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Original Research Article

COMPARATIVE ANALYSIS OF RENAL PROFILE AND SERUM ELECTROLYTES AMONG DIABETIC AND NON DIABETIC GROUPS IN DISTRICT PESHAWAR KP

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Abstract: *Diabetes mellitus is a prevalent non-communicable disease worldwide, contributing significantly to morbidity and mortality. Renal complications are a significant concern in diabetes, with hyperglycemia exacerbating renal dysfunction.* ***Objective:*** *This study aimed to assess renal function and electrolyte balance in diabetic and non-diabetic individuals, focusing on serum urea, creatinine levels, and electrolyte imbalances.* ***Methods:*** *This study was conducted at Al-Khidmat Hospital and processed at the MLT Skill Lab at Abasyn University, Peshawar. A total of 100 participants were enrolled, including diabetic and non-diabetic subjects. Blood samples were collected using a questionnaire design. Renal function tests (RFTs) were analysed using a biochemistry analyser, and serum electrolytes were assessed using an Electrolytes Analyzer. Data collection duration, methodology, and statistical analysis methods were employed.* ***Results:*** *Among the participants, individuals aged 40 to 70 in both genders exhibited a higher prevalence of elevated urea and creatinine levels, particularly in diabetic patients. Diabetic individuals showed a significant association with azotemia. Electrolyte imbalances, notably hypokalemia, were observed, indicating potential complications in diabetic patients.* ***Conclusion:*** *The study highlights the importance of proactive management strategies to mitigate renal complications in diabetic individuals. Comprehensive monitoring of renal function and electrolyte balance is essential in clinical practice.*

Keywords: Creatinine, Diabetes Mellitus, Electrolytes, Hyperglycemia, Urea

Introduction

Diabetes mellitus, characterised by abnormal glucose metabolism and hyperglycemia, poses a significant global health challenge (1). It is associated with a range of symptoms, including polyuria, polydipsia, and polyphagia (2). Historically, the term "diabetes" dates back to around 230 BCE, although it was relatively uncommon during the Roman Empire (3). Subsequently, Indian physicians identified distinct forms of diabetes around 400-500 CE (4). The discovery and isolation of insulin in the early 20th century marked a pivotal advancement in diabetes management. Despite these strides, diabetes prevalence continues to rise globally, particularly in middle- and low-income countries, with profound implications for health outcomes and mortality rates (5, 6).

Type 1 diabetes involves the loss of insulin-producing beta cells in the pancreatic islets, resulting in insulin deficiency (7). It is predominantly immune-mediated, with T cell-mediated autoimmune attack leading to beta cell loss. Although commonly associated with childhood-onset, type 1 diabetes can also manifest in adults (8). Conversely, type 2 diabetes, accounting for the majority of diabetes cases, is characterised by insulin resistance and impaired insulin secretion. Gestational diabetes shares similarities with type 2 diabetes and occurs during pregnancy, affecting around 2-10% of pregnancies.

Renal complications, such as diabetic nephropathy, are common sequelae of diabetes (9). Diabetic nephropathy progresses to end-stage renal disease (ESRD) and is characterised by reduced glomerular function rate (GFR), hypertension, and cardiovascular morbidity (10). Serum creatinine and urea are established indicators for assessing diabetic nephropathy progression (11).

While the relationship between diabetes and renal function is well-documented, there remains a gap in understanding the association between serum electrolyte levels, renal function, and type 2 diabetes (T2D). High blood sugar levels (hyperglycemia) in diabetes can lead to osmotic diuresis, electrolyte imbalances, and alterations in plasma osmolality, contributing to renal dysfunction (12).

This study aims to evaluate serum electrolyte levels and renal function in individuals with and without diabetes, comparing serum creatinine and urea levels and analysing blood electrolyte levels. Understanding the relationship between hyperglycemia and these parameters is crucial for elucidating the pathophysiology of diabetic nephropathy and informing clinical management strategies.

