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ASSESSMENT OF ELECTROLYTES IMBALANCE IN DIABETIC PATIENTS

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Abstract

Background: *Electrolyte disturbances are clinically significant yet underrecognized complications of diabetes mellitus, particularly in patients with poor glycemic control. Chronic hyperglycemia promotes osmotic diuresis and impairs renal ion handling, leading to alterations in sodium, potassium, and calcium homeostasis.*

Objective: *To determine the prevalence and pattern of electrolyte imbalances in adult diabetic patients and to evaluate their association with glycemic markers (fasting blood sugar [BSR] and HbA1c).*

Methods: *A cross-sectional study was conducted at a tertiary care biochemistry laboratory. A convenience sample of 103 diabetic patients (aged 30–70 years) was enrolled. Serum sodium (Na^+), potassium (K^+), and calcium (Ca^{2+}) were measured using ion-selective electrode methods on an automated analyzer. HbA1c was quantified by HPLC. Spearman correlation and multivariate regression (ANOVA) were applied using SPSS.*

Results: *The cohort comprised 63 males (61.2%) and 40 females (38.8%), with a mean age of 46.1 ± 11.0 years. Mean HbA1c was 9.33 ± 2.14%, indicating poor glycemic control. Mean serum Na^+ was 138.3 ± 4.0 mEq/L, K^+ was 3.98 ± 0.47 mEq/L, and Ca^{2+} was 9.81 ± 8.48 mg/dL. Spearman correlation revealed significant positive associations between HbA1c and Na^+ ($\rho = 0.452$, $p < 0.001$), K^+ ($\rho = 0.289$, $p = 0.003$), and Ca^{2+} ($\rho = 0.314$, $p = 0.001$). HbA1c was the only significant independent predictor of serum Na^+ in multivariate regression ($\beta = 0.857$, $p = 0.002$).* ***Conclusion:*** *Electrolyte disturbances are significantly associated with worsening glycemic control in diabetic patients. Routine monitoring of serum electrolytes alongside blood glucose should be integrated into standard diabetic care to prevent serious neurological, cardiovascular, and metabolic sequelae.*

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from impaired insulin secretion, insulin action, or both. It has become one of the leading global health challenges because of its rapidly increasing prevalence and its association with severe microvascular and macrovascular complications. According to the International Diabetes Federation (IDF), approximately 537 million adults were living with diabetes in 2021, and this number is projected to rise to 784 million by 2045 (Sedighi et al., 2023). Chronic hyperglycemia contributes to progressive damage of multiple organs, particularly the kidneys, cardiovascular system, peripheral nerves, and eyes, resulting in increased morbidity and mortality (Yameny, 2024). Sodium imbalance is one of the most frequently reported electrolyte disorders in diabetes. Hyperglycemia promotes osmotic movement of water from intracellular to extracellular compartments, producing dilutional hyponatremia, whereas excessive urinary water loss may lead to hypernatremia in poorly controlled diabetes (Zhang et al., 2023). Potassium homeostasis is also altered because insulin

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facilitates intracellular potassium uptake through activation of the Na^+/K^+-ATPase pump. Consequently, insulin deficiency or resistance may result in extracellular potassium accumulation despite total body potassium depletion, particularly in diabetic ketoacidosis (Mears & Treacy, 2020; Thomas & Harvey, 2023). Growing evidence suggests that electrolyte imbalance is highly prevalent among diabetic patients. Eshetu et al. (2023) reported electrolyte abnormalities in more than 80% of diabetic patients, with significantly lower serum sodium and calcium concentrations than healthy controls. Similarly, Jasim et al. (2024) demonstrated significantly higher serum sodium and potassium levels among diabetic patients, whereas Sahu et al. (2026) identified hyponatremia (53%), hypomagnesemia (38.5%), hypokalemia (33.5%), and hypocalcemia (31.5%) as the most common electrolyte disturbances in patients with uncontrolled diabetes. These findings indicate that electrolyte abnormalities are common but may vary across populations because of differences in disease severity, treatment, hydration status, and renal function.

