological tide, particularly in regions like Pakistan, where outdated statistics belie the true surge in incidence, the imperative for meticulous surveillance and intervention becomes ever more pronounced. Pakistan, ensconced within the escalating epicenter of the diabetes pandemic, witnesses a relentless rise in the prevalence of both T1DM and its more prevalent counterpart, type 2 diabetes [5]. Notably, the landscape is evolving at an alarming pace, with T1DM outpacing type 2 diabetes in its annual growth rate, underscoring the urgent need for contemporary epidemiological insights [6].

The ominous specter of chronic hyperglycemia looms large, exacting its toll through a litany of debilitating complications, including ocular, renal, neurological, and cardiovascular sequelae. Against this grim tableau, glycated hemoglobin (HbA1c) emerges as a beacon of prognostic significance, offering a window into the long-term trajectory of glycemic-control and its ramifications on ill-health and death [7,8].

Glycemic control, pivotal in diabetes management, poses a formidable clinical hurdle, with a substantial proportion of patients failing to attain optimal glucose regulation. An array of variables, spanning socio-demographics to lifestyle choices, intricately shape the landscape of glycemic control, underscoring the need for a multifaceted approach to diabetes care [9].

The pivotal juncture spanning adolescence to adulthood emerges as a crucible of metabolic upheaval, characterized by a confluence of physiological, psychological, and social dynamics. The transition heralds a paradigm shift, entailing heightened autonomy, peer-driven influences, and burgeoning insulin demands accentuated by escalating insulin resistance. This period of flux engenders formidable challenges to adherence, as the delicate balance between glycemic control and the pursuit of autonomy teeters precariously, with profound implications for health outcomes [10]. Yet, amidst the proliferating tide of T1DM, a conspicuous void persists in the scientific discourse, notably the paucity of data elucidating the trajectory of glycemic control during adolescence in locales like Pakistan [11].

Addressing these lacunae transcends academic curiosity, representing a pivotal imperative for informing evidence-based interventions aimed at stemming the tide of diabetes-related morbidity and mortality. Through the convergence of clinical insights and epidemiological rigor, we endeavor to chart a course towards tailored strategies poised to mitigate the burden of diabetes and safeguard the health and well-being of populations globally.

Aim/Objective: To assess glycemic control and discover characteristics that predict glycemic outcomes among people with type 1 diabetes.

Study materials and methods
This single center prospective observational study was carried-out at Liaquat University of Medical & Health Sciences, Jamshoro, Pakistan in the duration from September, 2023 to February, 2024.

Inclusion Criteria
The study encompassed individuals diagnosed with diabetes mellitus type-1, aged >18 years who had commenced antidiabetic medication. Participants adhered diligently to a rigorous 1-month follow-up schedule for clinic visits, ensuring meticulous data collection without the risk of redundant inclusion.

Moreover, only patients who observed fasting protocols during data collection were deemed eligible for enrollment.

Exclusion Criteria
Patients afflicted with diabetes mellitus type-2 were categorically omitted from the research. Furthermore, individuals below the age threshold of 18 years and those expressing reluctance to partake were automatically disregarded. Patients who deviated from the prescribed 1-month follow-up regimen for clinic visits, as well as those who failed to adhere to fasting guidelines during data collection, were also excluded from consideration.

Methodology
A cohort of 130 patients diagnosed with type-1 diabetes constituted this study. Monthly follow-ups were conducted to maintain data integrity. Glycemic control was assessed through monthly fasting blood sugar (FBS) measurements over three consecutive months, with good control defined as an average FBS ranging from 80 to 125mg/dl. Sociodemographic, clinical, and behavioral factors were evaluated using structured questionnaires and clinical records. Laboratory tests, including FBS and serum creatinine levels, were conducted following standardized protocols. Statistical analyses, encompassing descriptive statistics and logistic regression, were performed using SPSS software to identify determinants of suboptimal blood sugar control. An approval was acquired from the hospital's Ethical Research Committee, and an informed written consent was secured from all subjects.

Results
Out of these 130 participants, 78 were male (60%) and 52 were female (40%). The mean age of the participants was 49.88 ±14.23 years, with a considerable proportion between the ages of 41-60years (47.5%). In terms of educational status, 71 participants (54.6%) had primary education, while 26 (20%) had secondary education, and 33 (25.4%) had tertiary education. Occupation-wise, farmers were prevalent among the participants (34.2%), followed by merchants (29.4%) and employees (13.6%). Urban residents made up 53.6% of the study population. The mean BMI of the participants was 23.69 ±4.31kg/m², with 61.8% of them having a healthy-weight. [Table-I]

Table-I: Base-line characteristics of the study group

Characteristic	Number (n)	Mean ± SD/ Percentage
Total Participants	130	-
Male	78	60%
Female	52	40%
Age (years)	-	49.88 ±14.23
Age Range	41-60 years	47.5%
Education Level	-	-
Primary	71	54.6%
Secondary	26	20%
Tertiary	33	25.4%
Profession	-	-
Farming	44	34.2%
Merchant	38	29.4%
Employee	18	13.6%
Urban Residents	70	53.6%
BMI (kg/m²)	-	23.69 ±4.31
Healthy Weight	-	61.8%

The majority of participants (76.1%) reported never smoking cigarettes. About 39.7% of participants followed a sufficiently healthy eating plan, while 40.3% exercised for at least thirty minutes routinely. Non-adherence to treatment regimen was reported by 59.1% of participants. 54.7% of those surveyed had an excellent awareness of diabetes, whereas 23.9% of them monitored their blood glucose levels at home. [Table-II]