Methodology

This cross-sectional study was conducted at Alkhidmat Hospital, Peshawar, and the MLT Skill Lab at Abasyn University, Peshawar. A total of 100 blood samples were collected, 50 from diabetic patients and 50 from non-diabetic individuals. The study lasted four months.

Blood samples were collected using aseptic techniques, with at least 2 ml of blood drawn into Gel tubes. The samples were then transferred to the MLT Skill Lab at

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Abasyn University, Peshawar, for further analysis. Renal function tests were performed to assess kidney function, including serum creatinine and urea. For the creatinine test, serum was separated by centrifugation, and 25 microliters of serum were mixed with R1 and R2 reagents before analysis using a micro lab 300 biochemistry analyser. The urea test involved preparing test tubes marked S1, S2, and T, with R1 and R2 reagents added accordingly. Standard solutions were run for calibration before analysing the patient's serum sample. Serum electrolytes were analysed using a Gel tube-clotted blood sample. After centrifugation, serum was run on an electrolyte analyser machine, which measured the electrolyte levels using different electrodes. Normal ranges for sodium, potassium, and chloride were considered during analysis.

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 16. Results were expressed as Mean ± Standard Error of the Mean (SEM), with frequencies presented in tables and figures. The Pearson chi-square ($\chi 2$) test was used to compare proportional differences in electrolyte and renal function indices between diabetic (D) and non-diabetic (ND) patients. Mean differences in electrolytes, creatinine, urea levels, and baseline parameters were compared between diabetic and non-diabetic individuals using parametric independent sample t-tests.

Results

One hundred blood samples were collected at Al Khidmat Hospital in Peshawar. Fifty samples were acquired from patients with diabetes mellitus, and 50 samples were collected from healthy individuals. These samples were processed at the MLT Skill Laboratory at Abasyn University Peshawar. Among 50 patients, 31(62%) were male, and 19 (38%) were female, while among 50 healthy individuals, 28 (56%) were male, while 22 (44%) were female, which is given in figure 1.

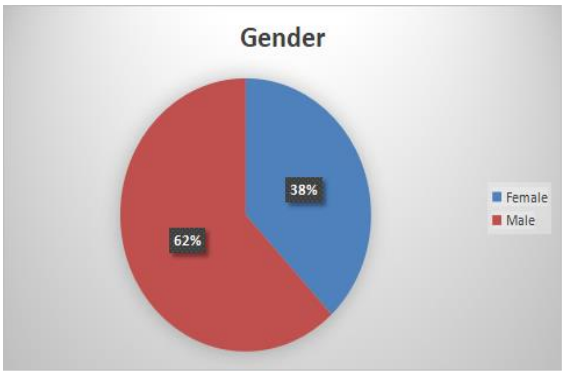

Fig. 1 Gender-Wise Distribution of DM Patients and Healthy Controls

Figure 2 depicts the distribution of diabetes patients based on age and gender. The male cohort's ages ranged from 33 to 63, with the majority clustered between 45 and 57. The female group included individuals aged 28 to 60, with the majority falling between 40 and 63, while two females were over the age of 70.