Objective:

1. To identify the blood levels of sodium, potassium, and calcium in diabetic people
2. To assess their electrolyte balance and monitor their blood sugar levels, including fasting blood sugar and HbA1c.
3. To evaluate and find out how Patients being low calcium, potassium, and salt levels are common electrolyte abnormalities in diabetics.

Research Questions

1. What are the average blood levels of sodium, potassium, and calcium in patients with diabetes?
2. How are electrolyte levels (sodium, potassium, calcium) associated with glycemic control indicators such as fasting blood sugar and HbA1c in diabetic patients?
3. What is the prevalence of electrolyte imbalances (hyponatremia, hypokalemia, and hypocalcemia) among individuals with diabetes?

Therefore, the present study aimed to assess serum sodium, potassium, and calcium concentrations in diabetic patients and evaluate their relationship with fasting blood glucose and glycated hemoglobin (HbA1c). The findings may contribute to the development of evidence-based recommendations for routine electrolyte monitoring and comprehensive management of diabetes mellitus.

Materials and Methods

Study Design and Setting

A cross-sectional, observational study was conducted at the Biochemistry Laboratory of a tertiary care hospital following approval by the Institutional Ethics Committee. All participants provided written informed consent.

Participants

Adult diabetic patients aged 30–70 years with a confirmed diagnosis of type 1 or type 2 DM were enrolled by convenience sampling. Patients with renal failure, hepatic disease, cardiac failure, or those receiving diuretics or electrolyte supplements were excluded to minimize confounding.

Sample Size

Sample size was calculated using the prevalence formula $n = Z^2pq/d^2$, assuming a 50% prevalence of electrolyte imbalance (no prior local data), 95% confidence ($Z = 1.96$), and 10% margin of error, yielding a minimum of 96; 103 patients were enrolled.

Statistical Analysis

Data were entered in Microsoft Excel and analyzed using SPSS. Normality was assessed by Kolmogorov–Smirnov and Shapiro–Wilk tests. Given non-normal distributions, Spearman's rank correlation was used to assess associations between electrolytes and glycemic variables. Multivariate linear regression (ANOVA) examined independent predictors of serum electrolytes. Statistical significance was set at $p < 0.05$.

Results

Demographic and Clinical Characteristics

Table 3.1

Demographic and Clinical Characteristics of Diabetic Patients (N = 103)

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Variable	Mean ± SD	Minimum	Maximum
Age (years)	46.14 ± 11.02	25	66
HbA1c (%)	9.33 ± 2.14	6.8	15.3
Blood Sugar Random (mg/dL)	240.42 ± 64.98	109	390
Sodium (mmol/L)	138.25 ± 3.99	132	147
Potassium (mmol/L)	3.98 ± 0.47	3.30	5.40
Calcium (mg/dL)	9.81 ± 0.85*	8.3	95.0

Note:The calcium maximum (95.0 mg/dL) appears to be a probable data-entry error and should be verified before publication.

Gender Distribution
Table 3.2
Gender Distribution of Study Participants

Gender	n	%
Male	63	61.2
Female	40	38.8
Total	**103**	**100.0**

Normality Assessment
Table 3.3
Tests of Normality

Variable	Shapiro–Wilk	p	Distribution
Sodium	0.955	.001	Non-normal
Potassium	0.941	<.001	Non-normal
Calcium	0.097	<.001	Non-normal
BSR	0.950	.001	Non-normal
HbA1c	0.903	<.001	Non-normal

Shapiro–Wilk and Kolmogorov–Smirnov tests indicated that all study variables significantly deviated from normality ($p < .05$). Consequently, **non-parametric statistical methods** were used for correlation analyses (Table 3).

Correlation between Electrolytes and Glycemic Markers
Table 3.4
Spearman Correlation between Glycemic Parameters and Electrolytes

Variables	HbA1c	BSR	Sodium	Potassium	Calcium
HbA1c	–	.748***	.452***	.289**	.314**
BSR		–	.347***	.260**	.325**
Sodium			–	.608***	.636***
Potassium				–	.727***

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Variables	HbA1c	BSR	Sodium	Potassium	Calcium
Calcium					–

*Note. p < .01 **, *p < .001.*

Spearman's correlation analysis demonstrated a strong positive correlation between HbA1c and BSR (r_s = .748, p < .001). HbA1c also showed significant positive correlations with sodium (r_s = .452, p < .001), calcium (r_s = .314, p = .001), and potassium (r_s = .289, p = .003). Serum sodium exhibited strong positive correlations with calcium (r_s = .636, p < .001) and potassium (r_s = .608, p < .001). Calcium and potassium were also strongly correlated (r_s = .727, p < .001) (Table 4).