Table-II: Personal-care practices and/or knowledge of study group

Practice/Knowledge	Number (n)	Percentage
Never smoked cigarettes	99	76.1%
Followed healthy eating plan	51	39.7%
Engaged in daily physical activity (≥ 30 mins)	52	40.3%
Non-adherence to treatment regimen	77	59.1%
Good knowledge of diabetes	68	54.7%
Adhered to blood sugar monitoring at home	29	23.9%

Participants had diabetes for an average of 7.72 ±5.91 years. The family history related to diabetes was documented by 28.8% of the subjects. Diabetes ketoacidosis was previously diagnosed in 29.7% of individuals. 43.3% of participants had additional chronic conditions, with high blood pressure being particularly common (39.1%). 59.4% of participants had an estimated rate of glomerular filtration (eGFR) of ≥90 ml/min per 1.73 m². [Table-III]

Table-III: Clinical characteristics of the study group

Characteristic	Number (n)	Mean ± SD /Percentage
Average length of diabetes(years)	-	7.72 ± 5.91
Positive history of diabetes in family	38	28.8%
History of diabetes ketoacidosis	39	29.7%
Additional chronic diseases	56	43.3%
Hypertension	51	39.1%
eGFR ≥90 ml/min per 1.73 m²	77	59.4%

45.5% of individuals were provided oral antidiabetic medications in addition to insulin, with 27.6% receiving metformin-based therapy. Insulin injections were recommended to 40.3% of individuals, and polypharmacy to 6.7%. Statin and aspirin medication were started to 12.1% and 10.0% of the individuals, respectively. [Table-IV]

Table-IV: Usage of medications

Medication	Number (n)	Percentage
Oral antidiabetic drugs with insulin	59	45.5%
Insulin + Metformin combination	36	27.6%
Insulin only	52	40.3%
Polypharmacy	9	6.7%
Statin therapy	16	12.1%
Aspirin therapy	13	10.0%

The average fasting blood sugar (FBS) measurement was 188.28 ±75.69 mg/dl at baseline, and 178.34 ± 53.73 mg/dl during 3 months. The average HbA1c reading was 8.2 ±1.5%, showing blood sugar control during the previous 2-3 months. 72.7% of patients had inadequate glucose control, as seen by increased FBS and HbA1c levels, emphasizing the importance of enhanced management measures for better control. [Table-V]

Table-V: Status of glycemic control

Parameter	Mean ± SD
Baseline FBS (mg/dl)	188.28 ± 75.69
3-Month Average FBS (mg/dl)	178.34 ± 53.73
HbA1c (%)	8.2 ± 1.5

Discussion

The investigation of controlling glycemic levels and associated variables among diabetic individuals provides critical insights into diabetes care. Our analysis found an alarming incidence of inadequate glucose control, consistent with observations from similar studies around the world, reinforcing the global problem of properly managing diabetes.

Comparing our results with existing literature, we observed similarities and differences. For instance, the percentage of individuals with insufficient control of their glucose levels in our investigation's population closely resembled findings from studies conducted in diverse regions, including a study by Abejew et al. [12]. However, our results contrasted with studies conducted in other Ethiopian regions (Jimma, Mekele, Gondar) and Kenya, where lower rates of poor glycemic control were reported [13, 14, 15,16]. This discrepancy may be attributed to variations in study methodologies, including the use of HbA1c measurements and differences in cultural, environmental, and genetic factors influencing glycemic control.

A striking finding in our study was the high link between inadequate glycemic regulation and obesity, which is consistent with prior research conducted in the United States, Saudi Arabia, and India by Kaur et al [17, 18, 19]. This emphasizes the importance of lifestyle variables, specifically eating behaviors, in glycemic management. In contrast to several research, our study found no significant relationships between sex or age and glycemic control, indicating that the influence of demographic factors may vary between groups.

Furthermore, our study identified a noteworthy relationship between higher estimated glomerular filtration rate (eGFR) and poor glycemic control, consistent with prior research conducted by Selvin et al. [20], Tsuda et al. [21], and Naderpoor et al [22]. Understanding this association is vital, as impaired renal function can exacerbate challenges in glycemic regulation. Strategies aimed at enhancing adherence to dietary recommendations and medication regimens emerged as pivotal in improving glycemic outcomes, echoing findings from study conducted by Alramadan et al. in Gulf Cooperation Council Countries [23].

Additionally, our observation of an increased likelihood of inadequate glycemic management among individuals with diabetes type 1 as opposed to those with diabetes type 2 is consistent with earlier research [24]. This underscores the complexity of managing type 1 diabetes and emphasizes the need for personalized treatment approaches tailored to individual patient needs.

Our work provides useful insights into the varied issues of glycemic management in diabetic patients. Addressing modifiable risk factors through comprehensive, patient-centered care strategies is essential for improving glycemic outcomes and mitigating the burden of diabetes-related complications. Moving forward, targeted interventions focusing on weight management, adherence promotion, and personalized treatment approaches are imperative in advancing diabetes care and enhancing patient well-being.

Conclusion

This study highlights the widespread issue of diabetics having poor glycemic control, emphasizing the need for targeted interventions. Lifestyle factors like overweight/obesity play a crucial role, alongside challenges related to renal function. Moving forward, personalized approaches focusing on adherence and weight management are imperative for improving diabetes care and reducing complications.

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