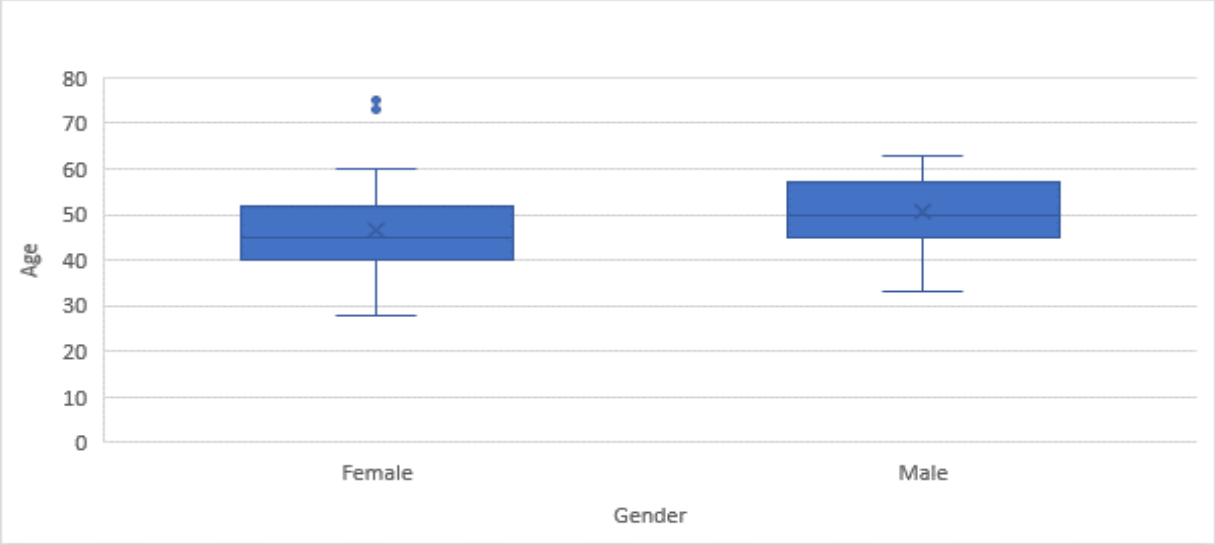

Fig 2: Age and gender-wise distribution

Table 2 presents the descriptive statistics for the diabetes group dataset. The mean urea concentration is 71.36 mg/dl, with a standard deviation 73.14. The range of urea levels spans from a minimum of 24.80 mg/dl to a maximum of 425 mg/dl. Typically, the normal range for urea falls between 5 and 20 mg/dl.

The average serum creatinine value is 2.27 mg/dl, with a standard deviation of 1.90. The observed creatinine levels vary between a minimum of 1.0 mg/dl and a maximum of 1.90 mg/dl. The normal range for serum creatinine is typically between 0.7 and 1.3 mg/dl.

Regarding sodium levels, the mean concentration is 138.49 mEq/L, with a standard deviation of 4.80. The range extends from a minimum of 113.1 mEq/L to a maximum of 146.86 mEq/L. The normal range for sodium is generally between 135 and 145 mEq/L.

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The average potassium level is 3.40 mEq/L, with a standard deviation 1.00. Potassium levels range from a minimum of 2.12 mEq/L to a maximum of 7.34 mEq/L. typically, the normal range for potassium levels falls between 3.5 and 5.3 mEq/L.
The mean concentration for chloride is 103.0 mEq/L, with a standard deviation of 4.55. The range spans from a minimum of 96.64 mEq/L to a maximum of 114.68 mEq/L. The normal range for chloride is typically between 96 and 106 mEq/L.
Lastly, the mean value of random blood sugar (RBS) is 2.77 mg/dl, with a standard deviation of 87.140. The observed RBS levels vary from a minimum of 173 mg/dl to a maximum of 510 mg/dl. Normal RBS levels generally fall between 110 and 140 mg/dl.

Table 2: Statistical Analysis of Diabetic Patients Data

Parameters	Mean	Standard Deviation	Minimum	Maximum
Urea	71.3600 mg/dl	73.14108 mg/dl	24.80 mg/dl	425.00 mg/dl
Creatinine	2.2722 mg/dl	1.90923 mg/dl	1.00 mg/dl	12.90 mg/dl
Na	138.4946 mEq/L	4.80099 mEq/L	113.81 mEq/L	146.86 mEq/L
K	3.4088 mEq/L	1.00455 mEq/L	2.12 mEq/L	7.34 mEq/L
Cl	103.0012 mEq/L	4.55660 mEq/L	96.64 mEq/L	114.68 mEq/L
RBS	277.02 mg/dl	87.140 mg/dl	173 mg/dl	510 mg/dl