Multiple Linear Regression

Table 3.5

Multiple Linear Regression Analysis Predicting Serum Electrolyte Levels

Dependent Variable	F	p	Significant Predictor	β	P
Sodium	8.40	<.001	HbA1c	.459	.002
Potassium	2.01	.099	None	–	–
Calcium	0.62	.650	None	–	–

For serum sodium, the overall regression model was statistically significant, **F**(4, 98) = 8.40, **p** < .001. HbA1c was the only significant independent predictor of sodium concentration (β = .459, **p** = .002), whereas age, gender, and BSR were not significant predictors.

Discussion

Additionally, the link between electrolyte imbalance and glycated hemoglobin (HbA1c) levels was evident. Patients with greater HbA1c levels were more likely to have electrolyte abnormalities, indicating that poor long-term diabetes control exacerbates metabolic imbalances. This bolsters the argument that regular diabetes care should include electrolyte monitoring, particularly for those who control this (Rajagopal, Ganesan et al. 2018).

The study also highlights the need of quickly recognizing and addressing electrolyte abnormalities. Regular laboratory tests that were successful in pinpointing deviations included ion-selective electrode methods and standardized biochemical assays. With proper hydration monitoring, complications such as dehydration, neurological impairment, and cardiac can be prevented from occurring (Crintea, Cindrea et al. 2025). The current study points out the importance of routine biochemical screening in diabetic patients to lessen the burden of consequences due to electrolyte abnormalities. Renal function, which is crucial for sustaining a healthy electrolyte balance, is one of the numerous organ systems impacted by diabetes mellitus. Persistent hyperglycemia can induce hyponatremia, hypokalemia, or other metabolic issues because it damages kidney function and increases electrolyte production in the urine(Alam, Hasan et al. 2021).

Heart function, neuron transmission, and muscle activity may all suffer as a result of these disruptions. As a result, regular laboratory testing of serum electrolytes ought to be considered a crucial part of diabetic monitoring. Early abnormality discovery lowers the likelihood of hospitalization and major adverse effects while permitting early medical treatment. Patients' prognosis can be optimized by incorporating electrolyte monitoring into standard diabetic care practices(Ripa, George et al. 2023). Overall, this study's findings confirm the strong link between electrolyte abnormalities and diabetes. They emphasize the need for.

Conclusion

Electrolyte imbalance is a clinically significant consequence that people with diabetes often encounter, particularly if they have poor glycemic control. The study found that irregularities in calcium, potassium, and sodium levels are closely associated with hyperglycemia and its metabolic effects. If these abnormalities are not detected and

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discussed immediately, they may cause major problems that impact neurological, cardiovascular, and musculoskeletal processes. To avoid negative outcomes, both excellent blood glucose control and routine electrolyte level monitoring are required. Patients' quality of life and prognosis can be greatly enhanced by early diagnosis and treatment. Therefore, it is extremely strongly recommended that routine electrolyte tests be included in diabetic care plans.

Limitation

This study has several limitations. First, the cross-sectional design limits the ability to establish causal relationships between glycemic control and electrolyte imbalance. Second, the study was conducted at a single tertiary care hospital with a relatively small sample size, which may limit the generalizability of the findings. Third, important confounding variables such as renal function, duration of diabetes, medication use, dietary habits, hydration status, and comorbid conditions were not comprehensively evaluated. Finally, only serum sodium, potassium, and calcium were assessed, whereas other clinically important electrolytes such as magnesium, chloride, and phosphate were not included.

Recommendations

Routine serum electrolyte assessment should be incorporated into the regular follow-up of diabetic patients, particularly those with poor glycemic control. Clinicians should monitor electrolyte disturbances alongside HbA1c to facilitate early identification of metabolic complications. Future multicenter prospective studies with larger sample sizes are recommended to validate these findings and determine causal relationships.

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