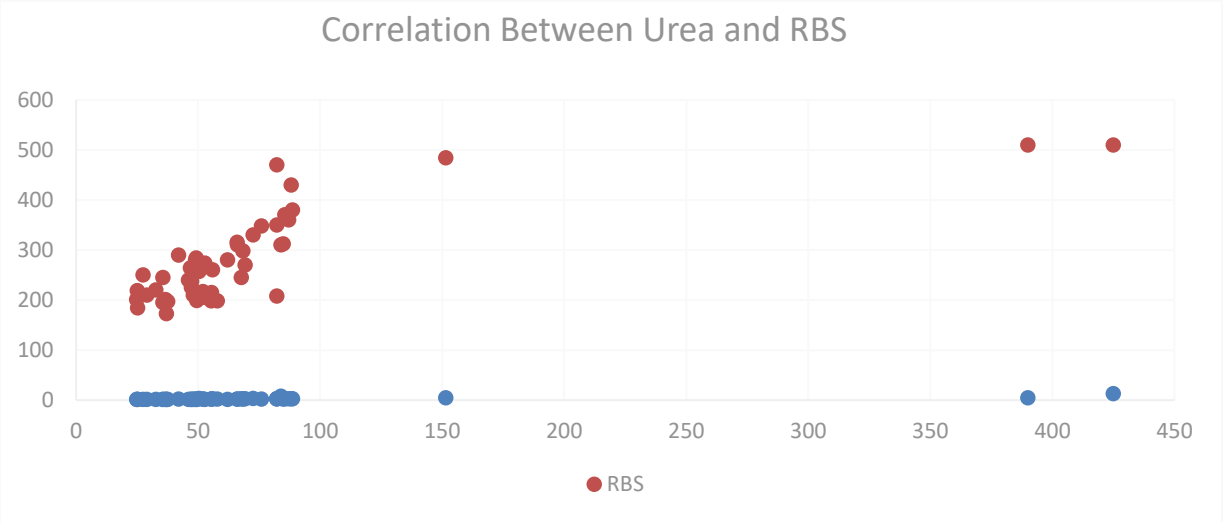

Fig 3: Correlation between Urea and RBS

Partial correlation analysis indicates that among diabetic patients, those with urea levels exceeding 400 mg/dl exhibit random blood sugar (RBS) levels around 500 mg/dl in a few cases (approximately 2 to 3 patients). Conversely, most diabetic patients with urea levels ranging between 25 mg/dl and 100 mg/dl demonstrate RBS levels falling between 200 mg/dl and 350 mg/dl. This relationship is visually represented in Figure 3.

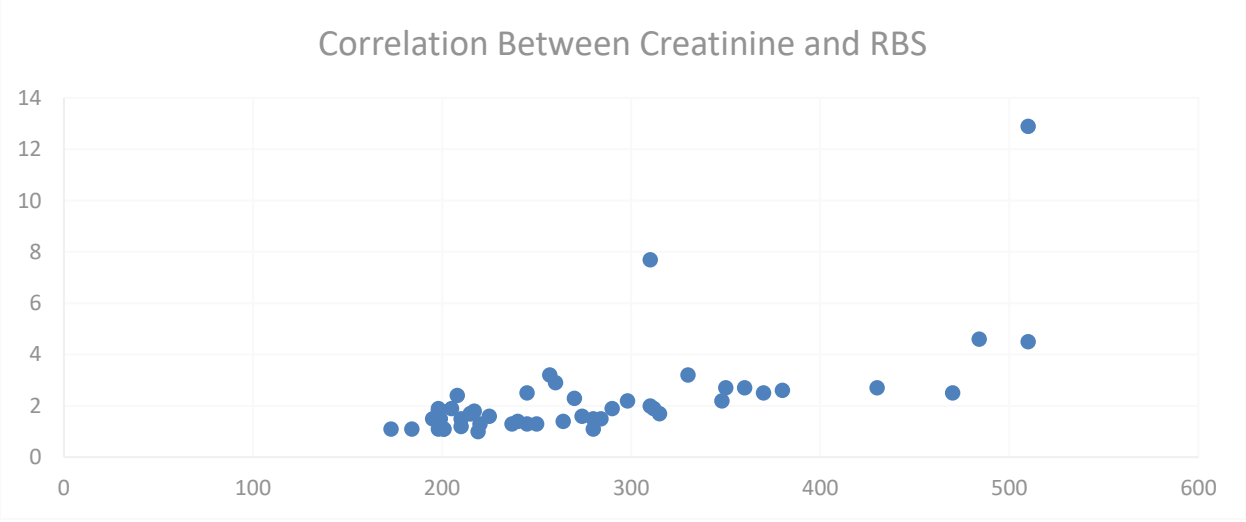

Fig 4. Correlation between Creatinine and RBS

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Partial correlation analysis reveals that among diabetic patients, those with random blood sugar (RBS) levels exceeding 500 mg/dl demonstrate creatinine values of 12 mg/dl in only one patient and another with a creatinine level of 4.5 mg/dl. In contrast, the majority of diabetic patients with creatinine levels ranging between 0.7 mg/dl and 3.7 mg/dl exhibit RBS levels between 190 mg/dl and 400 mg/dl. This association is illustrated in Figure 4

The analysis of sodium levels indicates that hyperglycemia does not exert any significant influence on its concentrations. However, the partial correlation analysis shows that 5% of individuals with hypokalemia exhibit random blood sugar (RBS) levels ranging from 200 to 300 mg/dl. Additionally, hyperchloremia is observed in 2% of patients. Nevertheless, hyperglycemia does not appear to affect most individuals with chloride levels. These findings are illustrated in Figure 5

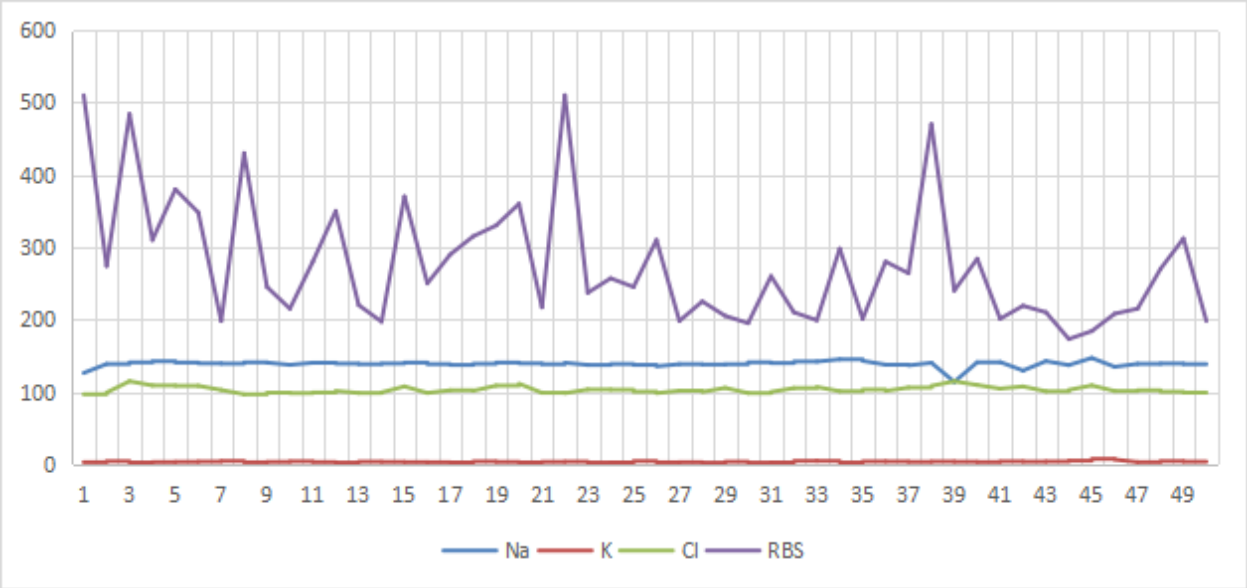

Fig 5. Correlation between Electrolytes and RBS

Discussion

Diabetes is a metabolic disorder characterised by hyperglycemia, which mainly occurs because of insufficient insulin function, insulin secretion or both. Diabetes-induced hyperglycemia is closely associated with organ dysfunction, damage or failure involving the blood vessels, heart, eyes, nerves and kidneys (13). In this study, serum K+ levels significantly increased ($p< 0.05$) in DM patients compared to ND patients, while the increase in Na+ levels was not significant ($p>0.05$). These results are consistent with previously reported studies, which have shown Na+ and K+ levels to increase in diabetic patients as a result of excessive loss of water due to osmotic diuresis (14).

The significantly lower mean level of chloride among T2DM patients compared to non-diabetics in the present study is consistent with the substantially higher chloride levels among Pakistani patients with uncontrolled T2DM (15). In the present study, serum potassium, sodium and chloride levels were not significantly correlated with the patient's age, BMI, or duration of T2DM. A similar finding was observed among Sudanese T2DM patients (16). Renal damage could also lead to electrolyte derangement, especially when the glomerulus is destroyed and fluid leaks out. Since creatinine and urea indicate the progression of renal damage, an increase in the levels of these markers may influence serum electrolyte levels (17). In our study, we have taken cases with high blood sugar levels, which indicates poor glycemic control, and this is indicative of renal nephropathy (RN). Glycemic control reflects the risk of nephropathy and other diabetic complications. An increase in urea level indicates impairment or damage to the kidney, whereas creatinine is a marker of GFR. An increase in both creatinine & urea with increased blood sugar shows damage to the kidney (18).

As our study shows, increased blood urea and serum creatinine levels clearly indicate prolonged hyperglycemia, which causes irretrievable damage to the kidney's nephrons. The tiny kidney filtering units, i.e., nephrons, are damaged due to high blood sugar levels. As the kidney's primary function is to maintain the fluid-electrolyte balance, this function is impaired. The increase in serum creatinine & blood urea is due to the diminishing GFR as the creatinine is an indirect measure of glomerular filtration and indicates reduced filtration capacity of the kidney (19).

Conclusion

The present study establishes that diabetes influences renal parameters like blood urea and serum creatinine, and urea shows much variation from their normal range than creatinine. A strong positive correlation exists between blood urea and serum creatinine with hyperglycemia. And the current study reveals that Diabetic participants showed significantly reduced potassium levels. Hyperglycemia does not affect serum sodium and chloride.

Recommendations

Our study underscores the importance of managing Diabetes Mellitus (DM) to prevent renal disorders and electrolyte imbalances. We recommend regular blood

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glucose monitoring, especially during illness or when there are severe hyperglycemia or hypoglycemia concerns. For Diabetic Kidney Disease (DKD) patients, a protein-restricted diet and regular exercise are advised for better blood sugar control. Consistent follow-up appointments with healthcare providers are essential for monitoring diabetes management, renal function, and electrolyte balance, allowing for timely interventions and adjustments to treatment plans. These measures are crucial to minimising complications and optimising health outcomes in DM and healthy individuals.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department concerned. (Dairy number AlKD-20-10-2020/196)
Consent for publication
Approved
Funding
Not applicable

Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

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Manuscript drafting.
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Study Design, Review of Literature.
Conception of Study, Development of Research Methodology Design, Study Design, manuscript Review, and final approval of manuscript.
KAMRAN KHAN
Conception of Study, Final approval of manuscript.
ABDUR REHMAN
Manuscript revisions, critical input.
SYED JAWAD ALI SHAH
Coordination of collaborative efforts.
MUHAMAD KASHIF AZAM
Manuscript drafting.
FAISAL KHAN
Data acquisition and analysis.

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